(Techno-Feasibility Report for Metro Connectivity along SPR in Between Sector 56 and Vatika Chowk, Gurugram)

SALIENT FEATURES

1. Gauge (Standard) :1435 mm

2. Route Length : 6.34 kms

3. Number of Stations : 05

4. Station Names, Chainages etc

S.No	Station Name	Chainage (Mts)	Inter-Station Distances (Mts)	Remarks
	Dead End	0.0		• (Front Reversal Facility only)
1	Sector-56*	130.30	130.30	
2	Sushant Lok	1653.10	1522.80	
3	Sushant Lok 3	3113.00	1459.90	
4	Rosewood City	4948.40	1835.40	
5	Vatika Chowk*	6229.80	1281.40	
	Dead End	6340.10	110.30	

5. Speed

a) Design Speed: 90 Km/h

b) Maximum permissible speed 80 Km/h

c) Scheduled Speed 35 km/h

6. Traffic Forecast:

RIDERSHIP SUMMARY UNDER MODERATE SCENARIO

Year	Daily Passenger Trips	PHPDT	Daily Passenger Kilometers (PKM)	Average Trip Length (km)
2025	17706	961	77907	4.4
2031	34459	1666	158511	4.6
2041	47347	2604	227264	4.8
2051	66296	4070	318221	4.8

RIDERSHIP SUMMARY UNDER OPTIMISTIC SCENARIO

Year	Daily Passenger Trips	PHPDT	Daily Passenger Kilometers (PKM)	Average Trip Length (km)
2025	19477	1057	85698	4.4
2031	37905	1833	174362	4.6
2041	52081	2864	249991	4.8
2051	72927	4477	350048	4.8

7. Traction Power Supply System: Over Head Traction (OHE)

8. Rolling Stock:

Year	2021	2031	2041	2051
Frequency (minutes)	10	7.5	5.50	4.0
No. of Train	5	6	7	9
No. of cars in each train	3	3	3	3

9. Total Estimated CAPITAL COST (at June'2019 price Level)

(i) Estimated Cost (without taxes) : Rs.1533 Cr

(ii) Taxes, GST Duties etc : Rs. 206 Cr

(iii) Total Estimated Cost (i/c taxes, GST, Duties etc) : Rs 1739 Cr

EXECUTIVE SUMMARY

0.1 INTRODUCTION

Government of Haryana has envisaged the metro connectivity along **Southern Peripheral Road (SPR)** i.e. Sector 56 Gurugram to Vatika Chowk, Gurugram (Hry) Haryana Mass Rapid Transport Corporation (HMRTC) vide their letter No. HMRTC/FO/2018/767 dated 30-11-2018 requested Delhi Metro Rail Corporation (DMRC) to prepare Techno-Feasibility Report (TFR) in respect of Metro Rail connectivity between Sector 56 Gurugram to Vatika Chowk, Gurugram along **SPR**.

DMRC vide letter No. DMRC/CE/CS/ NPR-SPR-TF/2017/280 dated 17-12-2018 submitted terms of reference (TOR) for carrying out the techno feasibility study. Consequent to acceptance of TOR, HMRTC vide their letter no. HMRTC/2019/FO/559 dated 30-05-2019 released mobilization advance and conveyed to start undertaking work for above cited feasibility study.

The proposed metro connectivity along **SPR** i.e. Sector 56 Gurugram to Vatika Chowk, Gurugram would cover areas such as Sector 56 GGN, Sushant Lok, Sushant Lok Phase 3, Rosewood City and Vatika Chowk etc.

0.1.1 EXISTING TRANSPORT SCENARIO

Roadways: The major highway that links Gurgaon is National Highway 48, the road that runs from Delhi to Mumbai. While the 28 km Delhi-Gurgaon border-Kherki Dhaula stretch has been developed as an expressway, the rest is expanded to six lanes.

Gurugram is very well connected with roads both within Intracity and Intercity. There are 115 sectors in Gurugram and other adjoining area near the city which are very well connect by roads.

Railways

Intercity Rail: Gurgaon railway station is operated by Northern Railway of Indian Railways. The rail station forms a part of the larger Indian Railways network. Along with that Gurgaon has Tajnagar railway station, Dhankot railway station, Ghari Harsaru Railway Junction and Farrukhnagar Railway Station, Patli Railway Station.

Delhi Metro Line: There are five stations served by Delhi Metro Rail Corporation Ltd. located on the Yellow Line, which are HUDA City Centre, IFFCO Chowk, MG Road, Sikanderpur and Guru Droncharya.

Rapid Metro: It has eleven stations in Gurgaon, with an interchange with Yellow Line of Delhi Metro at Sikandarpur metro station. The Rapid Metro covers a distance of 11.7 km.

Airways: Gurgaon is served by Delhi's Indira Gandhi International Airport, which is located just outside of Gurgaon city limits near National Highway 8.

Mass Rapid Transit Systems are Under Operation, Planning and Implementation in Gurugram

- Delhi-Gurugram-Alwar Corridor, NCRTC is under implementation
- Gurugram-Panchgaon Corridor, HSIIDC is under implementation
- Delhi – Gurgaon Yellow Metro Line is under operation
- Sector 56 Gurugram-Sikanderpur-Cyber City Rapid Metro, IL &FS is under operation

There are two Mass Rapid Transit System serving to Gurugram namely Delhi Metro and Rapid Metro with an interchange at Sikanderpur.

The Delhi Metro Yellow line (Samayapur Badli – HUDA CC) served with five major stations in Gurugram namely HUDA City centre, IFCCO chowk, M.G. Road, Sikanderpur and Gurudronacharya.

Rapid Metro has eleven stations in Gurugram namely Sikanderpur, DLF Phase II, Belvedere Towers, Gateway Tower, Moulsari Avenue, DLF Phase III, DLF Phase-I, Sushant Lok, Sector 53-54, AIT Chowk and Sector 55-56.

0.1.1 PROPOSED METRO ROUTE ALIGNMENT

As per accepted Terms of Reference (TOR) and various discussions, site visits, studies/surveys etc the proposed route alignment for metro connectivity in between **Sec 56 GGN and Vatika Chowk, Gurugram (Haryana)** shall be as follows:-

Table No. 0.1: Indicating route alignment of Sec 56 GGN and Vatika Chowk, Gurugram (Haryana)

S.No	Description	Length (Kms)
01	Metro Corridor along Sothern Periphery Road (SPR) in between Sec 56 GGN and Vatika Chowk, Gurugram (Haryana)	6.34 kms

0.2 TRAFFIC SURVEYS

This proposed corridor from Sector 56 GGN to Vatika Chowk has been envisaged as 6.34kms with 5 new metro stations as shown in figure:-

1. Sector 56 – Chainage – 0.1303 km
2. Sushant Lok – Chainage – 1.65 km
3. Sushant Lok 3– Chainage – 3.11 km
4. Rosewood City– Chainage – 4.95 km
5. Vatika Chowk– Chainage – 6.23 km
   Dead End- Chainage- 6.34 km

0.2.1 TRAFFIC VOLUME COUNT SURVEY INCLUDING OCCUPANCY

Classified Traffic Volume Count (TVC) Survey was carried through manual and videographic methods. TVC surveys (including occupancy surveys) provide information regarding traffic characteristics and the average Occupancy on the study corridor. Manual Classified Traffic Volume Count Surveys were undertaken at 18 identified locations across the study corridor, while videographic TVC Survey was also carried out across the same 18 locations to validate the manual count numbers. This section discusses the salient aspects of the data collated as part of the traffic volume count surveys. Manual TVC surveys were conducted for 16 hours for 1 weekday, while Videographic surveys were conducted for 24 hours for 1 weekday.

Directional classified traffic volume counts are analysed to obtain:-

1. **Average Daily Traffic (ADT)** - ADT provides an insight to the amount of traffic moving on various stretches of the corridors and is further appropriately used for assessment.

2. **Peak Hour flows** - From observing the peak hour values, the observed peak hour time, its associated traffic and also the peak hour factor the location are obtained.

3. **Directional distribution by hour of the day** -Directional distribution presents the directional split in traffic at each survey location.

4. **Traffic composition -** Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area.

In addition, Occupancy survey was carried out along with the TVC Survey wherein the mode wise occupancy values were also recorded. These in conjunction with one another are further used for the traffic assessment.

Traffic Volume counts conducted at various locations along the project corridor provided an insight to the amount of traffic moving on various stretches of the corridor. The observed average occupancy values for all passenger modes were collated to obtain an accurate estimation of passenger movement. Occupancy values were used in conjunction with the traffic volumes to estimate the prevalent passenger movement at individual survey locations. The following table presents the location wise summary of the above- mentioned survey locations. The table below the average traffic volume observed at all individual locations.

0.2.2 ORIGIN – DESTINATION SURVEY INCLUDING WILLINGNESS TO SHIFT

The Origin – Destination (OD) survey including willingness to shift was conducted to understand the existing travel pattern of the region. Origin Destination survey of passengers was conducted on stratified random sampling basis for 1 weekday (16 hours duration). To capture the travel patterns, trained enumerators were organized into multiple shifts with sufficient enumerators for each direction of flow. Passengers were surveyed for their trip origin, destination, trip purpose, occupancy, frequency etc.

0.2.3 TRIP PURPOSE

The respondents were questioned their purpose of the trip so as to have wider perspective of their reason for travel. Trip purpose information was categorized into four broad categories: Work / Business trips, Education trips, Social/ Recreational/Religious trips and others.

Looking at the trip purposes observed across all the OD survey locations, it can be seen that 44% of the respondents were travelling for Work/Business activities, while 15% were educational trips.

0.2.4 ZONING SYSTEM

Further the trip patterns were assessed with respect to the study area zoning to understand the predominant travel patterns on the corridor and the major origin-attraction zones. For the study purpose, a comprehensive zoning system was adopted consisting of 44 zones. The zoning system was developed in lieu of the administrative boundaries and road networks.

0.2.5 TRAVEL PATTERN

The collated OD data was coded to the respective Origin Destination zones and was thus assessed to understand the prominent travel patterns. Mode wise origin destination matrices were developed which was later combined to provide the overall passenger matrices.

0.3 TRAFFIC DEMAND ESTIMATION

The present study focuses on carrying out a realistic assessment of traffic on the proposed metro corridor along SPR in between Sector 56 GGN to Vatika Chowk with approximate length of about 6.34 km. Proposed Metro alignment will cater for existing population of approximate 0.42 million.

GURUGRAM (GURGAON)

Gurgaon district now named as Gurugram is adjacent to the Delhi State surrounded by Jhajjar, Rewari, Mewat, Palwal and Faridabad districts. It has both oval and

elongated shape. It has a geographical area of 1258.0 Sq.km. containing 976.65 Sq.km. of rural area and 281.35 Sq.km. of urban area. The district is having common border with Delhi State in the north.

Gurgaon City (MC) is a sub-district of Gurgaon district, having its State Headquarter in Chandigarh. There is a total of 34 villages in Gurgaon (MC). Gurgaon (MC+OG) is spread on a total area of 184.59 sq.km. with a density of approx. 5,201 persons per sq.km and inhabiting 2.1 lakh households having an average family size of 5 persons.

Gurgaon district now named as Gurugram is adjacent to the Delhi State surrounded by Jhajjar, Rewari, Mewat, Palwal and Faridabad districts. It has both oval and elongated shape. It has a geographical area of 1258.0 sq.km. containing 976.65 sq.km. of rural area and 281.35 sq.km. of urban area. The district is having common border with Delhi State in the north.

0.3.1 DEVELOPMENT OF MODEL FOR RIDERSHIP ESTIMATION

As the study was initiated in 2019, the same has been considered and demand forecasting on the network was undertaken till 2051. In order to estimate the demand on the metro corridor, all relevant data has been collated from primary and secondary sources available. The envisaged metro development has been considered for the following horizon years:

- 2025
- 2031
- 2041
- 2051

0.3.2 SCENARIO BUILDING

Scenario building is a process of analysing possible future events by considering alternative possible outcomes. Thus, scenario analysis, a method of projections, does not try to show one exact picture of the future. Instead, it presents several alternative future developments. Consequently, a scope of possible future outcomes is observable. Not only are the outcomes observable, but also the development paths leading to the outcomes. The development programs are taken from the City Development Plan and other relevant studies. Keeping the PCTR value constant, the scenarios that have been evaluated are as follows:

- Moderate Scenario – with realistic Population Growth Trend where future growth rates for the horizon years have been moderated as compare to predicted growth rates in different development plans and

- Optimistic Scenario – with Population Growth Trend as per the predicted growth rates in different development plans.

0.3.3 RIDERSHIP ESTIMATION

This section highlights the assignment details especially for public transport along with overall network loading based upon our model results. Public transport network loading represents the metro ridership separately. This is presented at aggregate level for the entire network as well as for different metro lines/ corridors. The peak hour factor has been adopted from the primary survey data.

0.3.3.1 ESTIMATION OF RIDERSHIP

Forecasted mode-wise passenger trip matrices assigned to the entire network for horizon years and assigned public transport trips have been obtained for entire network level to estimate the aggregated daily ridership on the proposed metro corridor. The aggregated demand estimated for both scenarios at an aggregated network level is given in the following tables:

Table 0.2: Proposed Corridor Ridership Summary for Moderate Scenario

Year	Daily Passengers Trips	PHPDT	Daily Passenger Kilometres (PKM)	Average Trip Length (km)
2025	17706	961	77907	4.4
2031	34459	1666	158511	4.6
2041	47347	2604	227264	4.8
2051	66296	4070	318221	4.8

Table 0.3: Proposed Corridor Ridership Summary for Optimistic Scenario

Year	Daily Passengers Trips	PHPDT	Daily Passenger Kilometres (PKM)	Average Trip Length (km)
2025	19477	1057	85698	4.4
2031	37905	1833	174362	4.6
2041	52081	2864	249991	4.8
2051	72927	4477	350048	4.8

0.4 SYSTEM SELECTION

Metro system is used in metropolitan areas to transport large number of people at high frequency. Rapid transit evolved from railways during the late 19th Century. The first system opened was the Metropolitan Railway (London) which connected most of the main railway termini around the city. The technology swiftly spread to other cities in Europe and then to United States and other parts of the world. At present, more than 160 cities have built rapid transit systems, and about twenty five have new systems under construction. The system is seen as an alternative to

an extensive road transport system with many motorways. The capital cost is high, with public financing normally required.

India is experiencing a rapid growth in both population and rate of urbanisation. Travel demand is increasing by 5% annually on average, leading to sharp increase in personal vehicles and overwhelming the limited transport infrastructure. A need was therefore felt to develop mass rapid transit systems in metro cities of India to reduce the burden on normal railways as well as road transport service providers. Major cities were facing a situation of rising population and increasing vehicles which had led to problems like congestion and pollution. To overcome these problems, Ministry of Housing and Urban Affairs took an initiative towards development of urban mass transit system by starting metro rail. Metro rail systems are operational in Delhi, Kolkata and Bangalore. Metro projects are now being executed in various cities like, Mumbai, Chennai, Hyderabad, Jaipur, Kolkata, Kochi and Lucknow etc.

0.4.1 OPTIONS FOR PUBLIC TRANSPORT SYSTEM

THE FOLLOWING SYSTEMS ARE MAINLY AVAILABLE FOR URBAN MASS TRANSIT:

(i) **Metro System**: Metro system is a grade separated dedicated system for high peak hour traffic densities exceeding 20,000 PHPDT. It is characterized by short distances of stations spaced at 1 km, high acceleration and declaration and scheduled speeds of 30-35 kmph.

(ii) **Light Rail Transit:** Modern trams-Street Cars running on Rails at grade or elevated with sharp curves of 24m radius. These are extremely popular and operating in large number of European countries. Generally the stations are spaced at 500m to 1 km and have high acceleration and deceleration characteristics. In most of the countries, they are operating at-grade with prioritized signaling at road inter-section.

(iii) **Other Rail Based Systems:** A number of options are available but have not been introduced in India. Some of these are very briefly mentioned below:-

(a) **Maglev:** This is an advanced Rail based transit system in which Magnetic Levitation is used to raise the vehicles above the rail surface. Rail wheel interaction is thus avoided and very high speeds are attainable. Maglev Levitation can either be due to attractive force or due to repulsive forces.

(b) **Linear Induction Motor (LIM) Train:** This is also an advanced Rail based transit system in which propulsion is through a Linear Induction Motor whose stator is spread along the track. The rotor is a magnetic material provided in the under frame of train. In the technology the tractive force is not transmitted through rail-wheel interaction, and so there is no limitation on account of adhesion. This technology is most appropriate for turnouts, as the height of the tunnel can be reduced to lower height of cars.

(iv) **Monorail:** Monorail trains operate on grade separated dedicated corridors with sharp curves of up to 50m radius. This is a rubber tyred based rolling stock, electrically propelled on concrete beams known as guide-ways. The system is extremely suitable in narrow corridors as it requires minimum right of way on existing roads and permits light and air and is more environmental friendly. This is prevalent in several countries for traffic densities of over 20,000 PHPDT.

(v) **Bus Rapid Transit System:** This system involves operation of buses on a dedicated corridor (except of traffic integration) at a high frequency to achieve PHPDT.

For providing a very high transport capacity say 20,000 PHPDT, about 200 buses shall be required per hour i.e., at headway of 20 seconds. Such a high PHPDT can be achieved by providing two lanes of traffic in each direction and elimination of traffic intersection on the route.

(vi) **Automated Guide way Transit System:** The term is used for systems other than conventional rail based system on grade separated guide ways. The system can be rail based or rubber tire based but fully automated guided systems with driver less operation.

0.4.2 MODE SELECTION NORMS IN INDIA

Metro Rail Policy (2017) and the Appraisal Guidelines for Metro Rail Project Proposals (September, 2017) issued by Government of India Ministry of Housing and Urban Affairs (MOHUA) mandates compulsory incorporation of Alternatives Analysis in the Detailed Project Report of Metro Rail for submitting the same to the central government while seeking central assistance.

Guidelines for adoption of various modes – During 12th Five Year Plan, a Group were formed to study various types of modes and lay down the criteria for their adoption. This Group has recommended the PHPDT and other parameters for various modes as given below:

Table 0.4: Mode Selection-Recommendation by Working Group on Urban Transport for 12th five-year plan

Mode Choice	PHPDT in 2021	Population as per 2011 census (mill.)	Av. trip length (km.)
Metro	More than 15000 in 5 Km. stretch	More than, equal to 2	More than 7-8
LRT at grade	Less than, equal to 10000	More than 1	More than 7-8
Mono Rail	Less than, equal to 10000	More than 2	About 5-6
BRT	4000-20000	More than 1	More than 5
Org. City Bus		>1 Lac, 50000 in case of hilly towns	>2 to 3

However, the above recommendations are only for guidance and the decision has to be taken case to case basis after calculating the return of the project.

0.4.3 FEASIBILITY OF OTHER SYSTEMS:

System Selection is about finding best alternative to address the transportation related problems for specific corridors or areas of a City. Detailed appraisal guidelines for mass transport project proposals have been laid down by Ministry of Housing and Urban Affairs (MoHUA), Government of India, 2017. The guideline stresses CMP to be pre-requisite for conception of mass transport projects in cities.

The guideline enables to identify the system having maximum utility and satisfy basic criteria. The policy document has listed guidelines for preparation of Comprehensive Mobility Plan (CMP), Alternatives Analysis and Detailed Project Report (DPR) for most viable alternative.

Maglev is an energy guzzler and the AGT is primarily a proprietary system. Sky train is yet on experimental stages. LRT & Mono rail system may not be viable in the present scenario.

0.4.4 MODE RECOMMENDATION FOR THE CORRIDOR:

Due to extremely low projected ridership demand in the horizon year 2025 worked out from traffic and transportation studies conducted in between Sector 56 GGN to Vatika Chowk with approximate length of about 6.34 km**,** DMRC recommends not to implement this “Stand Alone” metro project at this stage as this shall not economically and financially be viable at all. However as seen from following table in year 2025 daily boarding figure is 17,706 & PHPDT 961 for moderate scenario and for optimistic scenario daily boarding figure is 19,477 & PHPDT 1057. To meet this demand Conventional Bus /ITS enabled E-Bus System is sufficient.

Table 0.5: Projected Traffic figure under various scenario

Scenario		Moderated Scenario			Optimistic Scenario		
Target Year	Route Length (km)	Daily Ridership (Passengers)	PHPDT	Average Trip Length	Daily Ridership (Passengers)	PHPDT	Average Trip Length
2025	6.34	17706	961	4.4	19477	1057	4.4
2031	6.34	34459	1666	4.6	37905	1833	4.6
2041	6.34	47347	2604	4.8	52081	2864	4.8
2051	6.34	66296	4070	4.8	72927	4477	4.8

However Government of Haryana (GoH) vide their letter no HMRTC/2019/AO/707 dated 01/07/2019, has envisaged to run Gurugram-Faridabad direct Metro Connectivity via Southern Peripheral Road (SPR) and shall terminate the same at Vatika Chowk in Gurugram. The aforesaid Faridabad- Gurugram metro corridor shall also cover this small portion of 6.34 kms spanning in between Sec 56, GGN

and Vatika Chowk along SPR or another option is to serve Golf course extension road by way of extending the existing rapid metro from Sec 56 Gurugram to Vatika Chowk along SPR.

0.5 GEOMETRIC DESIGN

The geometrical design norms are based on international practices adopted for similar metro systems with standard gauge. The maximum operational speed for this connection will be 80 kmph and design speed of 90kmph.

The elevated tracks will be carried on box-shaped/U-shaped/Double U-girder elevated decking supported in single circular piers, generally spaced at 28m centres and located on the median of the road. The horizontal alignment and vertical alignment are, therefore, dictated to a large extent by the Geometry of the road and ground levels followed by the alignment.

0.5.1 STATION LOCATIONS

Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport.

0.5.2 TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy in view.

Two types of track structures are proposed for the corridor. The normal ballasted track in Depot (except inside the Workshops, inspection lines and washing plant lines). The ballastless track is recommended on Viaducts and inside tunnels as the regular cleaning and replacement of ballast at such locations will not be possible.

For the depots, ballasted track is recommended as ballastless track on formation is not suitable due to settlement of formations. Ballastless track in depot is required inside the workshop, on inspection lines and washing plant lines.

From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be joint-less. The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

0.5.3 RAIL SECTION

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section. Since on main lines, sharp

curves and steep gradients would be present, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T-12-2009. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the rails of grade 880 are recommended, which are available indigenously.

0.5.4 BALLASTLESS TRACK ON MAIN LINES

On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths. Further, it is proposed to adopt fastening system complying to performance criteria laid down by Indian Railways on ballastless track structures, with a base-plate spacing of 60 cm. on viaducts.

0.5.5 BALLASTLESS/BALLASTED TRACK IN DEPOT

The ballastless track in Depot may be of the following types:

- Supported on steel pedestal for inspection lines.
- Embedded rail type inside the Workshop.
- Plinth type for Washing line.
- Track is to be laid on PRC sleepers with sleeper spacing of 65 cm. All the rails are to be converted into rail panels by doing flash butt/Thermit welding.

0.5.6 ROUTE ALIGNMENT

The proposed metro corridor shall run along **Southern Peripheral Road (SPR)** in between sec-56 GGN and Vatika Chowk, Gurugram with a approximate length of 6.34 Kms with 05 new metro stations namely Sector 56 GGN, Sushant Lok, Sushant Lok Phase-3, Rosewood city and Vatika Chowk. This metro corridor originates from Sec-56 GGN. The chainage of Sec 56 metro station is considered as 130.30 mts (keeping dead end as 0.00 kms). At this point, the corridor shall provide an interchange with Sec 55-56 metro station of **Rapid Metro, Gurgaon.** The corridor further runs along SPR towards Sohna road and reaches Sushant lok metro station at chainage 1653.10 mts where it connects the areas such as Kendriya Vihar, Bahrampur, Sector 62 and Sushant Lok. The corridor further runs along SPR and passes Sushant Lok Phase-3 at chainage 3113.00 mts where it connects nearby places like Tiagra, Nangli Umarpur, Sector 50, Mayfiel Garden and Sector 65.Thereafter the corridor moves further and reaches at Rosewood City metro station at chainage 4948.40 mts where it connects nearby places like sec 49, Sec 50, sec 65 & Bahdurshahpur. The corridor now runs further along SPR and terminates at Vatika Chowk, Gurugram at chainage 6229.80 mts where it connects nearby places like Rosewood city, Sector 49 Badshahpur, Nirvana Country II, Sector 66 and Sector 69. The nearest National Highway to this proposed metro corridor is Sohna- Gurgaon Road near Vatika Chowk station location. The corridor shall provide interchange with proposed metro corridor Gurugram- Panchgaon at Vatika Chowk location. This corridor will provide connectivity to the proposed RRTS

along Southern peripheral road. The metro corridor along SPR between Sec 56 and Vatika Chowk, Gurugram has been shown in Figure 5.1.

0.5.7 INTER- STATION DISTANCES

Inter-Station distances in between proposed metro stations shall be as per Table 5 given below:-

Table 0.6: showing inter station distances

S.N	From	To	Inter-Station Distances (Mts)
01	Sector-56, GGN	Sushant Lok	1522.80
02	Sushant Lok	Sushant Lok Phase-3	1459.90
03	Sushant Lok Phase-3	Rosewood City	1835.40
04	Rosewood City	Vatika Chowk, Gurugram	1281.40
05	Vatika Chowk, Gurugram	Dead End	110.30

Figure 0.1: Showing Sector-56 Gurugram to Vatika Chowk

0.6 STATION PLANNING

PLANNING AND DESIGN CRITERION FOR METRO STATIONS

Salient features of a typical metro station are as follows:

(1) The stations can be divided into public and non-public areas (those areas where access is restricted). The public areas can be further subdivided into paid and unpaid areas.

(2) The platform level has adequate assembly space for passengers for both normal operating conditions and a recognized abnormal scenario.

(3) The platform level at elevated stations is determined by a critical clearance of 5.50 m under the concourse above the road intersection, allowing 3.00 m for the concourse height, about 2 m for concourse floor and 2.00 m for structure of tracks above the concourse. Further, the platforms are 1.09 m above the tracks. This would make the platforms in an elevated station at least 13.5 m above ground.

(4) The concourse contains automatic fare collection (AFC) system in a manner that divides the concourse into distinct areas. The 'un-paid area' is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the 'paid area', which includes access to the platforms.

(5) The arrangement of the concourse is assessed on a station-by-station basis and is determined by site constraints and passenger access requirements. However, it is planned in such a way that maximum surveillance can be achieved by the ticket hall supervisor over ticket machines, automatic fare collection (AFC) gates, stairs and escalators. Ticket machines and AFC gates are positioned to minimize cross flows of passengers and provide adequate circulation space.

(6) Sufficient space for queuing and passenger flow has been allowed at the ticketing gates.

(7) Station entrances are located with particular reference to passenger catchment points and physical site constraints within the right-of-way allocated to the MRTS.

(8) Office accommodation, operational areas and plant room space is required in the non-public areas at each station.

(9) The DG set, bore well pump houses and ground tank would be located generally in one area on ground.

(10) The system is being designed to maximize its attraction to potential passengers and the following criteria have been observed:

- Minimum distance of travel to and from the platform and between platforms for transfer between lines.
- Adequate capacity for passenger movements.
- Convenience, including good signage relating to circulation and orientation.
- Safety and security, including a high level of protection against accidents.

(11) Following requirements have been taken into account:

a. Minimum capital cost is incurred consistent with maximizing passenger attraction.

b. Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.

c. Flexibility of operation including the ability to adapt to different traffic conditions changes in fare collection methods and provision for the continuity of operation during any extended maintenance or repair period, etc.

d. Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.

e. Provision of display of passenger information and advertising.

(12) The numbers and sizes of staircases/escalators are determined by checking the capacity against AM and PM peak flow rates for both normal and emergency conditions.

(13) In order to transfer passengers efficiently from street to platforms and vice versa, station planning has been based on established principles of pedestrian flow and arranged to minimize unnecessary walking distances and cross-flows between incoming and outgoing passengers.

(14) Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit).

(15) A list of accommodation required in the non-public area at each station is given below:-

Table 0.7: Accommodation Required in Non-Public Area

Non Public Area – At Station	
Station Control Room	Cash & Ticket Room
Platform Supervisor's Booth	Fire Tank & Pump room
Station Master's Office	Staff Area
Traction Substation	UPS and Battery Room
Information & Enquiries	Cleaner's Room
Signaling Room	Security Room
Ticket Office	Staff Toilet
Communication Room	Refuse Store

Ticket Hall Supervisor & Excess Fare Collection (Passenger Office)	Miscellaneous Operations Room
Station Substation	First Aid Room

0.7 COST ESTIMATE

Metro Rail Policy 2017 requires Metro Rail Administrations and States to have a greater focus on reducing the cost of construction and operations through indigenization and fostering competition along with standardization in various areas. This is in addition to the standardization being attempted for various components of the metro rail system at the level of Central Government.

The new Metro Rail Policy and Appraisal Frame work, 2017 have brought to fore the importance of sustained cost reduction in construction and operations & maintenance, have given thumps up to systemic indigenization and "Make in India" have deliberately provided for more and more standardization with sufficient leeway for innovation.

In this connection all metro organizations should continue to work proactively on their own, in association with other institutions and more particularly in active collaboration with the Central Government for further systemic improvement and cost reduction.

Approximate cost of the corridor along **SPR in between Sec-56 GGN & Vatika Chowk** has been worked out based on the rates considered for Delhi Metro Rail Project (Phase IV) duly updated to June' 2019 price level by applying a suitable escalation factor.

While preparing this rough cost estimates, various items have generally been grouped under three major heads on the basis of:-

i) Route km. Length of alignment
ii) No. of units of that item and
iii) Item being an independent entity.

All items related with alignment, whether on elevated or at-grade construction, permanent way OHE, signaling and telecommunication, have been estimated on rate per route km basis. Cost of elevated stations includes civil work for station structures, architectural finishes, platform roofing, etc. Provisions for electrical and mechanical works, air conditioning, lifts, escalators, etc, have been worked out separately. These rates do not include cost of permanent way, O.H.E, power supply, signaling and telecommunication, automatic fare collection (AFC) installations, for which separate provisions have been made in the cost estimates. Similarly, for other items like Rolling stock, Traction & Power costs have been summed up separately.

In remaining items, viz. land, utility diversions, rehabilitation, etc the costs have been assessed on the basis of each item taken as an independent entity.

Unit rates of various items have been assessed on the basis of rates adopted in Delhi Metro's Phase IV project. A suitable escalation factor has been applied to bring these costs to June 2019 price level. GST as applicable, have been included in the cost estimates separately.

0.7.1 CAPITAL COST ESTIMATES

The overall Capital Cost for the proposed metro Corridor along **SPR** in between **Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)** estimated at June' 2019 price level, based on the above considerations without Taxes, GST and duties works out to be **Rs 1533 crores**. Taxes, GST and duties have been worked out as **Rs.206 crores**. Total cost inclusive of applicable taxes/Duties, GST will be **Rs. 1739 crores** as given below:-

Table 0.8: Estimated Cost for Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)

S.No	Description	Estimated Amount (in crores)	Taxes, Duties & GST (in crores)
01	Metro Corridor along SPR in between Sector-56 GGN and Vatika Chowk, Gurugram, Haryana	1533 cr	206 cr
		Grand Total	**1739 crores**

0.8 CONCLUSION AND RECOMMENDATIONS

Traffic and Transportation study in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana** has been done and included in this techno feasibility report which indicates total daily ridership (passengers) as 17706, 34459, 47347 & 66296 in horizon years 2025, 2031, 2041 and 2051 respectively under moderate scenario. And optimistic scenario shows the total daily ridership (passengers) as 19477, 37905, 52081 and 72927 in the horizon years 2025, 2031, 2041 and 2051 respectively. Accordingly, PHPDT is also on very low side as per details given in table below:-

Table 0.9: Showing PHPDT under moderate and optimistic scenarios

Target Year	PHPDT (under Moderate Scenario)	PHPDT (under Optimistic Scenario)
2025	961	1057
2031	1666	1833
2041	2604	2864
2051	4070	4477

0.8.1 GUIDE LINES FOR CHOICE OF MODE OF TRANSPORT

In their report on **Urban Transport for 12th Five Year Plan**, the Working Group of Urban Transport has set the guidelines for the choice of different modes is as follows:-

Table 0.10: Guidelines for Choice of Different Modes

SYSTEM	PHPDT IN 2021	POPULATIONIN 2011	AVG. TRIP LENGTH
Metro Rail #	>=15000 for at least 5km continuous length	More than 20 Lakhs	More than 7 Km
LRT primarily at grade	=<10,000	More than 10 Lakhs	More than 7 Km
Monorail @@	=<10,000	More than 20 Lakhs	About 5-6 Km
Bus Rapid Transit System	>=4,000 and upto 20000	More than 10 Lakhs	>5 Km
Organised City Bus Service as per urban bus specifications		>1 lac, >50,000 in case of hilly towns	>2 to 3 Km

 # for having Metro Rail, the city should have a ridership of at least 1 million on organized public transport (any mode)

@@ Monorail is desirable only as a feeder system or where the narrow roads are flanked on either side by high rise buildings. In monorail while the cost of construction, operation and maintenance is almost the same as elevated metro rail, the carrying capacity is much lesser.

Keeping the above guidelines of Urban Transport dett viz-a-viz PHPDT figures in view, the provision of Rail based MRTS does not appear to be justified & viable.

The overall rough Cost estimate for the Metro corridor in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana** has been formulated at June'2019 price level, based on the above considerations without Taxes, GST and duties works out to be Rs1533 crores. Taxes, GST and duties have been worked out as Rs.206 crores. Total cost inclusive of taxes & duties will be Rs.1739 crores.

Due to extremely low ridership demand/forecast in the horizon year 2025 worked out from traffic and transportation studies conducted in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana. DMRC recommends not to implement Rail based MRTS project such as metro rail, monorail, Light metro etc at this stage as this shall not be economically and socially viable at all.** In the year 2025 daily boarding figure is 17706 & PHPDT 961 for moderate scenario and for optimistic scenario daily boarding figure is 19477 & PHPDT 1057. To meet this demand Conventional Bus/ ITS enabled E-Bus System is sufficient. However, the traffic figures may be re-assessed after a gap of 05 years considering the development along this corridor.

Government of Haryana (GoH) vide their letter No. HMRTC/2019/AO/707 dated 01-07-2019, has envisaged to run Faridabad-Gurugram direct metro connectivity via Southern Peripheral Road (SPR) and shall terminate the same at Vatika Chowk in Gurugram. The aforesaid Faridabad-Gurugram metro corridor shall also cover this small portion of 6.34kms spanning in between Sec-56, GGN and Vatika Chowk along SPR. Or another option is to serve Golf Course extension road by way of extending the existing rapid metro from Sec-56 Gurugram to Vatika Chowk along SPR.

Therefore, it may not be prudent to implement this Rail based MRTS project (short spanned) as a **'Stand Alone'** metro project, which may not be justified and viable. Alternatively, this corridor could be implemented as an integral part of Faridabad- Gurugram metro corridor for which study (DPR) is being undertaken separately.

In case, decision is still taken to implement the proposal by Government of Haryana (GoH) the same may be done as a 'public project' and run on subsidy.

CHAPTER 1

INTRODUCTION

1.0 BACKGROUND

Government of Haryana has envisaged the metro connectivity along Southern Peripheral Road (SPR) i.e. Sector 56 Gurugram to Vatika Chowk, Gurugram (Hry) Haryana Mass Rapid Transport Corporation (HMRTC) vide their letter No. HMRTC/FO/2018/767 dated 30-11-2018 (Annexure-I) requested Delhi Metro Rail Corporation (DMRC) to prepare Techno-Feasibility Report (TFR) in respect of Metro Rail connectivity between Sector 56 Gurugram to Vatika Chowk, Gurugram along SPR.

DMRC vide letter No. DMRC/CE/CS/NPR-SPR-TF/2017/280, dated 17-12-2018 (Annexure-II) submitted terms of reference (TOR) for carrying out the techno feasibility study. Consequent to acceptance of TOR, HMRTC vide their letter No. HMRTC/2019/FO/559, dated 30-05-2019 (Annexure-III) released mobilization advance and conveyed to start undertaking work for above cited feasibility study.

The proposed metro connectivity along SPR i.e. Sector 56 Gurugram to Vatika Chowk Gurugram would cover areas such as Sector 56 GGN, Sushant Lok, Sushant Lok Phase 3, Rosewood City and Vatika Chowk etc.

All necessary provisions have been incorporated in this Techno-Feasibility Report in view of new Metro Policy-2017 announced by Government of India (GoI) Ministry of Housing and Urban Affairs (MoUHA) in the month of August' 2017.

1.1 A brief description of important areas in between the proposed metro connectivity i.e. along Southern Peripheral road (SPR) in between Sector 56 GGN and Vatika Chowk, Gurugram (Haryana) is given below:-

1.1.2 The **Southern Peripheral Road (SPR),** a 150 metre wide road is a part of New Gurgaon that is drawing attention of many end-users and investors. Southern Peripheral Road offers excellent connectivity to Delhi and its adjoining areas. SPR is well connected to Golf Course Road as well as NH-8 and Mehrauli Road. Besides, the existing Gurgaon-Faridabad Road is also directly linked to SPR. SPR has been declared as a national highway, which means that this stretch is

going to be maintained by the NHAI (National Highways Authority of India) and will be a six-lane expressway.

SPR includes new sectors like, 68, 69, 70, 70A, 71, 72, 73, 74, 74A, 75 & 75A. However, construction of a part of the road was stalled due to dispute between HUDA and Land owners' .Currently, the Southern Peripheral Road has a three-lane stretch for a few kilometers, after which the width reduces to two lanes. A green belt is being developed on the median of the road, making it eco-friendly. The layout plan of the new sectors lays emphasis on security, health and education. The central part of the road and the last section of SPR near Gurgaon-Sohna Road do not have proper road geometrics. The construction of the road will resume soon now and once completed, this road will provide excellent connectivity of NH-8 to Golf Course Extension road. Developers such as Unitech, DLF, Tata, Raheja Developers, Ireo, Parsvanath, BPTP, Vipul, and Emmar MGF have large tracts of land in this area. Many developers such as DLF, Tata, Unitech, BPTP and Spaze have already launched their premium projects in this location.

The 12-Km long proposed Southern Peripheral road (SPR) will connect New Gurgaon with Delhi via Golf Course Extension. Besides increasing connectivity to Delhi, the road would also reduce traffic on NH-8. It will also provide good connectivity to Faridabad through Gurgaon-Faridabad expressway.

Figure No. 1.1: Showing Southern Peripheral Road (SPR), Gurugram

Figure No. 1.2: Showing Operational SPR

1.1.3 VATIKA CHOWK, GURUGRAM

Vatika Chowk is a busy intersection as it leads commuters towards Rajiv Chowk and the Golf Course Extension Road. Hours-long jams have become normal here since the Huda cordoned off all lanes but one for concreting a stretch of the 16km SPR at Vatika Chowk, where SPR and Sohna Road intersect.

The under-construction 16km SPR starts from Ghata near Gurgaon-Faridabad Road and ends at the Kherki Daula toll on National Highway 8 (NH-8). It connects the Golf Course Road with NH-8. Its completion is bound to add more vehicles to the Vatika Chowk intersection, thereby affecting Sohna Road.

Vatika City in Sector 49, is one such premium project. It is one of the largest ever group housing development project in the region and it stretches across a massive 34 acres. It has a total of 1400 units to be launched in July 08. The flats are all ready to move in but are available only on resale. The size of the apartment would be disclosed to the prospective buyer only on resale. There are both 3 and 4 BHK flats but the details about price and size would be disclosed on request. The reason why this area is so much in demand is because it provides easy access to shops, markets, shopping malls, cinemas, parks, schools, fitness

centers, banks, hotels and more, making it a hub towards which all modern families are being attracted. Located on Sohna Road, the region is close to the Delhi and yet there is no pollution and hazards that plague the city dwellers.

Vatika City is an ultimate reflection of the urban chic lifestyle located in Sector 49, Gurgaon. The project hosts in its lap exclusively designed Residential Apartments, each being an epitome of elegance and simplicity.

About Locality: Located at Sector 49 in Gurgaon, Vatika City is inspiring in design, stirring in luxury and enveloped by verdant surroundings. Vatika City is in troupe with many famous schools, hospitals, shopping destinations, tech parks and every civic amenity required, so that you spend less time on the road and more at home.

About Builder: Vatika City is engineered by internationally renowned architects of Vatika Group. The Group has been involved in producing various residential and commercial projects with beautifully crafted interiors as well as exteriors.

Units and Interiors: Vatika City comprises of 2 BHK, 3 BHK and 4 BHK Apartments that are finely crafted and committed to provide houses with unmatched quality. The Apartments are spacious, well ventilated and Vastu compliant.

Amenities and security features: Vatika City offers an array of world class amenities such as Apartments. Besides that proper safety equipments are installed to ensure that you live safely and happily with your family in these apartments at Sector 49.

Figure No.1.3: Indicating SPR, Sohna Road & Vatika Chowk, Gurugram on Google Map

Figure No.1.4: Showing Vatika Chowk, Gurugram

1.1.4 ROSEWOOD CITY, GURUGRAM

The project is a planned township spread across 115 acres. Rosewood City is fully equipped with all modern features. The place gives all civic amenity, apart from peace and luxury. The project is located on the Gurgaon-Sohna Road, Rosewood City is well within the dazzling precincts of Gurgaon.

Rosewood Town, some sort of painstakingly designed township distributed around 115 acres build by Eros group. It provides 2BHK residential plots with covered area of around 540 sq. feet to 4770 sq. feet. Rosewood Town is actually fully furnished with some sort of College, Shopping Middle, Playing golf Tennis courts, Club and also regularly. The following you can find just about every civic amenity, apart from tranquility and also extravagance. You will discover attractively manicured parks like Hyde Playground and also Victoria Playground where by you and your family could drain in to the joy of your peaceful existence. Universities and also practices tend to be nearby as well as the other gratification of outstanding existence really are a breathing aside. Located on the Gurgaon-Sohna Path, Rosewood Town is actually inside the sizzling precincts of Gurgaon. The main features in this venture are generally in which Rosewood City is actually an integral part of this kind of many taking place local community associated with Delhi, which is the option in the high level course. It's merely 15-20 a few minutes far from IGI International airport. In a nutshell, it promises a person of your life-style that is certainly uncompromised in addition to unmatched.

Eros Rosewood Villas are premium residential villas developed as a part of Rosewood City in sector-49, Gurgaon. The residency offers an environment of luxury and exclusivity with its creative designing and innovative architecture. Eros Rosewood Villas provides well planned luxury villas equipped with international standard facilities and modular specifications. Located in a prime residential location in Gurgaon, Eros Rosewood Villas are well connected to various commercial, healthcare and educational facilities in the area.

Figure No.1.5: Showing Rosewood City Project

1.1.5 SUSHANT LOK (PHASE 3), GURUGRAM

Sushant Lok 3 is a residential project by Reputed Builder that offers 3 BHK apartments in Sector 57, Gurgaon. Sector 57 is connected to the city via road and railway. Gurgaon Railway Station is at a distance of 12.6 kilometers and the Indira Gandhi International Airport is at a distance of 19.8 kilometers. This sector is home to a number of well-known educational institutions, hospitals and banks. This sector also hosts the presence of many shopping centers and recreational venues. Sushant Lok 3 is in close proximity to many ATMs, petrol pumps, shopping malls, office complexes, supermarkets etc. catering to all your daily needs.

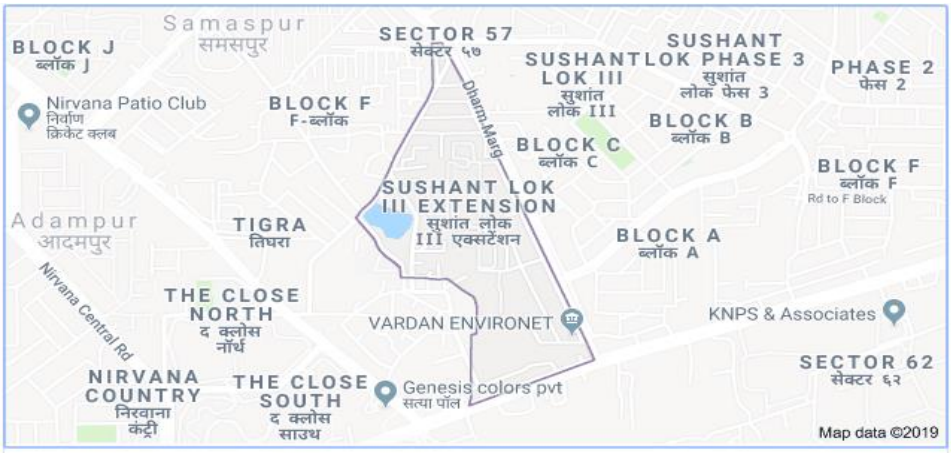


Figure No.1.6: Indicating the location of Sushant Lok (Phase 3)

1.1.6 SUSHANT LOK (PHASE I), GURUGRAM

Sushant Lok Phase I is a small part of Sector 43, located to the west of the city of Gurgaon in the state of Hayrana, to the north of Kanahi district. It includes small residential areas and a few industrial zones. There is a primary school, a small public park and two hotels in Sushant Lok Phase I.

Sushant Lok 1 is a one of a kind development and is amongst one of the most beautiful townships in the Gurgaon. Sushant Lok I include three blocks A, B and C. Sushant Lok I block A is located near MG Road Metro Station Gurgaon in Sector 27 & 28. ITC Laburnum is one of the landmarks in block A. Block B is located near the galleria market DLF Phase 4 and part of Sector 43. Max Hospital, Marriot Courtyard & Park Plaza Hotels are located in Sushant Lok I, Block B. This block is located in the South. Latitude and longitude coordinates are: 28.463531, 77.076950.

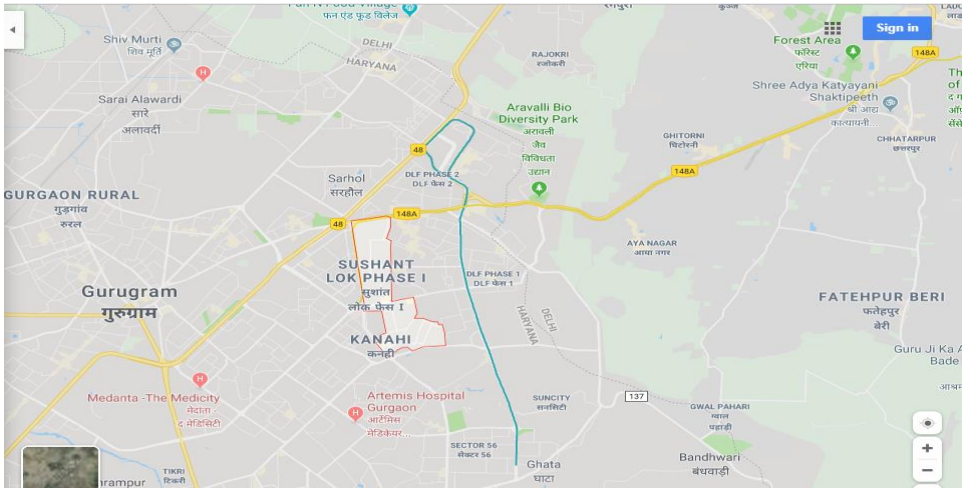


Figure No.1.7: Indicating the location of Sushant Lok (Phas I), Gurugram

1.1.7 SECTOR 56 (HUDA), GURUGRAM

Sector 56 is a locality in Gurgaon City in Haryana State, India. It is belongs to Gurgaon Division. Sector 56 Pin code is 122011 and postal head office is Gurgaon Sector 56. Sector 56 in Gurgaon is one of the oldest sectors. It was established when the early service class professionals started migrating and settling in Gurgaon due to many offices and commercial hubs springing up here. Today, this sector is thriving with many residential colonies, local markets and eateries. The HUDA market of Sector 56 is a popular hub for local eateries and shopping. Sector-56 is one of the oldest residential sectors of Gurgaon. Situated at the end of the Golf Course Road and adjacent to the Golf Course Extension Road. It is very well connected by public transport as well as autos. The rapid metro, under construction and the metro from Huda City Centre will make it the best connected sector. There are a number of very prestigious schools in the vicinity. Plenty of shopping centers are available for all kinds of requirements. The best medical facilities in terms of hospitals and clinics are available in or very close to the sector.

The sector does not have any new residential projects coming up. However, it is still popular among temporary residents due to its lower rental values as compared to its neighboring areas. The rental value ranges between Rs 8000 to 40000 per month. Multistorey apartments and residential houses are the main types of housing available for rent. The capital value of properties ranges between Rs 85 lakh and Rs 4 crore. Unlike the new multi-storey apartments across NCR, the housing units here are comparatively older in construction and do not have modern amenities such as gymnasium or swimming pool. Amenities such as tennis and squash courts and grocery stores are at a close proximity to the residential societies. They are priced economically compared to the new high rises. As a result, people living here enjoy the same facilities while paying lower rental value.

Another reason behind the popularity of the sector is the presence of a number of schools and hospitals within a 7 to 10 minutes drive from the locality. Tao Devi Lal Park, adjacent to the sector, gives children, senior citizens and families, a green space to relax in. Sector 56 also has a police station near the HUDA market.

In terms of connectivity, Sector 56 scores high as it is well connected to the Golf Course Extension Road and Golf Course Road. HUDA Metro Station is 15 minutes away from the sector. Autos, taxis and buses connect the sector with other parts of Gurgaon.

Sector 56 is a good locality situated within a 15 minute drive from the HUDA city metro station along NH 8 connecting Delhi and at a 30 minute drive from Indira Gandhi International Airport. This locality is dominated by CGHS societies but also has some plotted and commercial development.

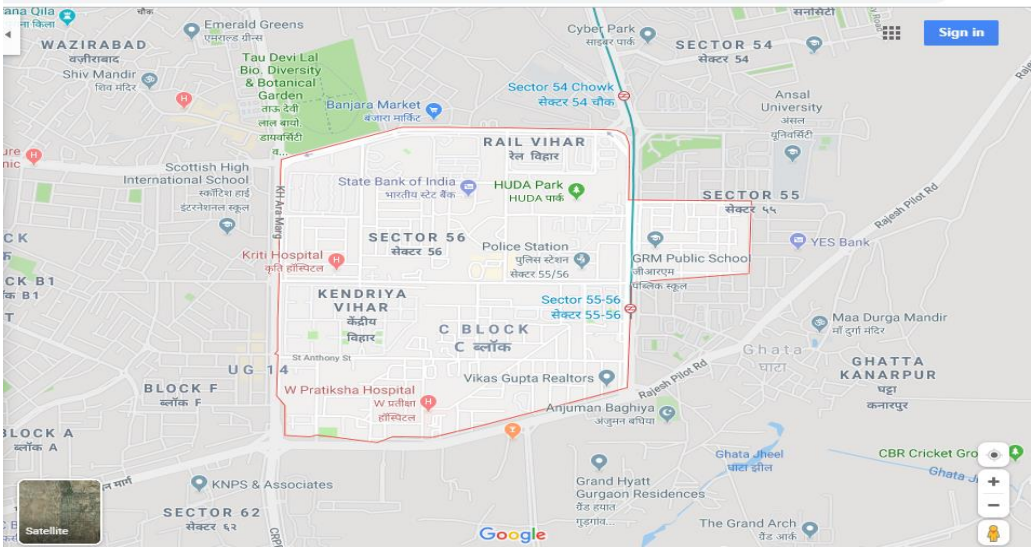


Figure No.1.8: Indicating the location of Sector 56 (HUDA),Gurugram

1.1.8 EXISTING TRANSPORT CHARACTERISTICS

Roadways: The major highway that links Gurgaon is National Highway 48, the road that runs from Delhi to Mumbai. While the 28 km Delhi-Gurgaon border-Kherki Dhaula stretch has been developed as an expressway, the rest is expanded to six lanes.

Gurugram is very well connected with roads both within Intracity and Intercity. There are 115 sectors in Gurugram and other adjoining area near the city which are very well connect by roads.

Railways

Intercity Rail: Gurgaon railway station is operated by Northern Railway of Indian Railways. The rail station forms a part of the larger Indian Railways network. Along with that, Gurgaon has Tajnagar railway station, Dhankot railway station, Ghari Harsaru Railway Junction and Farrukhnagar Railway Station, Patli Railway Station.

Delhi Metro Line: There are five stations served by Delhi Metro Rail Corporation Ltd. located on the Yellow Line, which are HUDA City Centre, IFFCO Chowk, MG Road, Sikanderpur and Guru Droncharya.

Rapid Metro: It has eleven stations in Gurgaon, with an interchange with Yellow Line of Delhi Metro at Sikandarpur metro station. The Rapid Metro covers a distance of 11.7 km.

Airways: Gurgaon is served by Delhi's Indira Gandhi International Airport, which is located just outside of Gurgaon city limits near National Highway 8.

Mass Rapid Transit Systems are Under Operation, Planning and Implementation in Gurugram

- Delhi-Gurugram-Alwar Corridor, NCRTC is under implementation
- Gurugram-Panchgaon Corridor, HSIIDC is under implementation
- Delhi – Gurgaon Yellow Metro Line is under operation
- Sector 56 Gurugram-Sikanderpur-Cyber City Rapid Metro, IL &FS is under operation

There are two Mass Rapid Transit System serving to Gurugram namely Delhi Metro and Rapid Metro with an interchange at Sikanderpur.

The Delhi Metro Yellow line (SamayapurBadli – HUDA CC) served with five major stations in Gurugram namely HUDA City centre, IFCCO chowk, M.G. Road, Sikanderpur and Gurudronacharya.

Rapid Metro has eleven stations in Gurugram namely Sikanderpur, DLF Phase II, Belvedere Towers, Gateway Tower, Moulsari Avenue, DLF Phase III, DLF Phase-I, Sushant Lok, Sector 53-54, AIT Chowk and Sector 55-56.

1.1.9 PROPOSED METRO ROUTE ALIGNMENT

As per accepted Terms of Reference (TOR) and various discussions, site visits, studies/surveys etc the proposed route alignment for metro connectivity in between Sec 56 GGN and Vatika Chowk, Gurugram (Haryana) shall be as follows:-

Table No. 1.1: Indicating route alignment of Sec-56 GGN and Vatika Chowk

S.No	Description	Length (Kms)
01	Metro Corridor along Sothern Periphery Road(SPR) in between Sec 56GGN and Vatika Chowk, Gurugram (Haryana)	6.34 kms

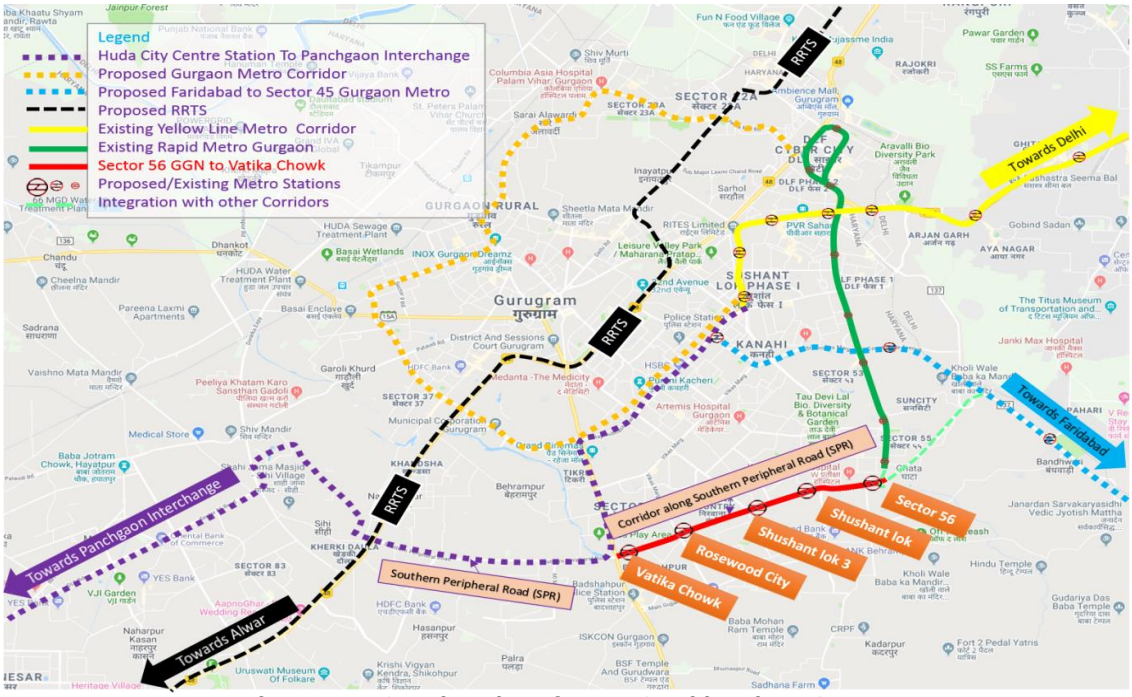


Figure No.1.9: Index Plan of Metro Corridor along SPR

1.2 STRUCTURE OF TECHNO- FEASIBILITY REPORT (TFR)

The Techno- Feasibility Report (TFR) for Metro Corridor along Southern Periphery Road (SPR) in between Sec 56 GGN and Vatika Chowk, Gurugram (Haryana) includes the following Chapters:-

1) Chapter -1: Introduction
2) Chapter-2: Traffic Study
3) Chapter-3: Traffic Demand Estimation (using Modelling)
4) Chapter-4: System Selection
5) Chapter-5: Geo-metrical Design
6) Chapter-6: Station Positions and Planning Parameters
7) Chapter-7: Cost Estimate
8) Chapter-8: Conclusion and Recommendations

Annexure-I

HARYANA MASS RAPID TRANSPORT CORPORATION LIMITED
Regd. office: C-3, HSVP Complex, Sector 6, Panchkula

Telephone no: 0172-2563003 **Email: adphmrtc@gmail.com**
CIN No: U60200HR2012SGC045471 **Website: www.hmrtc.org**

Letter No. HMRTC/FO/2018/767 **Dated: 30.11.2018**

To

The Managing Director,
Delhi Metro Rail Corporation Ltd.
Metro Bhawan,
Fire Brigade Lane, Barakhamba Road,
New Delhi-110001

Subject: Regarding Metro Connectivity along SPR (Sector 56, GGN to Vatika Chowk).

1. This has reference to your office letter dated 26.03.2018 vide which you have sent the revised ToR for the preparation of Techno feasibility Report for Metro Corridors along NPR & SPR, Gurugram. ToR was forwarded to MoHUA for the approval.
2. It is informed that MoHUA has approved the ToR for preparation of Techno feasibility Report of NPR portion in relation to the Metro Connectivity from Badsa (AIIMS & NCI Connection) to Dwarka (via NPR). Accordingly, you were requested to prepare the Techno Feasibility Study of this project vide letter dated 29.10.2018.
3. MOHUA has requested to send separate ToR for the preparation of Techno feasibility Report for SPR portion only.
4. It is, therefore, requested to send ToR for preparation of Techno feasibility Report of the SPR portion only at the earliest.

30/11/18
Advisor (Planning)
HMRTC

Annexure-II

SPEED Post

CIN No. U74899DL 1995G0I068150

दूरभाष Tel. : 23417910/12
फैक्स Fax : 23417921

दिल्ली मेट्रो रेल कॉर्पोरेशन लि०
DELHI METRO RAIL CORPORATION LTD.
(भारत सरकार एंव दिल्ली सरकार का संयुक्त उपक्रम)
(A JOINT VENTURE OF GOVERNMENT OF INDIA AND GOVT. OF DELHI)

DMRC/CE/CS/NPR-SPR-TF/2017/280

17 -12-2018

The Managing Director
Haryana Mass Rapid Transport Corporation Ltd
C-3, HUDA Complex
Sector-6, Panchkula-134109

Subject:- 'TOR' for preparation of Techno Feasibility Report for Metro Corridor along SPR in between Sector 56 GGN and Vatika Chowk ,Gurugram (Haryana)

Ref : Your letter no HMRTC/FO/2018/767 dated 30-11-2018

Sir,

In reference to your office letter dated 30-11-2018, enclosed herewith please find 'Terms of Reference(TOR)' for preparation of Techno Feasibility Report for Metro Corridor **along SPR in between Sector 56 GGN and Vatika Chowk ,Gurugram (Haryana).** The total tentative length of the metro corridors shall be 6.30 Kms. Index Plan showing proposed metro corridor along SPR in between Sector 56 GGN and Vatika Chowk, Gurugram(Haryana) is enclosed herewith.

It is, therefore, requested to communicate your acceptance of 'TOR' at an early date so that the work could be started accordingly.

Thanking you,

Encls:- 'TOR'

Yours Faithfully,

(T.Gupta)
Chief Engineer/CS-I

Annexure-III

HARYANA MASS RAPID TRANSPORT CORPORATION LIMITED
Regd. office: C-3, HSVP Complex, Sector 6, Panchkula

Telephone no: 0172-2563003 **E-mail: adphmrtc1@gmail.com**
CIN No:U60200HR2012SGC045471 **Website: www.hmrtc.org.in**

Letter No.: HMRTC/2019/FO/559 **Dated:** 30/05/2019

To

Managing Director,
Delhi Metro Rail Corporation Ltd.
Metro Bhawan,
Fire Brigade Lane, Barakhamba Road,
New Delhi-110001

Subject: Consultancy fee for preparation of Techno Feasibility for Met Connectivity along SPR (Sector 56, GGN to Vatika Chowk).

1. It is informed that an amount of Rs.18,52,404/- after deduction of TDS of R 31,938/- regarding mobilisation advance has been deposited in your OBC ba account number 05021131002591 on 29.05.2019.
2. This is for your information and further necessary actions, please.

Advisor (Planning)
HMRTC

CHAPTER 2

TRAFFIC SURVEYS

2.0 BACKGROUND

The Government of Haryana has envisaged a metro corridor along SPR in between **Sector 56 GGN to Vatika Chowk** with approximate length of about 6.34kms.The present study explores the traffic feasibility of the said corridor. This proposed corridor from Sector 56 GGN to Vatika Chowk has been envisaged as 6.34kms with 5 new metro stations as shown in figure:-

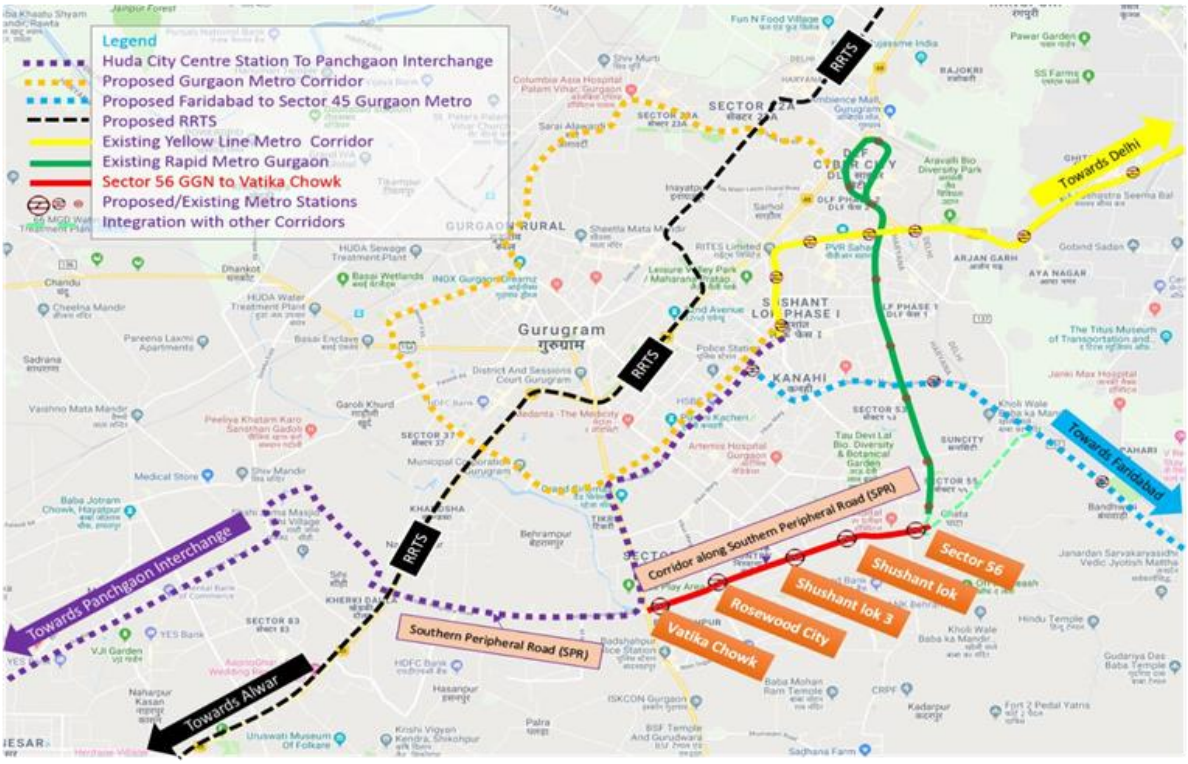


Figure 2.1: Representation of the Proposed Metro Corridor

- Sector 56 – Chainage – 0.1303 km
- Sushant Lok – Chainage – 1.65 km
- Sushant Lok 3– Chainage – 3.11 km
- Rosewood City– Chainage – 4.95 km
- Vatika Chowk– Chainage – 6.23 km
- Dead End- Chainage- 6.34 km

The above mentioned chainages are considering starting Chainage 0.0 Km for proposed Sector 56 metro station just adjacent to existing Sector 55-56 rapid metro Corridor.

2.1 PRIMARY SURVEY

Relevant primary surveys as mentioned in the table below were conducted in the month of June & July 2019 as per the terms of reference of the study so as to gain an understanding of the traffic and transportation characteristics of the study area. This chapter discusses the major findings of the primary surveys carried out as part of the study.

Table 2.1: Summary of Primary Survey

Name of Components	Duration/ Samples	Quantity
Traffic Volume Count including Occupancy Survey	16 hours for 1 Weekday	2
Passenger Entry-Exit Count Survey	16 hours for 1 Weekday	2
Traffic Volume Count -Videography	24 hours for 1 Weekday	2
Road side OD Survey including Willingness to Pay Survey	16 hours for 1 Weekday	2
Speed and Delay by Moving Car Observer Method	Morning and Evening Peak	2

Category-wise Primary Survey locations are listed in the following table and the survey location map is also presented below:-

Table 2.2: Primary Survey Locations

Type of Survey	Location ID	Location Name
Traffic Volume Count including Occupancy	L1	Sothern Peripheral Road near Vatika City
	L2	Sothern Peripheral Road near Ghata Chowk
Video graphic Traffic Volume Count	L1	Sothern Peripheral Road near Vatika City
	L2	Sothern Peripheral Road near Ghata Chowk
Origin-Destination Survey with Willingness to Shift	L1	Sothern Peripheral Road near Vatika City
	L2	Sothern Peripheral Road near Ghata Chowk

Terminal Survey	L3	Gurgaon Railway Station
	L4	Gurgaon Bus Terminal

*Note: * Passenger Entry-Exit Volume Count at Terminal*

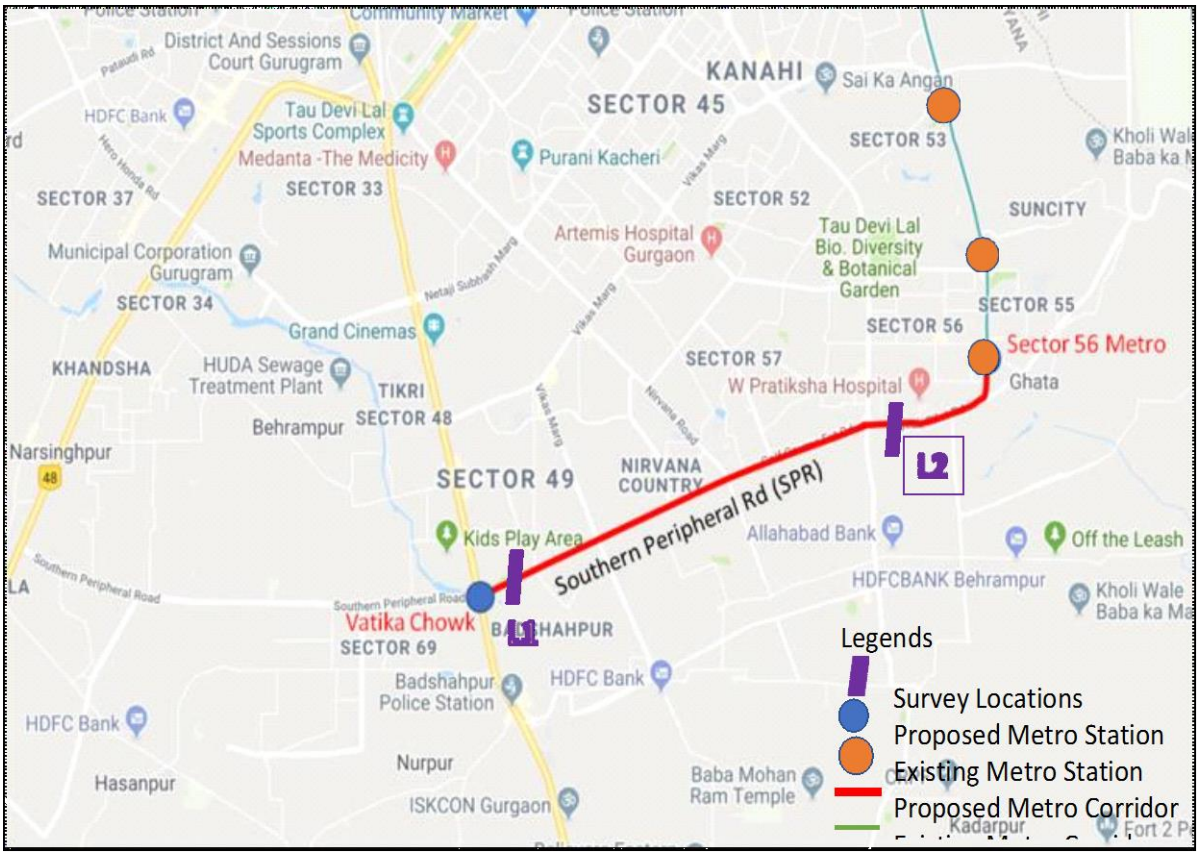


Figure 2.2: Representation of the Location of Survey on Map

2.2 TRAFFIC VOLUME COUNT SURVEY INCLUDING OCCUPANCY

Classified Traffic Volume Count (TVC) Survey was carried through manual and videographic methods. TVC surveys (including occupancy surveys) provide information regarding traffic characteristics and the average Occupancy on the study corridor. Manual Classified Traffic Volume Count Surveys were undertaken at 18 identified locations across the study corridor, while videographic TVC Survey was also carried out across the same 18 locations to validate the manual count numbers. This section discusses the salient aspects of the data collated as part of the traffic volume count surveys. Manual TVC surveys were conducted for 16 hours for 1 weekday, while Videographic surveys were conducted for 24 hours for 1 weekday.

Directional classified traffic volume counts are analysed to obtain:-

1. **Average Daily Traffic (ADT)** - ADT provides an insight to the amount of traffic moving on various stretches of the corridors and is further appropriately used for assessment.

2. **Peak Hour flows** - From observing the peak hour values, the observed peak hour time, its associated traffic and also the peak hour factor the location are obtained.

3. **Directional distribution by hour of the day** -Directional distribution presents the directional split in traffic at each survey location.

4. **Traffic composition -** Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area.

In addition, Occupancy survey was carried out along with the TVC Survey wherein the mode wise occupancy values were also recorded. These in conjunction with one another are further used for the traffic assessment.

Traffic Volume counts conducted at various locations along the project corridor provided an insight to the amount of traffic moving on various stretches of the corridor. The observed average occupancy values for all passenger modes were collated to obtain an accurate estimation of passenger movement. Occupancy values were used in conjunction with the traffic volumes to estimate the prevalent passenger movement at individual survey locations. The following table presents the location wise summary of the above- mentioned survey locations. The table below the average traffic volume observed at all individual locations.

Table 2.3: Traffic Volume Summary at Identified Locations (16 -hour volumes)

Location ID	L1	L2
Location Name	Sothern Peripheral Road near Vatika City	Sothern Peripheral Road near Ghata Chowk
Two Wheeler	7853	13981
Auto	3071	2874
Car/Jeep/Van/Taxi	30608	41376
Mini Bus	50	180
Standard Bus	30	7
Chartered Bus	102	164
Total Passenger Vehicles	41714	58582
Total Passenger PCUs	38077	52024
Total Passenger	110835	144721
Directional Split (Towards Vatika Chowk : Towards Sector 56 Metro)	54:46	53:47

The Passenger Car Unit (PCU) values adopted for the study are provided in the following table.

Table 2.4: PCU Values Adopted for the Study

Type	Two-Wheeler	Three-Wheeler	Car/ Jeep/ Van/Taxi	Mini Bus	Standard Bus
PCU	0.5	1	1	1	3

In addition, occupancy survey was also carried out along with TVC Survey. The location wise occupancy details are provided in the following table, wherein mode wise observed average occupancy values are listed.

Table 2.5: Occupancy Survey Summary

Location ID	Location Name	Two-Wheeler	Three-Wheeler	Car / Jeep / Van / Taxi	Mini Bus	Standard Bus	Chartered Bus
L1	Sothern Peripheral Road near Vatika City	1.52	2	2.88	17.64	28.36	28.17
L2	Sothern Peripheral Road near Ghata Chowk	1.61	1.86	2.63	15.38	31.44	30.85
Average Occupancy		**1.57**	**1.93**	**2.75**	**16.51**	**29.9**	29.51

The observed average Passenger values for all passenger modes were collated to obtain an accurate estimation of passenger movement. Occupancy values were used in conjunction with the traffic volumes to estimate the prevalent passenger movement at individual survey locations. The following table presents the location wise summary of the above-mentioned survey locations.

2.3 VEHICULAR COMPOSITION

Classified Traffic Volume Counts also provides valuable insight into the vehicular composition of the traffic in the study area. The overall composition is expressed in Figure. Vehicular composition recorded during the traffic volume study shows that majority of the traffic comprises of Car/Jeep/Van/Taxi (73.4%) and Two-Wheelers (18%). Buses recorded the least negligible share of less than 1 %.

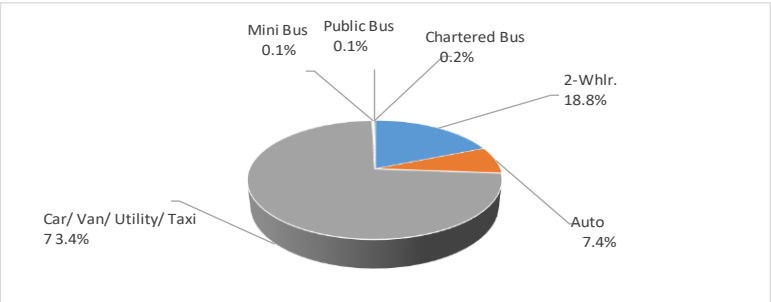


Figure 2.3: Vehicular Composition

2.4 PEAK HOUR FLOWS

Peak Hour and peak hour characteristics (Peak Hour PCU, Peak Period Factor) obtained during the 16 hours TVC survey are listed in the following table.

Table 2.6: Peak Hour, Peak Hour PCU and Peak Hour Factor Summary

Location ID	Location Name	Peak Hour	Peak Hour PCU	Peak Hour Factor w.r.t. 16 Hour PCU
L1	Sothern Peripheral Road near Vatika City	17:45-18:45	4303	11.30
L2	Sothern Peripheral Road near Ghata Chowk	17:45-18:45	4931	9.47

The average peak hour share across the nine survey locations is 10.50%. In addition to aggregate TVC estimates, other aspects of traffic were also covered through the survey viz. Traffic composition, hourly variation, intraday variation, peak hour traffic and peak hour characteristics, directional distribution of traffic etc Location wise detailed analysis of the collated TVC data, covering all the above discussed parameters are provided in Traffic & Transportation Study Report.

2.5 PASSENGER ENTRY-EXIT COUNTS AT TERMINAL LOCATIONS

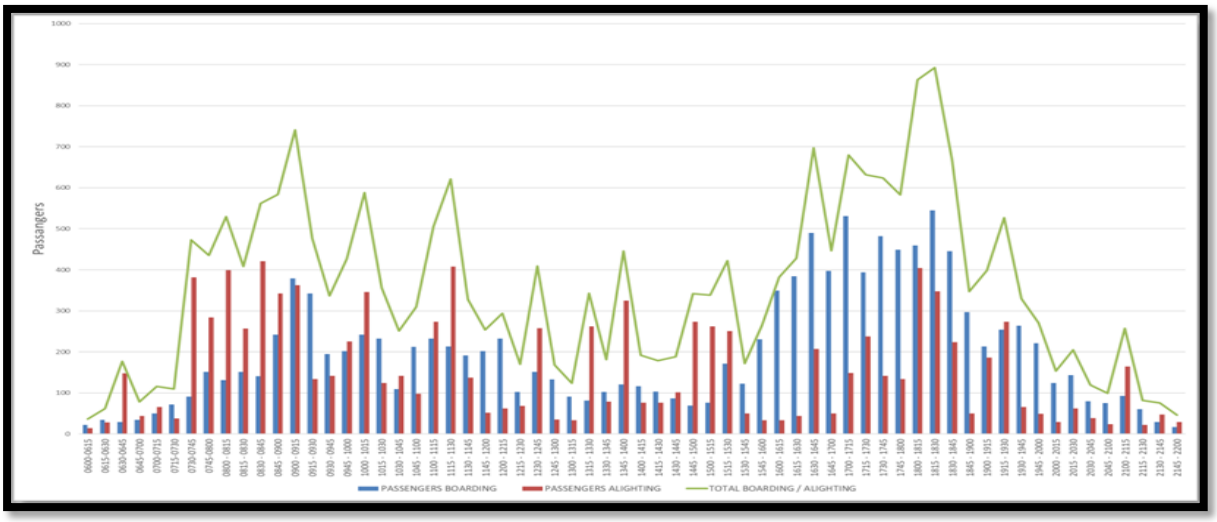
To understand the number of daily passengers contributing to major Terminal location within the catchment area, 16 hours entry exit counts has been conducted for the Terminal location namely “Gurgaon Railway Station” and “Gurgaon Bus Terminal”.

Hourly entry-exit passenger numbers collated at the above-mentioned Terminal has been analyzed to understand 16 hours as well as hourly passenger load, also the peak hour passengers has been identified at each of the above terminal. Entry-Exit summary of this Terminal location and its details are presented in the below Table and figure:

Table 2.7: Summary of Passenger Entry-Exit Counts at Terminal Locations

Location ID	Location Name	Entry	Exit	Total Passenger	Peak Hour Passenger	Peak Hour	Peak Hour Factor
L3	Gurgaon Railway Station	12682	10123	22805	3008	1745 - 1845	13.9
L4	Gurgaon Bus Terminal	8132	6330	14462	2011	1700 - 1800	13.91

HOURLY VARIATIONS OF PASSENGER ENTRY-EXIT AT RAILTERMINAL



HOURLY VARIATIONS OF PASSENGER ENTRY-EXIT AT BUS TERMINAL

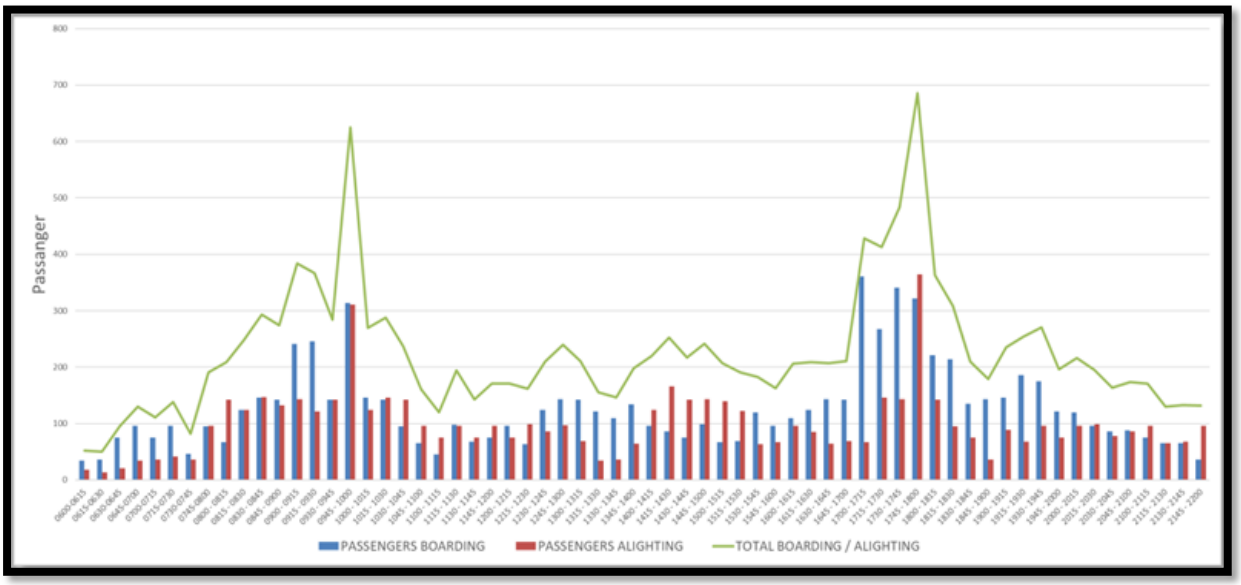


Figure 2.4: Hourly Variations of Passenger Entry-Exit at Different Terminal Locations

2.6 ORIGIN – DESTINATION SURVEY INCLUDING WILLINGNESS TO SHIFT

The Origin – Destination (OD) survey including willingness to shift was conducted to understand the existing travel pattern of the region. Origin Destination survey of passengers was conducted on stratified random sampling basis for 1 weekday (16 hours duration). To capture the travel patterns, trained enumerators were organized into multiple shifts with sufficient enumerators for each direction of flow. Passengers were surveyed for their trip origin, destination, trip purpose, occupancy, frequency etc.

2.6.1 TRIP PURPOSE

The respondents were questioned their purpose of the trip so as to have wider perspective of their reason for travel. Trip purpose information was categorized into four broad categories: Work / Business trips, Education trips, Social/ Recreational/Religious trips and others.

Looking at the trip purposes observed across all the OD survey locations, it can be seen that 44% of the respondents were travelling for Work/Business activities, while 15% were educational trips.

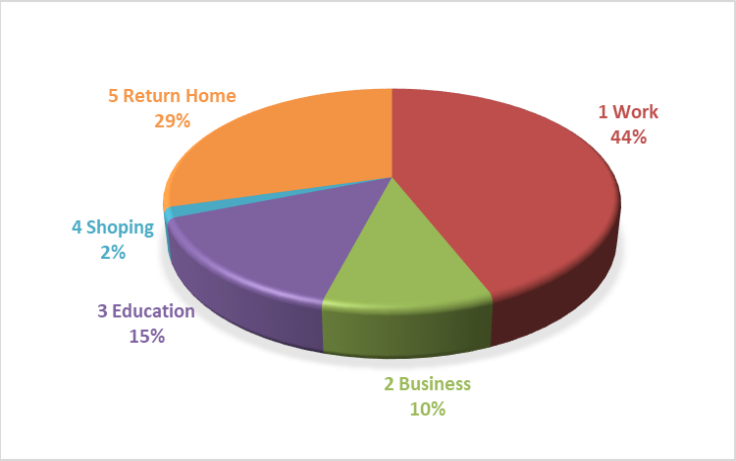


Figure 2.5: Trip Purpose

2.6.2 ZONING SYSTEM

Further the trip patterns were assessed with respect to the study area zoning to understand the predominant travel patterns on the corridor and the major origin-attraction zones. For the study purpose, a comprehensive zoning system was adopted consisting of 44 zones. The zoning system was developed in lieu of the administrative boundaries and road networks. Indicative zone map and zone list for the proposed corridor is provided below:

Table 2.8: List of Locations under Each Zone

Zone	Place/Region	Zone	Place/Region
1	Sector 73	23	Sector 52
2	Sector 60	24	Sector 50
3	Sector 68	25	Sector 49
4	Sector 69	26	Sector 72
5	Sector 48	27	Sector 71
6	Sector 70	28	Sector 74
7	Sector 75	29	Sector 34
8	Sector 67	30	Sector 35
9	Sector 66	31	Sector 33
10	Sector 65	32	Sector 47

11	Sector 64	33	Sector 46
12	Sector 63	34	Sector 45
13	Sector 62	35	Sector 43
14	Sector 61	36	Sector 44
15	Sector 58	37	Sector 39
16	Sector 59	38	Sector 30
17	Sector 55	39	Sector 38
18	Sector 54	40	Sector 32
19	Sector 53	41	Sector 31
20	Sector 56	42	Sector 40
21	Sector 57	43	Sector 41
22	Sector 51	44	Sector 42

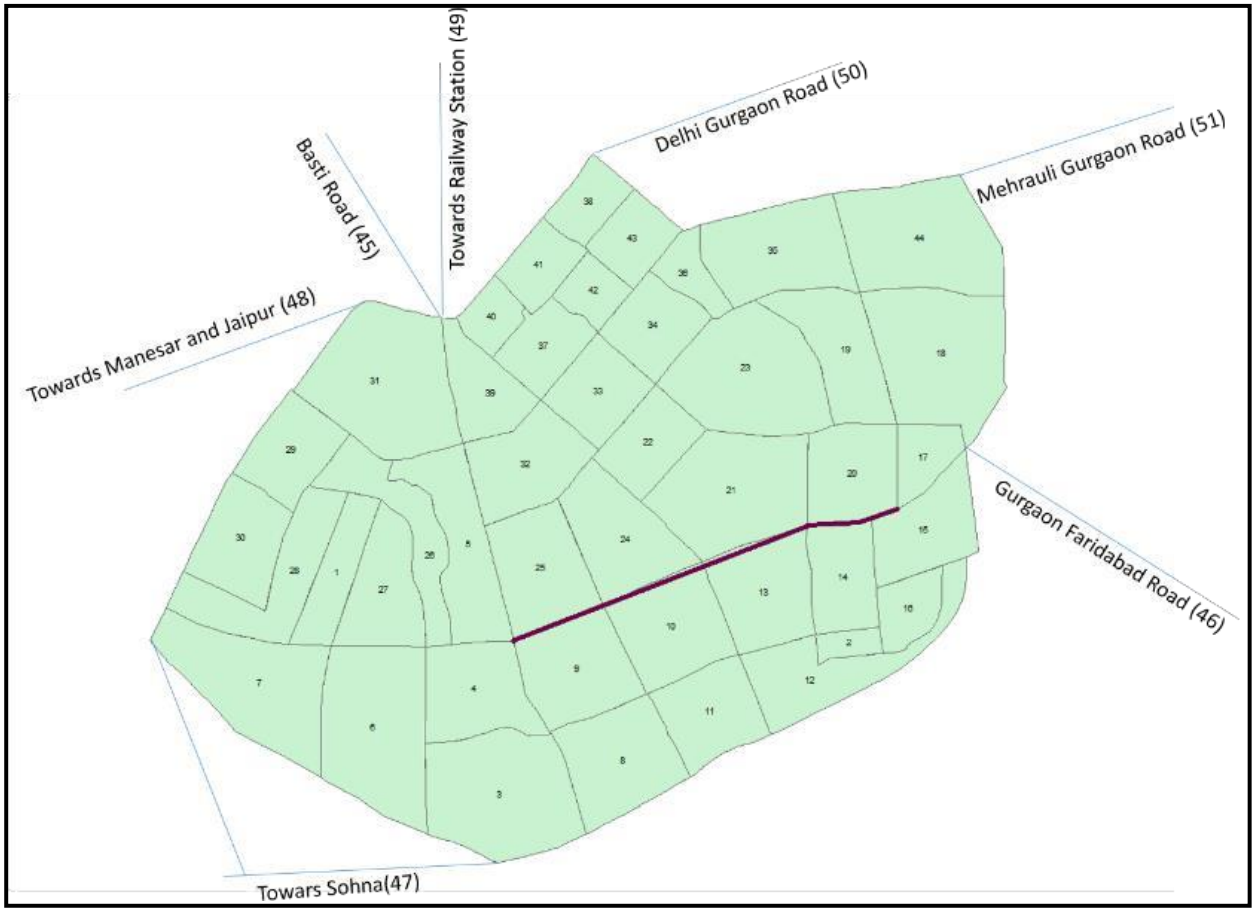


Figure 2.6: Zone Map

2.6.3 TRAVEL PATTERN

The collated OD data was coded to the respective Origin Destination zones and was thus assessed to understand the prominent travel patterns. Mode wise origin destination matrices were developed which was later combined to provide the overall passenger matrices as presented below:-

Table 2.9: Combined OD Matrix (No. of Passenger Trips)

D / O	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	Grand Total
1	0														33	42	17														17															32				42	53	234
2		0																																													35					35
3			0												84			21		21					90										84											11			84	32	426
4				32		10			59							22	84	263								10	38																	11	53	66				245	93	985
5					0																																															0
6						0									309		84	11		84	262																							75	43	33				429	83	1413
7							0		59						302					84					40																				132	121				352	412	1502
8								0							84			95			11				177																					42				85	87	581
9				61			77		201				82		604	95	277	222		269	95				61										84	118									472	1163	204			1408	484	5978
10										0							107	81			95				149					81														84	118	78			32	40	865
11											53									53					115																									84	237	544
12												0																																			24					24
13									61				0	22	108	75	184	55		86					87																				22	11				96	78	886
14														0	10										10																												10
15			78			260	287	78	535				228		0	78		146		29	455				1294		260		142	78	336		39													54	395			81	860	5714
16	20								90						84	0				118					99		78	59																			61				61	670
17	11			78		78			257	84			64				0	159							215			48					10														237				287	1529
18	24			234				81	162	118			61		168		180	0		298	84				246	35		37			61														24			130			321	168	2433
19																			0																																	61	61
20						78	78		234		90				84	84		240		0					90	101			93																62		153			84		1472
21						224			84	81					526			78			0				137																					205	78			150	318	1882
22																						0			157																									66	61	284
23																							0																													0
24																								0																										118		118
25			95	53			83	95	61	145	108		53	11	1674	221	388	384		186	145	190			0						83		118			180	84							292	2060	2644	338			2658	1378	13726
26	26																	54		128					59			24								53								32		21				437	84	917

Grand Total	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27
241	56	62				42																			
61		23			39																				
408	10				68		78									78									
984	66	264				66	84												45						
0																									
1502	213	263				99	242												10		26				
1476	261	242				142	204									64					40				
443	42	44			21		81																		
5483	483	849			235	1114	830								90	78									
836	66				84	84	78															95			
572	242	78																							
73	13	20			28	13																			
814	77	78					171																		
76	17				27																				
5873	769	17			263	72															337	95	173	49	38
1141	76				259																72	43		53	21
2032	219	65			356																			60	11
2224	148	81			11		114														50				11
50	28	11			11																				
1843	44	78			151		74														11	11	118		
1946	363	144			84	208																			
303	61	53																							
0																									
84		84																							
11699	1418	2063			399	3024	1228	64							78	333					66				
772	98	285			29		113									78			23						
862	42	226				52	88	78																	0
530	62	198				88	13																	0	
1160	152	275			42	288	125																42		
532		126				78	84									84						0			
2392	240	801			61	268	289														186			33	17
0																				0					
253						57	29												0						
0																		0							
0																	0								
550							150									0									
202															0										
0														0											
0													0												
0												0													
0											0														
0										0															
0									0																
591					11		43	0													118				11
4372	601	143			260		52												97		165	21	50	22	11
9261	2595	187			789	0	270												66	21	391	128	242	63	
6153	1975	1361			66	656	280														71				
0				0																					
0			0																						
12774	2127	22			1947	65	326													21	635	241	223	180	214
13793	1846	1977			703	2816	985	23													290		212	48	17
94359	14408	10118	0	0	5943	9233	6032	164	0	0	0	0	0	0	168	716	0	0	240	42	2457	633	1060	507	347

From the obtained OD data, the major zonal interactions were also identified. The following table provides the highest interacting zonal pairs while considering the total traffic movement pattern.

Table 2.10: Top 10 OD Pairs from All Passengers Combined Trip Matrix

Rank	Origin	Destination	Number of Trips	Trips %	Origin	Destination
1	45	25	2072	2.2	Basti Road	Sector 49
2	46	25	2643	2.8	Gurgaon Faridabad Road	Sector 49
3	50	25	2658	2.82	Delhi Gurgaon Road	Sector 49
4	50	45	2078	2.2	Delhi Gurgaon Road	Basti Road
5	50	47	1946	2.6	Delhi Gurgaon Road	Sohna Road
6	47	45	1884	2	Sohna Road	Basti Road
7	46	45	2996	2.86	Gurgaon Faridabad	Basti Road
8	45	46	2646	2.8	Basti Road	Gurgaon Faridabad Road
9	25	46	3023	3.2	Sector 49	Gurgaon Faridabad Road
10	25	50	2063	2.19	Sector 49	Delhi Gurgaon Road

Table 2.11: Passenger Trip Distributions for Different Catchment Areas

Travel Distance	Two--Wheeler	Car/Jeep/Van/Taxi	Bus
0--2	3%	1%	0%
2--4	9%	6%	12%
4--6	18%	11%	11%
6--8	17%	13%	15%
>8	52%	68%	62%
	100%	100%	100%

To understand the potential traffic for the proposed Metro Corridor, the project influence area has been categorized into different catchment areas with certain distances of the buffer area from the project corridor. These buffer area distances from the project corridor have been considered after analyzing the possible shift potential towards the proposed Metro.

It can be observed that within 4 km of the proposed corridor, 7% passenger trips were made by car users followed by 12% passenger trips by two-wheeler users out of the total passenger samples collected for respective modes. This results in a total of 31% passenger trips out of total sample passengers travelling on the project corridor. These trips originating or destining within this immediate influencing zone is the most potential traffic having higher impact on the proposed Metro Corridor.

Table 2.12: PCTR Calculation

Mode		No. of Trips	Percentage	
Vehicular Trips	Car	92286	21.20%	
	2- Wheeler	154424	35.40%	
	Auto	44644	10.20%	
	Share Auto	26944	6.20%	
	Taxi	13621	3.10%	
	Share Taxi	13342	3.10%	
	Bus	27703	6.30%	94.20%
	Mini Bus	17323	4.00%	
	Chartered Bus	5693	1.30%	
	School Bus	6857	1.60%	
	Train	8200	1.90%	
	Cycle	2179	0.50%	
	Cycle Rickshaw	4400	1.00%	5.80%
	Walk	18719	4.30%	
Total Trips		**436334**	**100.00%**	
Population		**412255**		
PCTR Including NMT		1.05		
Motorized Trips		**411036**		
PCTR Motorized		1		

The table below provides the mode wise percentage of trips either originating or destining within the influence zones:

Table 2.13: Mode-wise Passenger Interaction within Influence Area of Proposed Corridor

Two-Wheeler	Car	Taxi & Auto	Bus	Total Passenger
38%	23%	24%	14%	100%

It can be seen that a high proportion of the observed traffic from the survey locations either originates or destines within the identified influence area of the proposed metro corridor. The highest proportion was observed for passengers travelling by two-wheeler (38%), followed by passengers travelling by 3WH &Auto (38%) within the influence area.

2.7 SPEED AND DELAY SURVEY

Speed and Delay Survey was carried out to assess the network characteristics of the study corridor. Moving car method was adopted wherein the observed speed and delay was recorded while travelling through the network in a car. The findings of the same are provided in the following table:-

Table 2.14: Speed and Delay Observations for Different Runs at Peak Period

	Node From To	Length in KMS.	Name of Road	Running Time (Sec)	Journey Time (Sec)	Delay Time (Sec)	Journey Speed (Kms./Hrs.)	Running Speed (Kms./hrs.)	Reason of Delay
1	**2**	**1.49**	**Golf Course Road**	206	242	36	22.14	26	Traffic Signals
2	**3**	**0.91**	**Golf Course Road**	117	186	69	17.61	28	Traffic Congestion
3	**4**	**2.40**	**Golf Course Road**	270	299	29	28.90	32	Traffic Signals
4	**5**	**0.99**	**Golf Course Road**	105	105	-	34.00	34	-
5	**6**	**0.41**	**Golf Course Road**	53	53	-	28.00	28	-

CHAPTER 3

TRAFFIC DEMAND ESTIMATION USING TRAFFIC MODEL

3.1 INTRODUCTION OF STUDY AREA

The present study focuses on carrying out a realistic assessment of traffic on the proposed metro corridor along SPR in between Sector 56 GGN to Vatika Chowk with approximate length of about 6.34 km. Proposed Metro alignment will cater for existing population of approximate 0.42 million.

GURUGRAM (GURGAON)

Gurgaon district now named as Gurugram is adjacent to the Delhi State surrounded by Jhajjar, Rewari, Mewat, Palwal and Faridabad districts. It has both oval and elongated shape. It has a geographical area of 1258.0 Sq.km. containing 976.65 Sq.km. of rural area and 281.35 Sq.km. of urban area. The district is having common border with Delhi State in the north.

Gurgaon City (MC) is a sub-district of Gurgaon district, having its State Headquarter in Chandigarh. There is a total of 34 villages in Gurgaon (MC). Gurgaon (MC+OG) is spread on a total area of 184.59 sq.km. with a density of approx. 5,201 persons per sq.km. and inhabiting 2.1 lakh households having an average family size of 5 persons.

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3.2 DEMOGRAPHIC DETAILS SOCIO – ECONOMIC OUTLINE

GURUGRAM (GURGAON)

Gurgaon City (MC) is a sub-district of Gurgaon district, having its State Headquarter in Chandigarh. There is a total of 34 villages in Gurgaon (MC). Gurgaon (MC+OG) is spread on a total area of 184.59 sq.km. with a density of approx. 5,201 persons per sq.km. and inhabiting 2.1 lakh households having an average family size of 5 persons.

In Gurgaon (MC), the total population recorded in Census India 2011 was 9.8 lakh with approximate 93% living in its Urban area. The city has seen a decadal growth of 112.9% between year 2001 and 2011. The highest ratio of decadal growth in urban areas was observed in Gurgaon with 280.05% amongst the other tehsils of Gurgaon District. There are 5.3 lakh (54%) male and 4.5 lakh (46%) female population in the city. The city has a total of 7.4 lakh (87%) literate population with male and female literacy rate being 90.9% and 82.45%, respectively. Gurgaon (MC) leads in Haryana out of 74 tahsils in literacy with the literacy rate of 87%.

The sex ratio has been recorded to 849 which is lower than state's sex ratio (878). The total population in 0-6 age group has been recorded to be 1.26 lakh with 54% male child and 47% of female child. The child sex ratio (0-6 years) of Gurgaon is 843.

As per the Development Plan 2031 AD for Gurgaon- Manesar Urban Complex, the area is designed to accommodate 42.5 Lakh population by the year 2031 AD. In Gurgaon (MC), out of total population, 3.7 lakh (37.46% of the total Gurgaon MC population) were engaged in work activities with approx. division of 80%-20% among male workers and female workers, respectively. 94% of workers describe their work as Main Work (Employment or Earning more than 6 Months). Of the total worker population, 8,524 were cultivators (owner or co-owner) while 7,942 were Agricultural labourer. As per the census 2011, the most important commodity manufactured in this town is Software, Auto spare Parts, and Readymade Garments.

3.3 LAND-USE PATTERN

GURUGRAM (GURGAON)

The Gurgaon-Manesar Urban Complex, which is known for Automobile Industries, Modern Commercial Malls, Towers of Cyber Parks and Software Development. The availability of high-level infrastructure of Airways, Railways, Highways, world famed medical and educational institutions in its close proximity at National Capital of Delhi have become the main factors of attraction for international companies for setting up their business at Gurgaon and hence, the Gurgaon-Manesar Urban Complex has become abode of International Companies. In order to accommodate the projected population of 42 lakh, an area of 160.21 sq.km. has been reserved for the residential purpose. The proposed land use and its distribution for the Gurgaon- Manesar Complex for year 2031 is presented below:

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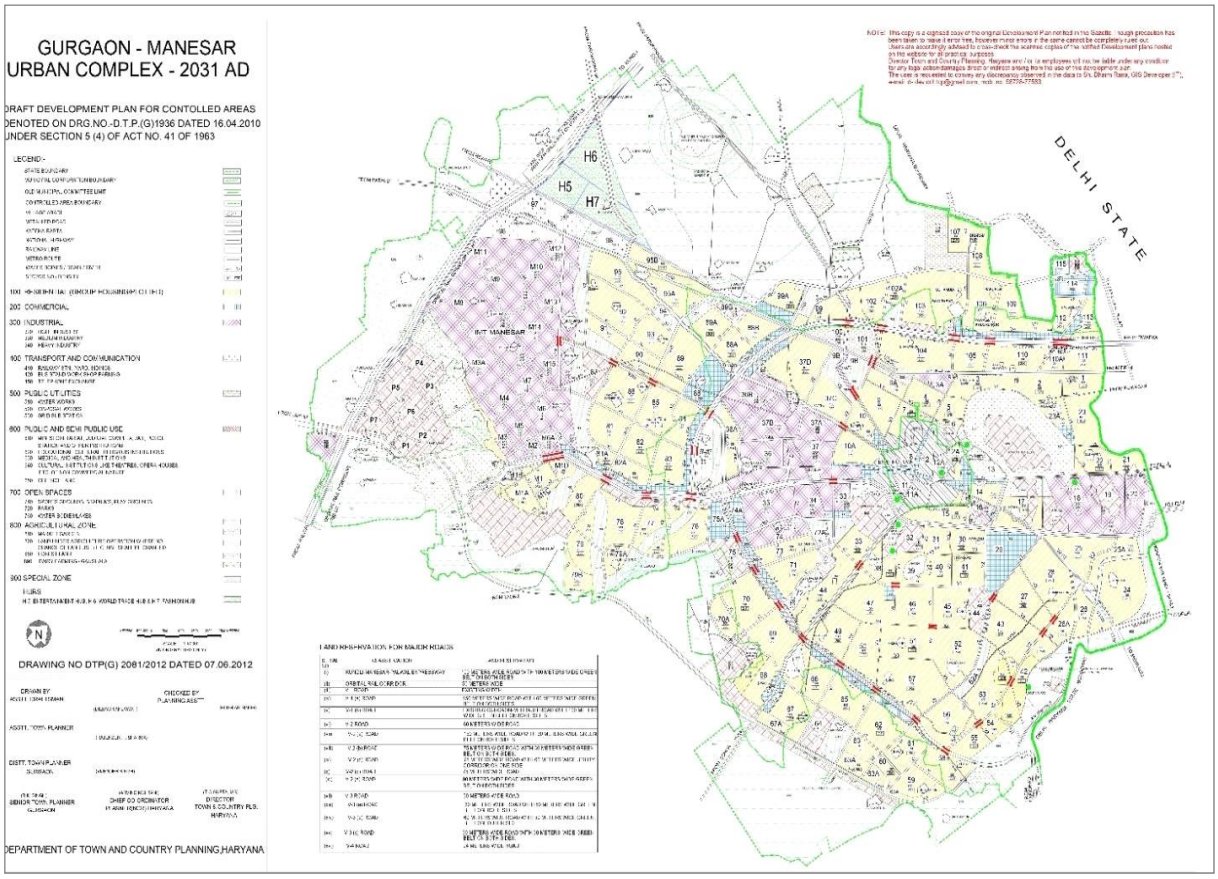


Figure 3.1: Proposed (2031) Land-use Map of Gurgaon- Manesar Urban Complex

Source: Department of Town and Country Planning, Haryana

Table 3.1: Proposed (2031) Land-use Distribution of Gurgaon- Manesar Urban Complex

Land Use Classes	Area (in Sq.km.)	Area (%)
Residential	160.21	47.3
Commercial	16.16	4.8
Industrial	46.13	13.6
Transport and Communication	44.28	13.1
Public utilities	6.08	1.8
Public and Semi public	20.27	6.0
Open Spaces	29.28	8.6
Special Zones	1.14	0.3
Defence Land	6.33	1.9
Existing Towns	4.06	1.2
Village Abadis	4.78	1.4
Grand Total	338.72	100

Source: Final Development Plan 2031 AD for Gurgaon- Manesar Urban Complex

3.4 PUBLIC TRANSPORT

GURUGRAM (GURGAON)

Gurgaon- Manesar Urban Complex is situated on prime location on National Highway Number 8 Delhi- Jaipur, only at a distance of 4 km from the Indira Gandhi International Airport and is well linked with all capitals of the world

through airways. The only Broad-Gauge Railway Line of the district goes side by side of the SH-26 in the district. There are direct bus services from Gurgaon to Delhi, Alwar and Chandigarh as well as to Uttar Pradesh, Jammu and Kashmir.

Table 3.2: Bus Route

Route	Source	Destination	View Route
1	Route no 111	Huda City Centre	Badshahpur
2	Route No 132	Ambiance Mall	Gurugram Bus Stand
3	Route No 116	Tau Devilal Biodiversity Park	Dwarka Expressway Chowk B Daultabad
4	Route 112 (Loop)	Krishna Chowk Palm Vihar	Haryana Vidhyut Prasaran Nigam
5	Route No 215	Dundahera	Harsaru Wajirpur
6	Route 212 (Loop)	Basai Chowk (via Huda City Center)	Basai Chowk

3.5 DEVELOPMENT OF MODEL FOR RIDERSHIP ESTIMATION

As the study was initiated in 2019, the same has been considered and demand forecasting on the network was undertaken till 2051. In order to estimate the demand on the metro corridor, all relevant data has been collated from primary and secondary sources available. The envisaged metro development has been considered for the following horizon years:

- 2025
- 2031
- 2041
- 2051

SCENARIO BUILDING

Scenario building is a process of analysing possible future events by considering alternative possible outcomes. Thus, scenario analysis, a method of projections, does not try to show one exact picture of the future. Instead, it presents several alternative future developments. Consequently, a scope of possible future outcomes is observable. Not only are the outcomes observable, but also the development paths leading to the outcomes. The development programs are taken from the City Development Plan and other relevant studies. Keeping the PCTR value constant, the scenarios that have been evaluated are as follows:

- Moderate Scenario – with realistic Population Growth Trend where future growth rates for the horizon years have been moderated as compare to predicted growth rates in different development plans and

- Optimistic Scenario – with Population Growth Trend as per the predicted growth rates in different development plans.

MODEL DEVELOPMENT

Worldwide accepted CUBE Voyager software has been utilized to develop the ridership estimation model. A complete three- fold analytical approach consisting of network development, matrix development and trip assignment was adopted. The assignment technique adopted helped to ascertain the ridership at the proposed metro corridors.

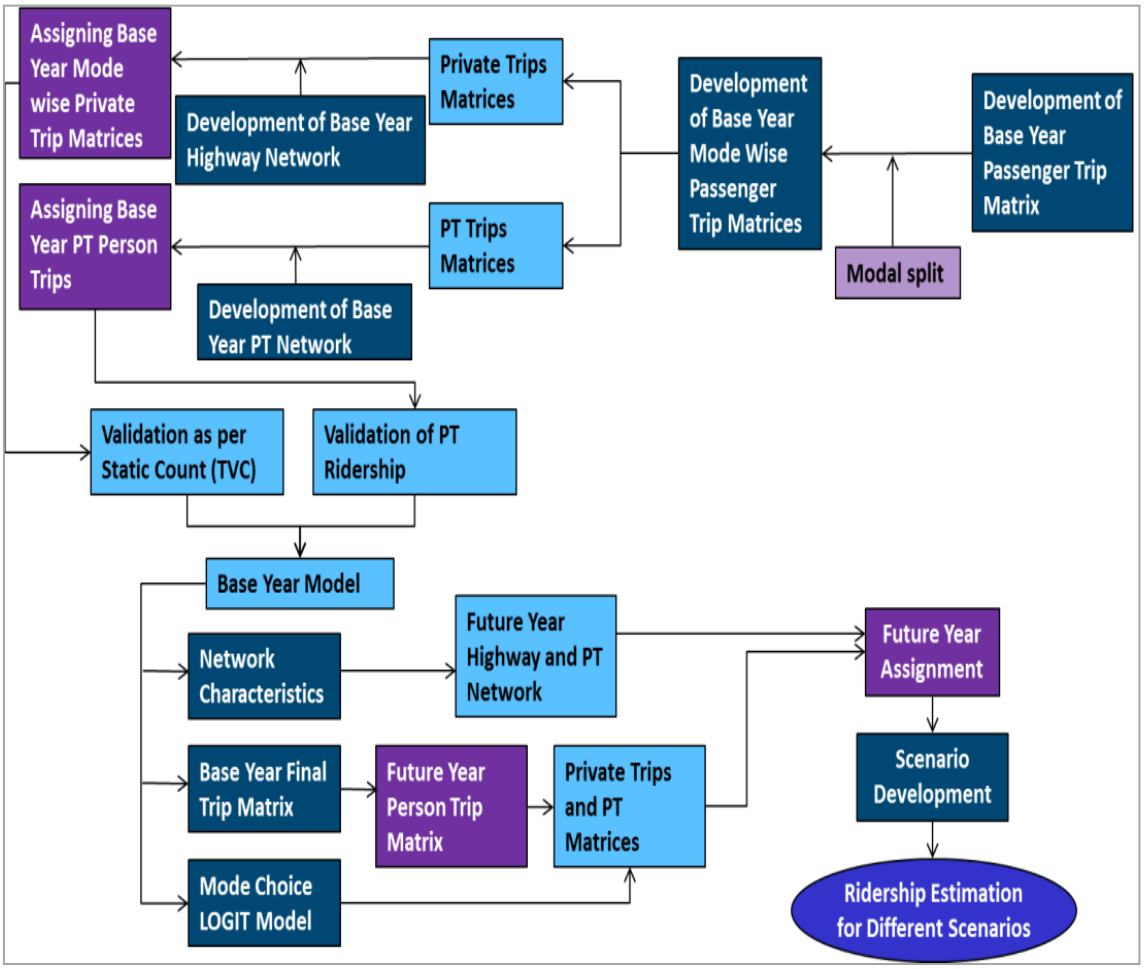


Figure 3.2: Methodology for Development of Ridership Estimation Model

NETWORK DEVELOPMENT

The network development stage involves both the highway and transit network throughout the entire study area. Base year network is the existing road network. Once the base year mode-wise matrices are developed and assigned to the base year network, the network characteristics have been calibrated and validated with respect to the ground conditions. Further future year proposed metro routes have been incorporated with the base year validated network.

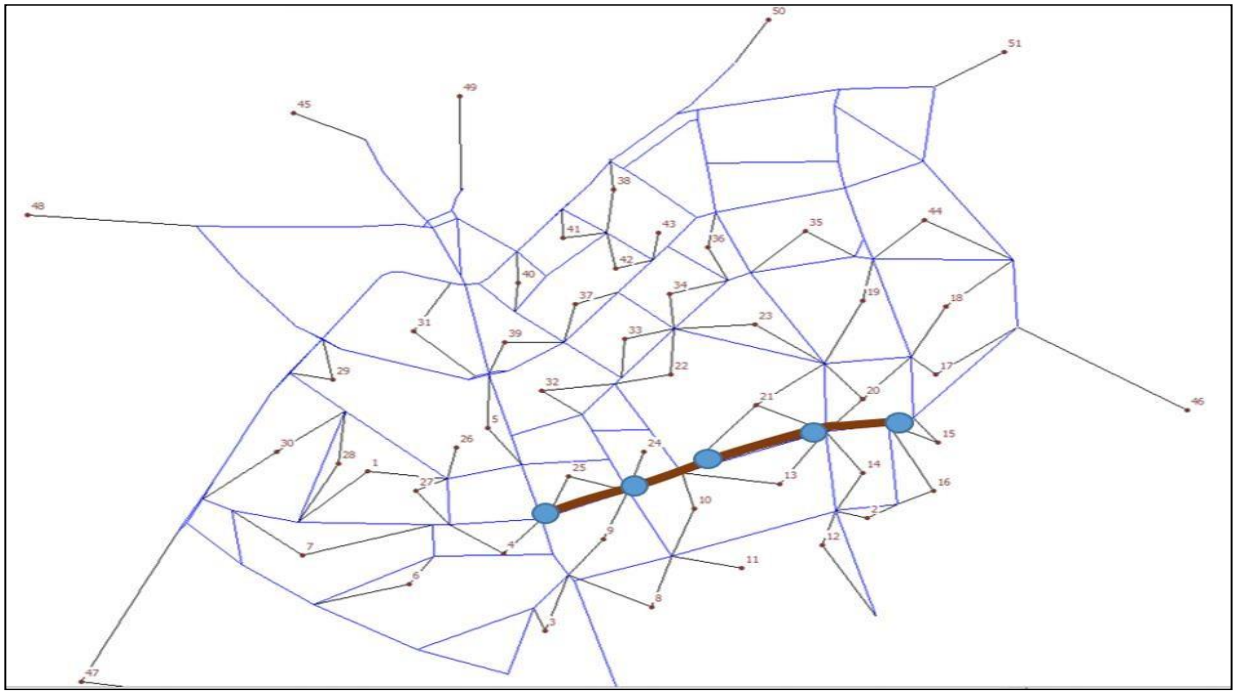


Figure 3.3: Network Developed in CUBE Voyager

MATRIX DEVELOPMENT

1. TRIP GENERATION

Trip generation forms the initial stage of the four-stage modelling process, wherein the respective zone wise trip production and attraction are evaluated. Trip production and attraction of each individual zone needs to be ascertained on the basis of observed relationships of population and employment with various trip generation parameters. For the present study, different horizon year population and employment for individual zone have been estimated (as presented in the table below) based on the available development plans / master plans for proposed urban areas and census data for villages.

Table 3.3: Zone-wise Horizon Year Population-Employment for Study Area: Moderate Scenario

Zone No	Population (2025)	Employment (2025)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
1	7629	2308	12539	7061	14973	10551	17879	15766
2	4703	1229	7729	1462	9230	1611	11022	1775
3	8666	3100	14244	8034	17009	11703	20311	17048
4	11295	6800	18563	9407	22167	11730	26471	14627
5	9559	6766	15711	9289	18761	9235	22403	9181
6	18694	5480	30724	7664	36688	9021	43810	10618
7	1413	2373	2322	21394	2773	31613	3312	46713
8	7065	3880	11612	9146	13866	13002	16558	18484
9	25106	3690	41263	8067	49273	11788	58838	17225
10	12923	3818	21239	8784	25362	12592	30285	18051
11	1413	2216	2322	6373	2773	9439	3312	13980
12	8160	3150	13412	8359	16016	12155	19126	17675

Zone No	Population (2025)	Employment (2025)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
13	12747	3114	20951	8123	25018	11900	29874	17433
14	8813	1504	14485	2417	17297	3040	20655	3824
15	19687	2876	32357	4325	38638	4300	46138	4275
16	5842	7233	9601	8350	11465	8670	13691	9002
17	11813	4295	19416	5091	23185	5061	27686	5031
18	8097	4478	13308	7122	15891	7080	18975	7038
19	10657	6071	17516	8296	20916	8247	24976	8198
20	27096	5265	44533	8470	53178	10490	63501	12992
21	17488	6480	28743	9766	34322	9709	40984	9652
22	13502	7507	22191	9163	26499	9110	31643	9057
23	48310	6509	79401	8430	94814	8381	113219	8332
24	10457	7325	17186	9820	20522	9763	24506	9706
25	19403	7784	31890	10030	38080	9972	45472	9914
26	1877	1193	3084	1355	3683	1458	4398	1569
27	11422	5029	18773	9520	22417	16217	26768	27625
28	1413	3636	2322	21980	2773	32195	3312	47157
29	3571	13420	5869	21311	7008	24290	8368	27685
30	11225	14522	18450	22164	22031	25138	26307	28511
31	37879	9105	62256	16914	74341	19918	88772	23456
32	16933	6508	27830	11780	33232	14815	39683	18632
33	18450	4529	30324	5814	36211	5780	43241	5746
34	23601	6792	38790	8129	46320	8082	55312	8035
35	18000	16228	29584	19740	35326	19624	42182	19509
36	1413	14627	2322	17166	2773	19134	3312	21328
37	5864	8689	9638	10479	11509	10417	13743	10355
38	12431	9735	20431	17546	24397	20547	29133	24061
39	20241	10840	33267	14912	39725	17928	47437	21554
40	35813	9246	58861	15424	70287	18437	83931	22039
41	5768	3889	9480	5006	11321	4976	13520	4946
42	3916	3209	6436	4069	7685	4046	9176	4023
43	17895	3188	29412	4003	35121	3979	41938	3955
44	4296	13435	7060	18248	8431	20210	10068	22383
Total	**582545**	**273071**	**957449**	**450001**	**1143307**	**537354**	**1365246**	**658169**

Table 3.4: Zone-wise Horizon Year Population-Employment for Study Area: Optimistic Scenario

Zone No	Population (2025)	Employment (2025)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
1	8392	2539	13793	7767	17219	12133	21496	18953
2	5173	1352	8502	1608	10614	1852	13251	2133
3	9533	3410	15668	8838	19560	13459	24419	20496
4	12424	7480	20420	10348	25492	13490	31824	17586
5	10515	7443	17283	10218	21576	10620	26935	11038
6	20563	6028	33796	8430	42191	10374	52671	12766

Zone No	Population (2025)	Employment (2025)	Population (2031)	Employment (2031)	Population (2041)	Employment (2041)	Population (2051)	Employment (2051)
7	1554	2610	2555	23533	3189	36355	3980	56163
8	7772	4268	12774	10060	15946	14953	19906	22226
9	27617	4059	45390	8873	56664	13556	70738	20711
10	14215	4200	23363	9662	29166	14480	36410	21701
11	1554	2438	2555	7010	3189	10855	3980	16809
12	8977	3465	14753	9195	18418	13978	22993	21249
13	14022	3425	23046	8935	28771	13685	35918	20960
14	9695	1654	15934	2659	19892	3496	24833	4596
15	21656	3164	35592	4758	44433	4945	55470	5139
16	6426	7956	10561	9185	13185	9971	16461	10824
17	12995	4725	21357	5600	26663	5820	33287	6049
18	8907	4926	14639	7834	18275	8142	22814	8462
19	11723	6678	19268	9125	24054	9484	30029	9857
20	29805	5792	48987	9317	61155	12063	76345	15618
21	19237	7128	31617	10742	39471	11165	49276	11605
22	14852	8258	24410	10080	30474	10476	38044	10888
23	53141	7160	87341	9273	109036	9638	136120	10017
24	11502	8058	18905	10802	23601	11227	29463	11669
25	21343	8562	35079	11033	43792	11467	54669	11918
26	2064	1312	3393	1490	4235	1677	5286	1887
27	12564	5532	20650	10472	25779	18650	32182	33215
28	1554	4000	2555	24178	3189	37025	3980	56698
29	3928	14762	6456	23442	8059	27933	10060	33284
30	12348	15974	20295	24380	25336	28908	31629	34277
31	41667	10016	68482	18605	85492	22906	106727	28201
32	18626	7159	30613	12958	38217	17037	47710	22400
33	20296	4982	33357	6396	41643	6647	51987	6908
34	25961	7471	42669	8942	53268	9294	66500	9660
35	19800	17851	32542	21714	40625	22568	50716	23456
36	1554	16090	2555	18882	3189	22004	3980	25642
37	6451	9558	10602	11526	13236	11980	16524	12452
38	13674	10709	22474	19301	28056	23629	35024	28927
39	22265	11924	36594	16403	45683	20617	57029	25914
40	39394	10171	64747	16966	80829	21203	100905	26498
41	6345	4278	10428	5506	13019	5723	16254	5949
42	4307	3530	7079	4476	8838	4652	11034	4835
43	19685	3507	32353	4403	40389	4576	50421	4756
44	4725	14779	7766	20072	9695	23241	12103	26910
Total	**640800**	**300378**	**1053194**	**495001**	**1314803**	**617957**	**1641388**	**791302**

Table 3 .5: Horizon Year Trip Ends of Different Zones for Moderate Scenario

Zone no.	2025		2031		2041	
	Production	Attraction	Production	Attraction	Production	Attraction
1	7526	5840	12370	9599	14771	11462
2	4000	3664	6574	6023	7851	7192
3	9212	9872	15141	16225	18080	19375
4	13625	12060	22394	19821	26741	23668
5	13963	14937	22949	24550	27404	29315
6	23982	16122	39415	26498	47066	31641
7	740	4344	1216	7140	1452	8526
8	9307	11136	15297	18302	18267	21855
9	19984	12410	32845	20396	39221	24356
10	14367	9858	23613	16202	28197	19347
11	931	5271	1530	8664	1827	10345
12	9889	10964	16254	18020	19409	21518
13	12711	10761	20891	17687	24946	21120
14	10607	5180	17433	8514	20817	10167
15	20127	9991	33080	16421	39502	19609
16	6038	13308	9924	21873	11850	26119
17	11645	10289	19139	16910	22854	20193
18	12684	12259	20847	20148	24893	24059
19	16131	14160	26512	23274	31659	27791
20	24602	12578	40435	20672	48284	24685
21	22782	18313	37443	30099	44711	35942
22	15039	14741	24718	24228	29516	28931
23	33133	22178	54457	36450	65028	43526
24	16424	17867	26995	29366	32235	35067
25	24013	16940	39467	27842	47128	33246
26	2127	2120	3496	3484	4175	4160
27	10458	10723	17188	17624	20524	21045
28	842	7745	1384	12729	1652	15200
29	4066	19354	6682	31810	7980	37985
30	7549	17050	12408	28022	14816	33462
31	25095	18058	41245	29680	49251	35441
32	20334	14905	33420	24497	39908	29252
33	18108	13630	29761	22402	35538	26750
34	20658	17094	33953	28095	40544	33549
35	22196	37089	36480	60958	43561	72791
36	906	19366	1490	31830	1779	38008
37	8306	12292	13652	20202	16302	24123
38	8536	12920	14030	21234	16753	25356
39	16974	21757	27897	35760	33313	42701
40	23807	17710	39128	29108	46724	34758
41	7511	8127	12345	13358	14742	15951

Zone no.	2025		2031		2041	
	Production	Attraction	Production	Attraction	Production	Attraction
42	5828	6288	9578	10335	11437	12341
43	16466	11488	27064	18881	32317	22547
44	9316	19785	15311	32518	18284	38830
Total	**582545**	**582545**	**957449**	**957449**	**1143307**	**1143307**

Table 3.6: Horizon Year Trip Ends of Different Zones for Optimistic Scenario

Zone no.	2025		2031		2041	
	Production	Attraction	Production	Attraction	Production	Attraction
1	8279	6424	13607	10559	16987	13182
2	4400	4031	7232	6625	9028	8271
3	10133	10859	16655	17848	20792	22281
4	14988	13266	24633	21803	30752	27219
5	15359	16430	25244	27004	31514	33712
6	26380	17734	43357	29148	54126	36388
7	814	4778	1337	7854	1670	9805
8	10238	12249	16827	20132	21007	25133
9	21983	13651	36130	22436	45104	28009
10	15804	10844	25974	17822	32426	22249
11	1024	5798	1683	9530	2101	11897
12	10878	12060	17879	19822	22320	24746
13	13982	11837	22980	19455	28688	24288
14	11667	5698	19176	9365	23939	11692
15	22140	10990	36388	18063	45427	22550
16	6642	14639	10916	24060	13628	30037
17	12809	11318	21053	18601	26283	23222
18	13952	13485	22931	22163	28627	27668
19	17744	15576	29163	25601	36408	31960
20	27062	13836	44478	22740	55526	28388
21	25060	20145	41187	33109	51418	41333
22	16543	16215	27189	26651	33943	33271
23	36447	24395	59902	40095	74782	50055
24	18067	19654	29694	32303	37070	40327
25	26414	18634	43414	30626	54197	38233
26	2340	2332	3846	3832	4802	4784
27	11503	11795	18906	19386	23603	24202
28	926	8519	1522	14002	1900	17480
29	4472	21290	7351	34991	9177	43683
30	8304	18755	13648	30825	17039	38481
31	27604	19864	45369	32648	56639	40757
32	22368	16395	36762	26946	45894	33640
33	19918	14993	32737	24642	40869	30763
34	22724	18804	37349	30905	46626	38582

Zone no.	2025		2031		2041	
	Production	Attraction	Production	Attraction	Production	Attraction
35	24415	40798	40128	67054	50096	83710
36	997	21303	1639	35012	2046	43709
37	9137	13521	15017	22222	18747	27742
38	9390	14212	15433	23358	19266	29160
39	18671	23933	30687	39336	38310	49106
40	26188	19481	43041	32018	53732	39972
41	8262	8940	13580	14694	16953	18344
42	6410	6917	10536	11368	13153	14192
43	18113	12637	29770	20770	37165	25929
44	10248	21763	16843	35769	21026	44654
Total	**640800**	**640800**	**1053194**	**1053194**	**1314803**	**1314803**

2. TRIP DISTRIBUTION

The second stage of the process involves distributing the estimated zonal trip ends within the zones, thereby yielding the zone wise production-attraction matrix. The obtained trip ends (as per the established relationship with relevant zonal parameters) were distributed as per the gravity model and further calibrated and validated as per the observed movement pattern from the primary Origin- Destination Survey.

Mode-wise person trips estimated for different horizon years as per the modal split mentioned above are presented below:

Table 3.7: Mode-wise Person Trips (without Metro) for Moderate Scenario

Modes	Year		
	2025	2031	2041
Car	172446	283425	338443
2-Wheeler	223314	367031	438278
Auto-rickshaw	103524	170148	203177
Bus	83261	136845	163409
Total Trips	**582545**	**957449**	**1143307**

Table 3.8: Mode-wise Person Trips (without Metro) for Optimistic Scenario

Modes	Year		
	2025	2031	2041
Car	189690	311768	389209
2-Wheeler	245646	403734	504019
Auto-rickshaw	113877	187163	233654
Bus	91587	150529	187920
Total Trips	**640800**	**1053194**	**1314803**

Trip distribution exercise has been carried out across all modes, considering the modal split as per Primary survey 2019. The future forecast, a realistic development scenario with improvement of public city bus service within the influence area has been considered. This implies the operation of public route buses within the influence area as per the future demand

3. ASSESSMENT OF SHIFT

Assessment of Shift to the proposed metro has been evaluated using the willingness to shift data collated as part of the primary survey. Analysis of willingness to shift data for all modes aggregated at passenger level considering the proposed metro route from Badsa to Dwarka in combination with the existing NCR metro network shows a parabolic nature related to access and egress distance from metro to the trip end. Definitely there is an additional impact of possible distance travel on the metro with respect to the total trip length as passengers are interested to shift to metro only if the travel distance on metro is substantial with respect to their total trip length. To understand the relation of willingness to shift to metro with access/ egress distance from the collated willingness to shift data, following matrix has been developed:

Table 3.9: Willingness to Shift Percentages with Respect to the Access/ Egress Distance from Metro

Access\Egress		Egress Distance		
		<1	**1-2**	**>3**
Access (km)	**<1**	51%	42%	7%
	1-2	42%	13%	3%
	>3	7%	3%	1%

Effective shift to the proposed metro was observed above 51% for different modes within 1km buffer on both sides of the proposed metro corridors. While, for the area beyond the 1km buffer the shift was found to be reduced radically for various modes. Further to analyse the mode-wise shift to metro, Logit model has been developed and as per the predicted travel pattern for different horizon years for both the moderate and optimistic scenario. Accordingly, mode-wise overall shift percentages within the project influence area for both the moderate and optimistic scenarios have been presented below:-

Table 3.10: Mode-Wise Overall Shift for Different Horizon Years in Moderate Scenario

Modes	Year		
	2025	**2031**	**2041**
Car	0.51%	0.60%	0.69%
2-Wheeler	1.07%	1.27%	1.46%
Auto-rickshaw	0.69%	0.82%	0.94%
Bus	0.76%	0.90%	1.04%

Table 3.11: Mode-Wise Overall Shift for Different Horizon Years in Optimistic Scenario

Modes	Year		
	2025	2031	2041
Car	0.46%	0.55%	0.60%
2-Wheeler	0.96%	1.14%	1.25%
Auto-rickshaw	0.76%	0.90%	0.99%
Bus	0.86%	1.01%	1.12%
Bus	0.86%	1.01%	1.12%

Table 3.12: Mode-Wise Individual mode Shift for Different Horizon Years in Moderate Scenario

Modes	Year		
	2025	2031	2041
Car	1.70%	2.00%	2.30%
2-Wheeler	2.80%	3.30%	3.80%
Auto-rickshaw	3.90%	4.60%	5.30%
Bus	5.30%	6.30%	7.30%

Table 3.13: Mode-Wise Individual mode Shift for Different Horizon Years in Optimistic Scenario

Modes	Year		
	2025	2031	2041
Car	1.60%	1.80%	2.00%
2-Wheeler	2.50%	3.00%	3.30%
Auto-rickshaw	4.30%	5.10%	5.60%
Bus	6.00%	7.10%	7.80%

As per the above analysis, minimum shift was observed from the bus passengers while the maximum was observed for two-wheeler passengers. After applying the above-mentioned shifts, the mode-wise person trips from different mode including metro for moderate and optimistic scenario are presented below:

Table 3.14: Mode-Wise Person Trips with Metro for Different Horizon Years in Moderate Scenario

Modes	Year		
	2025	2031	2041
Car	169475	277644	330499
2-Wheeler	217056	354850	421542
Auto-rickshaw	99484	162285	192373
Bus	78825	128211	151546
Metro	17706	34459	47347

Table 3.15: Mode-Wise Person Trips with Metro for Different Horizon Years in Moderate Scenario

	Year		
	2025	**2031**	**2041**
Car	186727	306001	381287
2-Wheeler	239502	391777	487591
Auto-rickshaw	108996	177666	220604
Bus	86097	139845	173240
Metro	19477	37905	52081

4. TRIP ASSIGNMENT

In order to assess the ridership estimates, the generated mode wise trip matrices have been assigned on the developed network as per the generalised costs of travel. Ridership estimates were assessed using the software CUBE Voyager.

During trip assignment, the trips are assigned or loaded onto the prepared transport network. The obtained inputs including the trip matrices, network files, zoning system etc. were used to carry out the trip assignment. Development of matrices were discussed in the previous sub sections. Operational characteristics of Metro, including fare was adopted as per Delhi Metro Chartaterstic. Sixteen hours of metro operation was considered for ridership assessment.

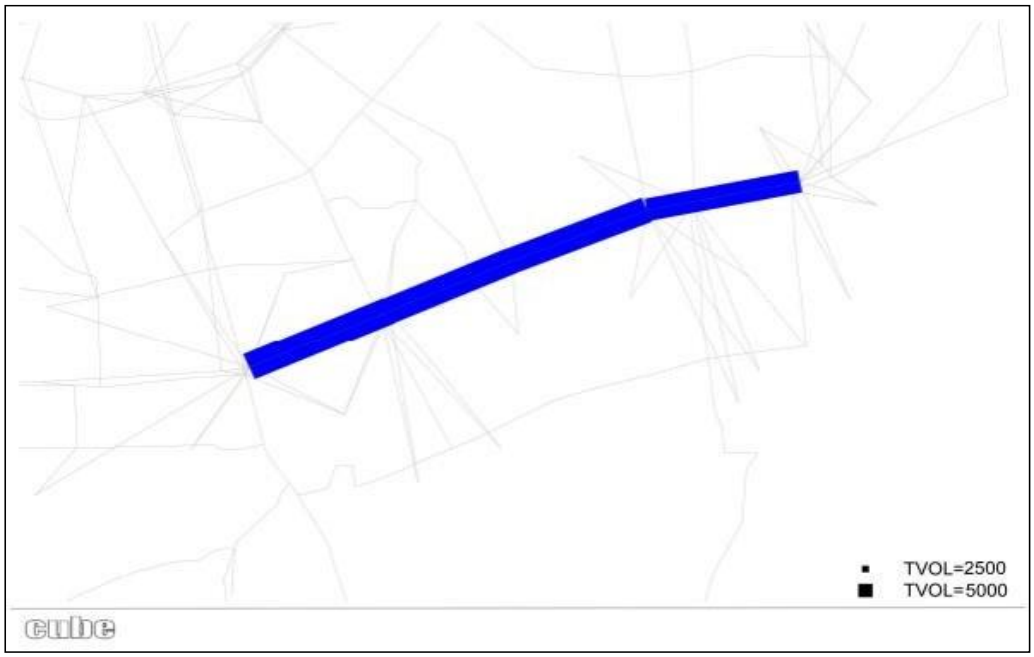


Figure 3.4: Snapshot of Typical (Moderate Scenario in 2031) Transit Assignment Result

3.6 RIDERSHIP ESTIMATION

This section highlights the assignment details especially for public transport along with overall network loading based upon our model results. Public transport network loading represents the metro ridership separately. This is presented at aggregate level for the entire network as well as for different metro lines/ corridors. The peak hour factor has been adopted from the primary survey data.

3.7 ESTIMATION OF RIDERSHIP

Forecasted mode-wise passenger trip matrices assigned to the entire network for horizon years and assigned public transport trips have been obtained for entire network level to estimate the aggregated daily ridership on the proposed metro corridor. The aggregated demand estimated for both scenarios at an aggregated network level is given in the following tables:

Table 3.16: Proposed Corridor Ridership Summary for Moderate Scenario

Year	Daily Passengers Trips	PHPDT	Daily Passenger Kilometres (PKM)	Average Trip Length (km)
2025	17706	961	77907	4.4
2031	34459	1666	158511	4.6
2041	47347	2604	227264	4.8
2051	66296	4070	318221	4.8

Table 3.17: Proposed Corridor Ridership Summary for Optimistic Scenario

Year	Daily Passengers Trips	PHPDT	Daily Passenger Kilometres (PKM)	Average Trip Length (km)
2025	19477	1057	85698	4.4
2031	37905	1833	174362	4.6
2041	52081	2864	249991	4.8
2051	72927	4477	350048	4.8

3.8 BOARDING AND ALIGHTING

From the ridership assignment model stop to stop passengers has been estimated with the CUBE Voyager Public Transport Assignment technique. The route wise station to Station passengers obtained from the model have been utilized to estimate the line loading for different scenarios within the horizon year. Applying the peak hour factor, peak hour boarding and alighting was also captured which helps in identification of the line PHPDT. The same has been provided for both the moderate and optimistic scenarios.

Table 3.18: Station wise Daily Ridership – Moderate Scenario (2025)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	6864	0	0	3386	6864	3386
Rosewood City	1575	2185	617	2432	2192	4616
Sushant Lok 3	1111	1109	1125	968	2237	2078
Sushant Lok	656	3237	2687	714	3342	3951
Sector 56	0	3675	3071	0	3071	3675
Total	**10206**	**10206**	**7500**	**7500**	**17706**	**17706**

Table 3.19: Station wise Daily Ridership – Moderate Scenario(2031)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	11901	0	0	6236	11901	6236
Rosewood City	3833	4870	1561	5663	5394	10533
Sushant Lok 3	2110	2590	2451	1838	4561	4428
Sushant Lok	1390	6520	5616	1489	7005	8009
Sector 56	0	5253	5598	0	5598	5253
Total	**19234**	**19234**	**15225**	**15226**	**34459**	**34459**

Table 3.20: Station wise Daily Ridership – Moderate Scenario(2041)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	18600	0	0	9076	18600	9076
Rosewood City	4748	6839	2226	7151	6973	13991
Sushant Lok 3	2574	3706	3341	2139	5915	5845
Sushant Lok	1493	8187	7036	1566	8529	9754
Sector 56	0	8682	7330	0	7330	8682
Total	**27415**	**27415**	**19932**	**19932**	**47347**	**47347**

Table 3.21: Station wise Daily Ridership – Moderate Scenario(2051)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	29069	0	0	13208	29069	13208
Rosewood City	5880	9882	3514	9031	9395	18914
Sushant Lok 3	3261	5304	4554	2593	7815	7897
Sushant Lok	1605	10281	8815	1648	10420	11929
Sector 56	0	14348	9598	0	9598	14348
Total	**39815**	**39815**	**26481**	**26481**	**66296**	**66295**

Table 3.22: Station wise Peak Hour Ridership – Moderate Scenario

Station Name		2025		2031		2041		2051	
From	To	DIR 1	DIR 2	DIR 1	DIR 2	DIR 1	DIR 2	DIR 1	DIR 2
Vatika Chowk	Rosewood City	961	474	1666	873	2604	1271	4070	1849
Rosewood City	Sushant Lok 3	876	728	1521	1447	2311	1960	3509	2622
Sushant Lok 3	Sushant Lok	876	706	1454	1361	2153	1792	3223	2347
Sushant Lok	Sector 56	514	430	735	784	1215	1026	2009	1344
MAXIMUM PHPDT		961		1666		2604		4070	

Table 3.23: Station wise Daily Ridership – Optimistic Scenario (2025)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	7550	0	0	3725	7550	3725
Rosewood City	1733	2403	679	2675	2412	5078
Sushant Lok 3	1222	1220	1238	1065	2460	2285
Sushant Lok	721	3561	2956	785	3677	4346
Sector 56	0	4042	3378	0	3378	4042
Total	11226	11227	8250	8250	19477	19477

Table 3.24: Station wise Daily Ridership – Optimistic Scenario (2031)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	13091	0	0	6860	13091	6860
Rosewood City	4216	5357	1717	6229	5934	11586
Sushant Lok 3	2321	2849	2696	2022	5017	4871
Sushant Lok	1528	7172	6177	1638	7706	8810
Sector 56	0	5779	6157	0	6157	5779
Total	21157	21157	16748	16748	37905	37905

Table 3.25: Station wise Daily Ridership – Optimistic Scenario (2041)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	20460	0	0	9983	20460	9983
Rosewood City	5222	7523	2448	7866	7671	15389
Sushant Lok 3	2831	4077	3675	2353	6506	6430
Sushant Lok	1643	9006	7739	1723	9382	10729
Sector 56	0	9550	8063	0	8063	9550
Total	30156	30156	21925	21925	52081	52081

Table 3.26: Station wise Daily Ridership – Optimistic Scenario (2051)

Station Name	VATIKA CHOWK - SECTOR 56		SECTOR 56 - VATIKA CHOWK		Total	
	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
Vatika Chowk	31976	0	0	14529	31976	14529
Rosewood City	6469	10872	3866	9934	10334	20806
Sushant Lok 3	3588	5834	5009	2853	8597	8687
Sushant Lok	1765	11309	9696	1813	11461	13121
Sector 56	0	15783	10558	0	10558	15783
Total	**43798**	**43798**	**29129**	**29129**	**72927**	**72927**

Table 3.27: Station wise Peak Hour Ridership – Optimistic Scenario

Station Name		2025		2031		2041		2051	
From	To	DIR 1	DIR 2	DIR 1	DIR 2	DIR 1	DIR 2	DIR 1	DIR 2
Vatika Chowk	Rosewood City	1057	521	1833	960	2864	1398	4477	2034
Rosewood City	Sushant Lok 3	963	801	1673	1592	2542	2156	3860	2884
Sushant Lok 3	Sushant Lok	963	777	1599	1498	2368	1971	3546	2582
Sushant Lok	Sector 56	566	473	809	862	1337	1129	2210	1478
MAXIMUM PHPDT		**1057**		**1833**		**2864**		**4477**	

TLFD for horizon years for moderate and optimistic scenario is as given in following tables:-

Table 3.28: TLFD for horizon years for moderate and optimistic scenario

Moderate Scenario			Optimistic Scenario		
2025			2025		
	Trip	%		Trip	%
0--1	866	5%	0--1	953	5%
1--2	1236	7%	1--2	1359	7%
2--3	1762	10%	2--3	1938	10%
3--4	3374	19%	3--4	3511	18%
4--5	5901	33%	4--5	6692	34%
<6	4567	26%	<6	5024	26%
Total	**17706**	**100%**	**Total**	**19477**	**100%**

CHAPTER 4

SYSTEM SELECTION

4.1 GENERAL

The population growth in cities and urban centres has put a lot of pressure on the infrastructure of these cities. In rapidly developing countries like India the urban infrastructure is stretched to limit and requires very effective solutions. The rapid development in India is not unprecedented and such development earlier took place in several nations of Europe, America and in Japan. So several modes of urban mass transit are now available for solution to the problem of Urban Transit.

Popularity and patronization of Mass a Rapid Transit mode depends upon its efficacy including punctual running of the transport mode. Unless a transport mode is available at a regular interval and headway not more than 10 minutes, the public may not prefer to use and they are likely to continue with the private mode of transport namely cars, two wheelers etc. For any city, mode selection is of the foremost importance keeping in view the demand for the various corridors. The cost of any Mass Rapid Transit system depends upon the mode selected. It is well known that the provision of metro system is the costliest while at grade BRTS may be the cheapest. The selection of mode for any corridor has to be made keeping in view the demand arising in coming 10 years. The life of any MRTS project may be as long as 100 years.

4.2 BENEFITS OF MASS TRANSPORT SYSTEM

The main benefits addressed by mass transport are the mobility and freedom. The sustainability of mass transport has greater potential and major benefits occur through immediate means of helping the environment and conserving energy. In developing countries, like India, benefit through mass transit systems extend to urban poor with affordable fare structure when compared with costs incurred by private transportation on fuels, parking, congestion etc. The supply of planned and integrated mass public transport is the only way to relieve traffic congestion and reduce hours of delay on major travel corridors. Moreover, supply of metro rail system in urban complex will mean a lot in terms of sustainable means of transport that meets the mobility and accessibility needs of people.

It is well known that when routes get congested, the need of grade separated mode of transport is felt. The grade separated mode may be either BRTS, Metro (heavy capacity, medium capacity or light capacity) or monorail or LRT.

4.3 METRO SYSTEM WORLD WIDE

Metro system is used in metropolitan areas to transport large number of people at high frequency. Rapid transit evolved from railways during the late 19th Century. The first system opened was the Metropolitan Railway (London) which connected most of the main railway termini around the city. The technology swiftly spread to other cities in Europe and then to United States and other parts of the world. At present, more than 160 cities have built rapid transit systems, and about twenty five have new systems under construction. The system is seen as an alternative to an extensive road transport system with many motorways. The capital cost is high, with public financing normally required.

India is experiencing a rapid growth in both population and rate of urbanisation. Travel demand is increasing by 5% annually on average, leading to sharp increase in personal vehicles and overwhelming the limited transport infrastructure. A need was therefore felt to develop mass rapid transit systems in metro cities of India to reduce the burden on normal railways as well as road transport service providers. Major cities were facing a situation of rising population and increasing vehicles which had led to problems like congestion and pollution. To overcome these problems, Ministry of Housing and Urban Affairs took an initiative towards development of urban mass transit system by starting metro rail. Metro rail systems are operational in Delhi, Kolkata and Bangalore. Metro projects are now being executed in various cities like, Mumbai, Chennai, Hyderabad, Jaipur, Kolkata, Kochi and Lucknow etc.

LONDON

MEDDELLIN

TAIPEI

PARIS

DELHI

KOLKATA

Figure 4.1: Famous Metro Systems

4.5 OPTIONS FOR PUBLIC TRANSPORT SYSTEM

4.5.1 THE FOLLOWING SYSTEMS ARE MAINLY AVAILABLE FOR URBAN MASS TRANSIT:

(i) Metro System: Metro system is a grade separated dedicated system for high peak hour traffic densities exceeding 20,000 PHPDT. It is characterized by short

distances of stations spaced at 1 km, high acceleration and declaration and scheduled speeds of 30-35 kmph.

(ii) Light Rail Transit: Modern trams-Street Cars running on Rails at grade or elevated with sharp curves of 24m radius. These are extremely popular and operating in large number of European countries. Generally the stations are spaced at 500m to 1 km and have high acceleration and deceleration characteristics. In most of the countries, they are operating at-grade with prioritized signaling at road inter-section.

(iii) Other Rail Based Systems: A number of options are available but have not been introduced in India. Some of these are very briefly mentioned below:-

(a) Maglev: This is an advanced Rail based transit system in which Magnetic Levitation is used to raise the vehicles above the rail surface. Rail wheel interaction is thus avoided and very high speeds are attainable. Maglev Levitation can either be due to attractive force or due to repulsive forces.

(b) Linear Induction Motor (LIM) Train: This is also an advanced Rail based transit system in which propulsion is through a Linear Induction Motor whose stator is spread along the track. The rotor is a magnetic material provided in the under frame of train. In the technology the tractive force is not transmitted through rail-wheel interaction, and so there is no limitation on account of adhesion. This technology is most appropriate for turnouts, as the height of the tunnel can be reduced to lower height of cars.

(iv) Monorail: Monorail trains operate on grade separated dedicated corridors with sharp curves of up to 50m radius. This is a rubber tyred based rolling stock, electrically propelled on concrete beams known as guide-ways. The system is extremely suitable in narrow corridors as it requires minimum right of way on existing roads and permits light and air and is more environmental friendly. This is prevalent in several countries for traffic densities of over 20,000 PHPDT.

(v) Bus Rapid Transit System: This system involves operation of buses on a dedicated corridor (except of traffic integration) at a high frequency to achieve PHPDT.

For providing a very high transport capacity say 20,000 PHPDT, about 200 buses shall be required per hour *i.e.,* at headway of 20 seconds. Such a high PHPDT can be achieved by providing two lanes of traffic in each direction and elimination of traffic intersection on the route.

(vi) Automated Guide way Transit System: The term is used for systems other than conventional rail based system on grade separated guide ways. The system can be rail based or rubber tire based but fully automated guided systems with driver less operation.

4.5.2The salient features of the various Transit Systems are summarized as under:-

Table 4.1

System	LRT (Light Rail Transit) (elevated)	AGT (Automated Guide way Transit)	Straddle type Monorail
Exterior of Vehicle			
	It is a transport system that runs on the exclusive beam slab track mainly built over highways.	It is a new transport system that runs on the exclusive track built on elevated structure with lightweight vehicle.	It is a new transport system that runs straddling on the exclusive beam track mainly built over highways.
Rolling stock			
Length (m)	30.0 (articulated type)	9.0	15.0
Width (m)	2.5	2.5	3.0
Height (m)	3.7	3.5	5.2
Number ofdoors	3	2	2
Wheel arrangement	2-2-2	2	2-2
Weight (tare) (ton)	44	10.5	27.9
Axle load (max)	10tf	9tf	11tf
Type of car load	Concentrated load	Concentrated load	Concentrated load
Running gear and track structure			
Traction system	Rotary Motor and steel wheel	Rotary Motor and rubber tire	Rotary Motor and rubber tire
Brake system	Electric brake and hydraulic brake	Electric brake and air brake	Electric brake and air brake
Guidance System	Steel rail	Lateral pinched Guidance	Guide Wheel (Rubber)
Power collector	Catenary	Conductor rail	Conductor rail
Voltage	D.C. 750 V	A.C. 750 V (three	D.C. 1,500 V

		phase)	
Track	Steel rail	Concrete slab	Track beam
Switch			
constitution	Switch and crossing	Lateral pinched switch	Flexure track beam
The Operation Characteristic			
Maximum speed	80 km/h	80 km/h	80 km/h
Schedule speed	30 km/h	30 km/h	30 km/h
Minimum curve radius	30m	30m	70m
Maximum gradient	4 %	6 %	6 %
Acceleration	3.5km/h/s	3.5km/h/s	3.5km/h/s
Deceleration Service brake	3.5km/h/s	4.8km/h/s	4.0km/h/s
Emergency brake	4.5km/h/s	6.0km/h/s	4.5km/h/s
Automatic Train operation	There is few example of it.	It has been developed aiming for automated operation. There are many examples of automated operation including driverless operation.	There are three cases of ATO operation in Japan.
Transportation capacity			
1 car seat	60	17	45
standing	90	33	60
Total	150 (30m)	60 (L=9m)	105 (L=15m)
4 car seat	120	162	180
standing	180	198	240
total	300 (30m+30m)	360 (6 car L=54m)	420 (L=60m)
8 car seat	240	324	360
standing	360	396	480
total	600 (30m+30m+30m+30m)	720 (12 car L=108m)	840 (L=120m)
8 car PHPDT (170% ,	24,480	17,300 (100%)	34,300

headway 2.5 min)			
	It is possible to deal with over 24,480 PHPDT of demand. (train length 120m)	It is possible to deal with up to 11,600 PHPDT of demand. (train length 108m)	It is possible to deal with over 34,300 PHPDT of demand. (train length 120m)
Structure			
Superstructure	Concrete slab	Concrete slab	Track beam
Pier and foundation	Concrete	Concrete	Concrete
Maintainability and cost			
Track	In addition to grinding of surface of rails, track maintenance work will require much time.	It has small maintenance of track.	It has small maintenance of track.
Vehicle	Maintenance of rotary motor and grinding of steel wheels shall be necessary.	Maintenance of rotary motor and exchange of rubber tires after every 120,000 km running shall be necessary.	Maintenance of rotary motor and exchange of rubber tires after every 120,000 km running shall be necessary.
Effect on ambient surrounding and harmony with urban landscape			
Effect on ambient surrounding	Its noise proof wheels make as small noise as rubber tires make.	Level Crossing between AGT and road is not available. This system, with rubber tires, makes small noise and vibration. Because its running surfaces are made of concrete slab, there remain problems like inhibition of sunshine or radio disturbance.	This system, with rubber tires, makes small noise and vibration.
Urban landscape	This system is inferior to other systems in terms of landscape because overhead wires for power collection must be installed.	Because its superstructure is made of concrete slab, oppressing feeling of view is an issue.	This system is superior to AGT or LIM Train in terms of landscape because its superstructure consists of only track beams that have small section.
Emergency evacuation			
	Evacuation other train	Evacuation other train	Evacuation other train

	(end to end or side by side)	(end to end or side by side)	(end to end or side by side)
	Walk way	Walk way	Evacuation device
	In case of emergency, supporting vehicles will engage in rescue activities. If supporting vehicles cannot do that, it is possible for passengers to evacuate to nearest stations through evacuation passage by walk.	In case of emergency, supporting vehicles will engage in rescue activities. If supporting vehicles cannot do that, it is possible for passengers to evacuate to nearest stations through evacuation passage by walk.	In this system, supporting vehicles are needed for passengers' emergency evacuation, which is of no matter because this straddle type system have many actual performances of running in Japan and has a established method for rescue.
Operation cost			
Electric energy			2.2kwh/car-km
Rolling stock cost			
/car			7.5 Crores

System	Urban Maglev (HSST)	Metro/Subway	Bus Rapid transit
Exterior of Vehicle	It is a new transport system that runs on the exclusive beam slab track mainly built over highways.	It is Medium to Heavy Rail Transit (HRT) is a specialized electrically powered rail system carrying passengers within urban areas,	It is a bus operation generally characterized by use of exclusive or reserved rights-of-way (bus ways) that permit higher speeds and avoidance of delays from general traffic flows.
Rolling stock			
Length (m)	14.0	24.0	18 (articulated type)
Width (m)	2.6	3.0	2.0
Height (m)	4.3	4.2	3.5
Number of doors	2	44	2
Wheel arrangement	5 module / car	2-2 or 3-3	Independent Axles

System	Urban Maglev (HSST)	Metro/Subway	Bus Rapid transit
Weight (tare) (ton)	15.0	41	12 to 16
Axle load (max)	2.3tf/m	17tfm	9tf to 15.3tf
Type of car load	Uniform load	Concentrated load	Concentrated load
Running gear and track structure			
Traction system	Linear Induction Motor and Electromagnetic levitation system	Rotary Motor and steel wheel	Rubber tyre
Brake system	Electric brake and air brake	Electric brake and hydraulic brake and Regenerative brakes	Hydraulic Brakes
Guidance System	Electromagnetic levitation system	Steel Rail	None/ special guide wheels on kerbs
Power collector	Conductor rail	Catenary or Conductor rail	Not applicable
Voltage	D.C. 1,500 V	D.C. 1500 V, A.C. 25kv	None
Track	Steel rail (Electromagnetic levitation system)	Steel rail	Road
Switch			
constitution	Flexure track beam	Switch and crossing	Road Crossings
The Operation Characteristic			
Maximum speed	80 km/h	80 to 100 km/h	80 km/h
Schedule speed	30 km/h	35 km/h	20 km/h
Minimum curve radius	50m	100m	12m
Maximum gradient	6 %	6 %	
Acceleration	3.5km/h/s	3.5km/h/s	
Deceleration Service brake	3.5km/h/s	3.5km/h/s	
Emergency brake	4.5km/h/s	4.5km/h/s	

System	Urban Maglev (HSST)	Metro/Subway	Bus Rapid transit
Automatic Train operation	There are cases of ATO operation in Nagoya Japan.	Automatic Train operation	No
Transportation capacity			
1 car seat	32	75	70
standing	42	125	40
Total	74 (L=14m)	200(L=24m)	110(L=18)
4 car seat	128	300	
Standing	172	500	
Total	300 (L=56m)	800(L=96m)	
8 car seat	256	600	
Standing	344	1000	
Total	600 (L=112m)	1600(L=192m)	
8 car PHPDT (170% , headway 2.5 min)	23,100 (max 160%)	50,000	
	It is possible to deal with over 23,100 PHPDT of demand. (train length 112m)	It is possible to deal with over 50,000 PHPDT of demand. (train length 112m)	It is possible to deal with max 6,000 PHPDT of demand.
Structure			
Superstructure	Concrete slab	Concrete slab	Roads
Pier and foundation	Concrete	Concrete	
Maintainability and cost			
Track	It has less maintenance of track as there is less physical movement.	It has less maintenance of track.	It requires maintenance of roads.
Vehicle	As it has no rotary motor, it is excellent on maintenance.	Maintenance of rotary motor and grinding of steel wheels shall be necessary.	Maintenance of engine and rubber tyres shall be necessary.
Effect on ambient			

System	Urban Maglev (HSST)	Metro/Subway	Bus Rapid transit
surrounding and harmony with urban landscape			
Effect on ambient surrounding	There remain problems like inhibition of sunshine or radio disturbance, because its running surfaces are made of concrete slab.	This system is noisy due to steel wheel arrangement	Noise and Pollution Problems
Urban landscape	This system is inferior to other systems in terms of landscape because overhead wires for power collection must be installed.	Because its superstructure is made of concrete slab, oppressing feeling of view is an issue. This system is inferior to other systems in terms of landscape because overhead wires for power collection must be installed.	No such issues
Emergency evacuation			
	Evacuation other train (end to end or side by side)	Evacuation other train (end to end or side by side)	No problems
	Walk way	Walk way	
	In case of emergency, supporting vehicles will engage in rescue activities. If supporting vehicles cannot do that, it is possible for passengers to evacuate to nearest stations through evacuation passage by walk.	In case of emergency, supporting vehicles will engage in rescue activities. If supporting vehicles cannot do that, it is possible for passengers to evacuate to nearest stations through evacuation passage by walk.	
Operation cost			
Electric energy	2.5kwh/car-km		
Rolling stock cost			
/ car		6 to 9 Crores	Few Lakhs

4.6 CHARACTERISTICS OF URBAN TRANSIT SYSTEM

4.6.1 TRANSPORT CAPACITY

It is product of passenger carrying capacity of a train and maximum permissible frequency of train operation. The passenger carrying capacity is determined by number of cars (units/ coaches), which can be clubbed to form a train and dimensions of each car. To compare different systems uniform packing density is considered although for different systems different crush loading may be permissible. The passenger carrying capacity is dependent on the following:-

(a) Dimensions of vehicle: Length and breadth- useful area. The car length vary from about 9m to 24m for most of systems. The width varies from 2.5m to 3.6m.

(b) Passengers per m^2: The normal to crush loading of most systems varies from 4 to 7 passengers per m^2.

(c) No of Cars per train: The cars can be from 1 to 15 for most of the systems and the train length can be up to 315m.

Table 4.2
Passenger carrying Capacity per Train (typical) for different Transit Systems

S. No.	Transit System	Car Size (length 'm' x breadth 'm')	Car Capacity (No. of passengers /car)	No of Cars /Train	Train Length 'm'	Train Capacity passenger /Train
1	Large-type monorail	15 x 3	175	2 to 8	120	1400 for 8cars
2	Heavy Metro Rail	21 to 24 x 2.8 to 3.6	250	8 to 15	190 to 315	2000 for 8cars
3	Bus	18 x 2.5 to 3	70 to 100	1 to 2	18	100 per bus
4	AGT	9 to 13 x 2.5 to 3	60 to 120	2 to 12	108	720
5	LRT	12* x 2.65	145*	3 to 6	24	200*
6	Maglev	16 x 2.6	170	2 to 8	128	1360 for 8 cars

(Standee Occupancy rate: 0.14 m^2/ passenger)
* Smallest combination of modules for an independent LRT

(d) Headway: The headway and frequency of train operation depends on Signalling and Rolling Stock characteristics viz. control systems, acceleration (tractive effort) and maximum permissible speed (adhesion). A graph showing the carrying capacity of different modes and passenger capacity is given below (see next page):

(e) Train Signalling and Control Systems: The various train Signalling and control systems which help in increasing frequency of operation are:

- **Automatic Train Operation and Control System (ATO)**
- **Automatic Train Supervision System (ATS)**
- **Automatic Train Protection System (ATP)**

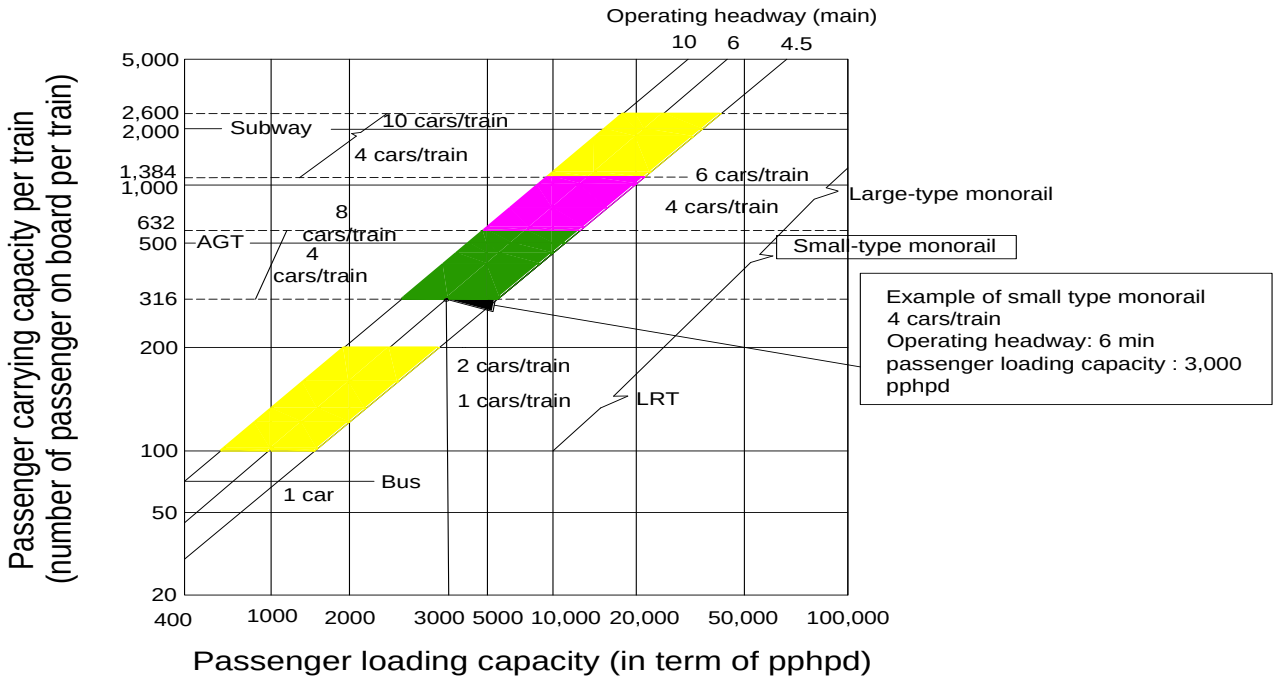


Figure 4.2: Transport Capacity of Different Modes as a Function of Headway

(f) Tractive effort and Acceleration: By increasing the tractive effort and acceleration it is possible to increase transportation capacity both by improving the average speed and also by permitting higher frequency of train operation. The factors influencing tractive effort/ acceleration/ speed are:-

- Adhesion
- Ratio of Motor coaches to trailer coaches
- Traction Motor Rating
- No of Traction Motors per car
- Drive System

4.6.2 SIGNALLING & TELECOMMUNICATION SYSTEM

(a) Train Signaling and Control Systems: -The main design feature of signalling and train control shall be proven and advance system being used worldwide. It shall provide the highest security level for means of an effective train control ensuring strict safety in train movements. At the same time, it shall meet the requirements for efficient train operation and high quality service.

The requirements of Metro are planned to be achieved by adopting CATC (Continuous Automatic Train Control System) based on ''CBTC'' (Communication Based Train Control System) which includes ATP (Automatic Train Protection), ATO (Automatic Train Operation) and ATS (Automatic Train Supervision) subsystems using radio communication between trackside and trains.

(b) Telecommunication System: - Telecommunication facilities are helpful in meeting requirement of operations of trains.

- Supplementing the Signaling system for efficient train operation.
- Exchange of managerial information.
- Crisis management during emergencies.
- Passenger information system.

It acts as a communication back-bone for signaling system and other systems and provides Telecommunication services to meet operational and administrative requirement of metro network.

The proposed telecom system shall include Radio System, Fibre Optic System, and Telephone system, Clock System, CCTV System, Data Channels, Power Supply Systems, Recording System, Passenger Information and Display System, Passenger Announcement System etc.

(c) Automatic Fare Collection System: - To achieve objective of metro system, ticketing system should be simple, easy to use / operate and maintain, easy on accounting facility, capable of issuing single / multiple journey tickets, amendable for quick fare changes and require overall less manpower. In view of above computer based automatic fare collection is proposed.

Seamless ticketing for other metro networks and the commuters travel hustle free by different mode of transports viz. Metro, Suburban trains, Buses, Parking, Toll without purchasing multiple tickets for each mode separately.

4.6.3 GEOMETRIC CHARACTERISTICS:

(i) Minimum Radius: Varies from 50m minimum for LRT, 25m for Monorail to 120m for Metro.

(ii) Right of Way: The Right of way required for a Grade Separated (elevated) system is solely determined by the building line provided the piers can be accommodated on the central verge. For an At Grade system the Right of Way required is determined by lanes required for motorized/ non motorized vehicles in addition to width of road required for the mass transit system. The minimum right of way required is about 22.5m.

(iii) Gradient: Ruling gradient varies from system to system.

- **Environmental Characteristics Noise:**

  Rubber tyre on road is less noisy as compared to steel wheels on rails.

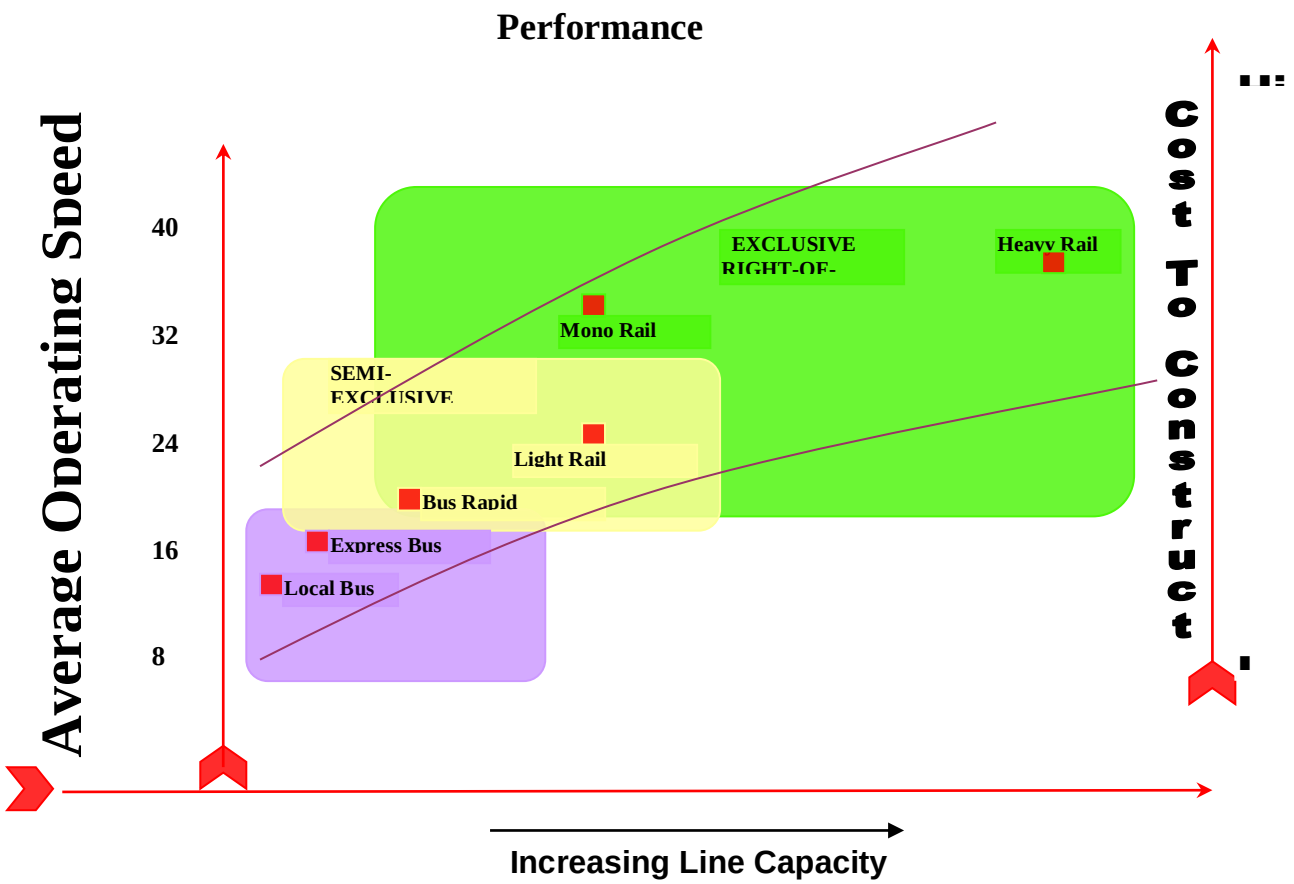
- **Aesthetics-Air and Sunshine:** The at grade systems are least restrictive in exposing the corridors, buildings next to these corridors and people (on these corridors/ inhabiting buildings next to these corridors) to natural air and sunshine.

  The effect of elevated systems on the existing buildings and their inhabitants is the worst. Comparatively the best system as far as this factor is considered is underground metro rail system.

- **Pollution:** All electrically driven systems are better than diesel operated systems. This is where Rail based systems score over the Road based vehicles.

  Graphical comparisons of the most important characteristics which influence selection of different technologies are depicted in the Figure 4.3 below:-

Fig-4.3



As shown, carrying capacity increases with the speed of the service and the cost to construct. The rail family can carry more passengers per hour at a faster speed, but most systems cost more to construct than do bus-based systems.

4.6.4 NEED FOR A GRADE SEPARATED TRANSIT SYSTEM

a) A large number of inter change points.
b) High vehicular density.
c) Excessive congestion and delays on the corridors, especially during peak hours.
d) As the corridors are normally following busy areas of the city, it is not easy to find the required areas for depots, workshops.

Additional capacity needs to be created on the corridors to accommodate more traffic on the roads. Mere re-allocation of road space to provide for dedicated bus lanes for public transport may not serve the purpose due to presence of large number of private vehicles, which will continue to operate, and whose numbers will continue to rise.

Further presence of large number of inter change points will severely restrict speed of operation of public transit system employing dedicated lanes. Considering projections of travel demand on these corridors it is essential to provide grade separated transit system for these corridors.

In view of levels of services that will be required to meet the travel demand on the corridors, a fixed guide way, grade separated system is unavoidable.

4.6.5 DISCUSSIONS ON SUITABILITY OF VARIOUS MODES

The following shows the suitability of various modes of public transport in terms of parameters.

Table 4.3: Suitability Matrix of Public Transport Modes

Mode of transport	Noise Generation	Noise Effect on Road users	Noise Effect on Inhabitants	Aesthetics- Exposure to Sunshine	Aesthetics- Effect on Skyline	Energy Efficiency	Pollution
Metro Rail elevated	√	x	√	√	√	x	x
Metro Rail underground	x	x	x	x	x	x	x
LRT elevated	√	x	√	√	√	x	x
LRT at Grade	√	√	√	x	x	x	x
Monorail	x	x	x	x	x	√	x
Subway elevated	√	x	√	√	√	x	x
AGT elevated	x	x	x	√	√	√	x
LIM/Maglev elevated	x	x	x	√	√	√	x
Bus At Grade	√	√	√	x	x	√	√
Bus Elevated	x	x	x	√	√	√	√

√	Adverse
X	No Adverse Effect

4.6.6 MODE SELECTION NORMS IN INDIA

Metro Rail Policy (2017) and the Appraisal Guidelines for Metro Rail Project Proposals (September, 2017) issued by Government of India Ministry of Housing and Urban Affairs (MOHUA) mandates compulsory incorporation of Alternatives Analysis in the Detailed Project Report of Metro Rail for submitting the same to the central government while seeking central assistance.

Guidelines for adoption of various modes – During 12th Five Year Plan, a Group were formed to study various types of modes and lay down the criteria for their adoption. This Group has recommended the PHPDT and other parameters for various modes as given below:

Table 4.4: Mode Selection-Recommendation by Working Group on Urban Transport for 12th five-year plan

Mode Choice	PHPDT in 2021	Population as per 2011 census(mill.)	Av. trip length (km.)
Metro	More than 15000 in 5 Km. stretch	More than, equal to 2	More than 7-8
LRT at grade	Less than, equal to 10000	More than 1	More than 7-8
Mono Rail	Less than, equal to 10000	More than 2	About 5-6
BRT	4000-20000	More than 1	More than 5
Org. City Bus		>1 Lac, 50000 in case of hilly towns	>2 to 3

However, the above recommendations are only for guidance and the decision has to be taken case to case basis after calculating the return of the project.

4.6.7 FEASIBILITY OF OTHER SYSTEMS:

System Selection is about finding best alternative to address the transportation related problems for specific corridors or areas of a City. Detailed appraisal guidelines for mass transport project proposals have been laid down by Ministry of Housing and Urban Affairs (MoHUA), Government of India, 2017. The guideline stresses CMP to be pre-requisite for conception of mass transport projects in cities. The guideline enables to identify the system having maximum utility and satisfy basic criteria. The policy document has listed guidelines for preparation of Comprehensive Mobility Plan (CMP), Alternatives Analysis and Detailed Project Report (DPR) for most viable alternative.

Maglev is an energy guzzler and the AGT is primarily a proprietary system. Sky train is yet on experimental stages. LRT & Mono rail system may not be viable in the present scenario.

4.6.8 MODE RECOMMENDATION FOR THE CORRIDOR:

Due to extremely low projected ridership demand in the horizon year 2025 worked out from traffic and transportation studies conducted in between Sector 56 GGN to Vatika Chowk with approximate length of about 6.34 km**,** DMRC recommends not to implement this "Stand Alone" metro project at this stage as this shall not economically and financially be viable at all. As from table 4.5, in year 2025 daily boarding figure is 17,706 & PHPDT 961 for moderate scenario and for optimistic scenario daily boarding figure is 19,477 & PHPDT 1057. To meet this demand Conventional Bus /ITS enabled E-Bus System is sufficient.

Table 4.5: Projected Traffic figure under various scenario

Scenario		Moderated Scenario			Optimistic Scenario		
Target Year	Route Length (km)	Daily Ridership (Passengers)	PHPDT	Average Trip Length	Daily Ridership (Passengers)	PHPDT	Average Trip Length
2025	6.34	17706	961	4.4	19477	1057	4.4
2031	6.34	34459	1666	4.6	37905	1833	4.6
2041	6.34	47347	2604	4.8	52081	2864	4.8
2051	6.34	66296	4070	4.8	72927	4477	4.8

However Government of Haryana (GoH) vide their letter no HMRTC/2019/AO/707 dated 01/07/2019, has envisaged to run Gurugram-Faridabad direct Metro Connectivity via Southern Peripheral Road (SPR) and shall terminate the same at Vatika Chowk in Gurugram. The aforesaid Faridabad- Gurugram metro corridor shall also cover this small portion of 6.34 kms spanning in between Sec 56, GGN and Vatika Chowk along SPR. Or another option is to serve Golf course extension road by way of extending the existing rapid metro from Sec 56 Gurugram to Vatika Chowk along SPR.

Therefore, it may not be prudent to implement this Rail based MRTS project (short spanned) as a "Stand Alone" metro project, which may not be justified and viable. Alternatively, this corridor could be implemented as an integral part of Faridabad- Gurugram metro corridor for which study (DPR) is being undertaken separately.

CHAPTER 5

GEOMETRIC DESIGNING PARAMETERS AND ALIGNMENT DESCRIPTION

5.1 GENERAL

This chapter deals with geometrical standards adopted for horizontal and vertical alignments, route description etc. The proposed corridor along **SPR** in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana** will consist of Standard Gauge (SG) line.

The geometrical design norms are based on international practices adopted for similar metro systems with standard gauge. The maximum operational speed for this connection will be 80 kmph and design speed of 90kmph.

The elevated tracks will be carried on box-shaped/U-shaped/Double U-girder elevated decking supported in single circular piers, generally spaced at 28m centres and located on the median of the road. The horizontal alignment and vertical alignment are, therefore, dictated to a large extent by the Geometry of the road and ground levels followed by the alignment.

5.2 GEOMETRIC DESIGN PARAMETERS

The design parameters related to the Metro system described herewith have been worked out based on a detailed evaluation, experience and internationally accepted practices. Various alternatives were considered for most of these parameters but the best-suited ones have been adopted for the system as a whole.

Bahadurgarh -Sampla metro corridor is to be designed for a maximum speed of 90 kmph. Permanent restrictions needed due to curvature and other reasons will be followed.

5.2.1 HORIZONTAL ALIGNMENT

As far as possible, the alignment follows the existing roads. This leads to introduction of horizontal curves. On consideration of desirable maximum cant of 110 mm and cant deficiency of 85 mm on Metro tracks, the safe speed on curves of radii of 400 m or more is 80 km/h. On elevated sections minimum radius of 160 m has been used at one location having speed potential up to 40 km/h.

HORIZONTAL CURVES

Table 5.1: Horizontal Curve Parameters

Description	Underground Section	Elevated Section
Desirable Minimum radius	300 m	200 m
Absolute minimum radius	200 m (only c/c)	120 m
Minimum curve radius at stations	1000 m	1000 m
Maximum permissible cant (Ca)	125 mm	125 mm
Maximum desirable cant	110 mm	110 mm
Maximum cant deficiency (Cd)	85 mm	85 mm

5.2.2 TRANSITION CURVES

It is necessary to provide transition curves at both ends of the circular curves for smooth riding on the curves and to counter act centrifugal force. Due to change in gradients at various locations in the corridor, it is necessary to provide frequent vertical curves along the alignment. In case of ballastless track, it is desirable that the vertical curves and transition curves of horizontal curves do not overlap. These constraints may lead to reduced lengths of transition curves at certain locations. The transition curves have certain minimum parameters:-

- Length of Transitions of Horizontal curves (m)

  Minimum: 0.44 times actual cant or cant deficiency (in mm) whichever is higher.

  Desirable: 0.72 times actual cant or cant deficiency, (in mm) whichever is higher.

- Overlap between transition curves and vertical curves not allowed.
- Minimum straight between two Transition curves (in case of reverse curves): either 25 m or Nil.
- Minimum straight between two Transition curves (in case of same flexure curves): either 25 m or both curves should be converted in to the compound curve by introducing single transition between the two circulars.
- Minimum curve length between two transition curves: 25 m

5.2.3 VERTICAL ALIGNMENT AND TRACK CENTRE

(a) ELEVATED SECTIONS

The viaducts carrying the tracks will have a vertical clearance of minimum 5.5 m above road level. To achieve this clearance rail level normally vary from 9.0 m to 9.5 m from the Ground level. However, at stations which are located above

central median, the rail level will be 13.5 m above the road level with concourse at mezzanine. These levels will, however, vary marginally depending upon where the stations are located.

The track center on the elevated section is kept as 4.1 m uniform throughout the corridor to standardize the superstructure, except at few locations, wherever scissors crossovers are planned, it is kept 4.5 meter.

(b) GRADIENTS

Normally the stations shall be on level stretch. In limited cases, station may be on a grade of 0.1 % between stations, generally the grades may not be steeper than 3.0 %. However, where existing road gradients are steeper than 2 %, or for Switch over Ramps gradient up to 4% (compensated) can be provided in short stretches on the main line.

(c) VERTICAL CURVES

Vertical curves are to be provided when change in gradient exceeds 0.4%. However, it is recommended to provide vertical curves at every change of gradient.

(d) RADIUS OF VERTICAL CURVES:

- On main line (desirable) : 2500 m
  (Absolute minimum) : 1500 m
- Other Locations : 1500 m
- Minimum length of vertical curve : 20 m

5.2.4 DESIGN SPEED

The maximum sectional speed will be 80 km/h. However, the applied cant, and length of transition will be decided in relation to normal speeds at various locations, as determined by simulation studies of alignment, vertical profile and station locations. Computerized train simulation studies need to be conducted with proposed gradients at the time of detailed design stage. This is with the objective of keeping down the wear on rails on curves to the minimum.

Table 5.2: Cant, Permitted Speed & Minimum Transition Length for Curves

RADIUS	CANT	MAXIMUM PERMISSIBLE SPEED	ELEVATED AND AT-GRADE
(Meters)	(mm)	(Kmph)	(mm)
3000	15	80	3650
2800	15	80	3650
2400	20	80	3650

2000	20	80	3650
1600	25	80	3650
1500	30	80	3650
1200	35	80	3650
1000	45	80	3700
800	55	80	3700
600	70	80	3750
500	85	80	3750
450	95	80	3800
400	105	80	3800
350	110	75	3800
300	110	70	3850
200	110	55	3950
150*	110	45	4050
150*	0	30	4050
120*	110	40	4150
120*	0	25	4150
100**	110	40	

Notes: (a)The track spacing is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.

(b) Track spacing shown is not applicable to stations which should be calculated depending on specific requirement.

(c) Figures for any intermediate radius of curvature may be obtained by interpolating between two adjacent radii. For higher radii, values may be extrapolated.

5.2.5 STATION LOCATIONS

Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport.

5.3 TRACK STRUCTURE

Track on Metro Systems is subjected to intensive usage with very little time for day-to-day maintenance. Thus it is imperative that the track structure selected for Metro Systems should be long lasting and should require minimum or no maintenance and at the same time, ensure highest level of safety, reliability and comfort, with minimum noise and vibrations. The track structure has been proposed keeping the above philosophy in view.

Two types of track structures are proposed for the corridor. The normal ballasted track in Depot (except inside the Workshops, inspection lines and washing plant

lines). The ballastless track is recommended on Viaducts and inside tunnels as the regular cleaning and replacement of ballast at such locations will not be possible.

For the depots, ballasted track is recommended as ballastless track on formation is not suitable due to settlement of formations. Ballastless track in depot is required inside the workshop, on inspection lines and washing plant lines.

From considerations of maintainability, riding comfort and also to contain vibrations and noise levels, the complete track is proposed to be joint-less. The track will be laid with 1 in 20 canted rails and the wheel profile of Rolling Stock should be compatible with the rail cant and rail profile.

5.4 RAIL SECTION

Keeping in view the proposed axle load and the practices followed abroad, it is proposed to adopt UIC-60 (60 kg. /m) rail section. Since on main lines, sharp curves and steep gradients would be present, the grade of rail on main lines should be 1080 Head Hardened as per IRS-T-12-2009. As these rails are not manufactured in India at present, these are to be imported. For the Depot lines, the rails of grade 880 are recommended, which are available indigenously.

5.5 BALLASTLESS TRACK ON MAIN LINES

On the viaducts, it is proposed to adopt plinth type ballastless track structure with RCC derailment guards integrated with the plinths. Further, it is proposed to adopt fastening system complying to performance criteria laid down by Indian Railways on ballastless track structures, with a base-plate spacing of 60 cm. on viaducts.

5.6 BALLASTLESS/BALLASTED TRACK IN DEPOT

The ballastless track in Depot may be of the following types:

- Supported on steel pedestal for inspection lines.
- Embedded rail type inside the Workshop.
- Plinth type for Washing line.
- Track is to be laid on PRC sleepers with sleeper spacing of 65 cm. All the rails are to be converted into rail panels by doing flash butt/Thermit welding.

5.7 TURNOUTS

All turn-outs/crossovers on the main lines and other running lines shall be as under:-

Table 5.3: Turn-Outs

S.No.	Description	Turn out Type
01	Main Line	1 in 9
02	Depot/Yard Lines	1 in 7

5.8 BUFFER STOPS

On main lines and Depot lines, friction buffer stops with mechanical impact absorption (non-hydraulic type) will be provided. In elevated portion, the spans on which friction buffer stops are to be installed will be designed for an additional longitudinal force, which is likely to be transmitted in case of Rolling Stock hits, the friction Buffer Stops.

5.9 RAILSTRUCTURE INTERACTION

For continuing LWR/CWR on Viaducts, the elevated structures will be adequately designed for the additional longitudinal forces likely to be transmitted as a result of Rail-Structure interaction. Rail structure interaction study will determine the need and locations of Rail Expansion Joints (REJ) required to be provided.

5.10 ROUTE ALIGNMENT

The proposed metro corridor shall run along **Southern Peripheral Road (SPR)** in between sec-56 GGN and Vatika Chowk, Gurugram with a approximate length of 6.34Kms with 05 new metro stations namely Sector 56 GGN, Sushant Lok, Sushant Lok Phase-3, Rosewood city and Vatika Chowk. This metro corridor originates from Sec-56 GGN. The chainage of Sec 56 metro station is considered as 130.30mts (keeping dead end as 0.00 kms). At this point, the corridor shall provide an interchange with Sec 55-56 metro station of **Rapid Metro, Gurgaon.** The corridor further runs along SPR towards Sohna road and reaches Sushant lok metro station at chainage 1653.10 mts where it connects the areas such as Kendriya Vihar, Bahrampur, Sector 62 and Sushant Lok. The corridor further runs along SPR and passes Sushant Lok Phase-3 at chainage 3113.00 mts where it connects nearby places like Tiagra, Nangli Umarpur, Sector 50, Mayfiel Garden and Sector 65.Thereafter the corridor moves further and reaches at Rosewood City metro station at chainage 4948.40 mts where it connects nearby places like sec 49, Sec 50, sec 65 & Bahdurshahpur. The corridor now runs further along SPR and terminates at Vatika Chowk, Gurugram at chainage 6229.80 mts where it connects nearby places like Rosewood city, Sector 49 Badshahpur, Nirvana Country II, Sector 66 and Sector 69 chainage for dead end shall be 6340.10 mts. The nearest National Highway to this proposed metro corridor is Sohna- Gurgaon Road near Vatika Chowk station location. The corridor shall provide interchange with proposed metro corridor Gurugram- Panchgaon at Vatika Chowk location. This corridor will provide connectivity to the proposed RRTS along Southern peripheral road. The metro corridor along SPR between Sec 56 and Vatika Chowk, Gurugram has been shown in Figure 5.1.

Figure 5.1: Showing Sector-56 Gurugram to Vatika Chowk

5.11 INTER- STATION DISTANCES

Inter-Station distances in between proposed metro stations shall be as per Table 5.4 given hereunder:-

Table 5.4: showing inter station distances

S.N	From	To	Inter-Station Distances (Mts)
01	Sector-56, GGN	Sushant Lok	1522.80
02	Sushant Lok	Sushant Lok Phase-3	1459.90
03	Sushant Lok Phase-3	Rosewood City	1835.40
04	Rosewood City	Vatika Chowk, Gurugram	1281.40
05	Vatika Chowk, Gurugram	Dead End	110.30

5.11.1 The Details of the Horizontal curves for **Sec-56 GGN to Vatika Chowk, Gurugram (Haryana)** Metro Corridor as designed on Google are given in the table below:-

Table 5.5: Details of Horizontal curves

Sec 56 Gurugram to Vatika Chowk Corridor (Horizontal Curve Details)								
Curve No.	Hand of Arc	Radius (m)	Arc Length (m)	Transition Length (m)		Included Angle	Tangent Length (m)	Straight Length (m)
				L1	L2	D M S		790.023
1	Right	302.515	44.148	55	55	18.4642	77.584	464.276
2	Left	-302.515	44.973	55	55	18.5605	78.009	1096.064
3	Left	-1002.52	53.822	25	25	4.3017	51.932	853.164
4	Left	-4002.52	35.833	25	25	0.5215	42.917	1818.719
5	Left	-1502.52	75.256	25	25	3.4923	62.647	163.375
6	Right	1002.515	104.588	25	25	7.2422	77.386	375.827

CHAPTER 6

STATION POSITIONS AND PLANNING PARAMETERS

6.1 METRO CORRIDOR ALONG SPR IN BETWEEN SEC-56 AND VATIKA CHOWK, GURUGRAM

This metro connectivity along SPR in between **Sec-56 GGN and Vatika Chowk, Gurugram** shall be 6.34 kms long and shall have 05 stations. The Station names, Chainages, inter-station distances etc are given in Table 6.1 below:-

Table 6.1: Indicating Chainages, Inter-Station Distances etc

S.N	From	To	Inter-Station Distances (Mts)
01	Sector-56, GGN	Sushant Lok	1522.80
02	Sushant Lok	Sushant Lok Phase-3	1459.90
03	Sushant Lok Phase-3	Rosewood City	1835.40
04	Rosewood City	Vatika Chowk, Gurugram	1281.40
05	Vatika Chowk, Gurugram	Dead End	110.30

6.2 PLANNING AND DESIGN CRITERION FOR METRO STATIONS

Salient features of a typical metro station are as follows:

(1) The stations can be divided into public and non-public areas (those areas where access is restricted). The public areas can be further subdivided into paid and unpaid areas.

(2) The platform level has adequate assembly space for passengers for both normal operating conditions and a recognized abnormal scenario.

(3) The platform level at elevated stations is determined by a critical clearance of 5.50 m under the concourse above the road intersection, allowing 3.00 m for the

concourse height, about 2 m for concourse floor and 2.00 m for structure of tracks above the concourse. Further, the platforms are 1.09 m above the tracks. This would make the platforms in an elevated station at least 13.5 m above ground.

(4) The concourse contains automatic fare collection (AFC) system in a manner that divides the concourse into distinct areas. The 'un-paid area' is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the 'paid area', which includes access to the platforms.

(5) The arrangement of the concourse is assessed on a station-by-station basis and is determined by site constraints and passenger access requirements. However, it is planned in such a way that maximum surveillance can be achieved by the ticket hall supervisor over ticket machines, automatic fare collection (AFC) gates, stairs and escalators. Ticket machines and AFC gates are positioned to minimize cross flows of passengers and provide adequate circulation space.

(6) Sufficient space for queuing and passenger flow has been allowed at the ticketing gates.

(7) Station entrances are located with particular reference to passenger catchment points and physical site constraints within the right-of-way allocated to the MRTS.

(8) Office accommodation, operational areas and plant room space is required in the non-public areas at each station.

(9) The DG set, bore well pump houses and ground tank would be located generally in one area on ground.

(10) The system is being designed to maximize its attraction to potential passengers and the following criteria have been observed:

- Minimum distance of travel to and from the platform and between platforms for transfer between lines.
- Adequate capacity for passenger movements.
- Convenience, including good signage relating to circulation and orientation.
- Safety and security, including a high level of protection against accidents.

(11) Following requirements have been taken into account:

a. Minimum capital cost is incurred consistent with maximizing passenger attraction.

b. Minimum operating costs are incurred consistent with maintaining efficiency and the safety of passengers.

c. Flexibility of operation including the ability to adapt to different traffic conditions changes in fare collection methods and provision for the continuity of operation during any extended maintenance or repair period, etc.

d. Provision of good visibility of platforms, fare collection zones and other areas, thus aiding the supervision of operations and monitoring of efficiency and safety.

e. Provision of display of passenger information and advertising.

(12) The numbers and sizes of staircases/escalators are determined by checking the capacity against AM and PM peak flow rates for both normal and emergency conditions.

(13) In order to transfer passengers efficiently from street to platforms and vice versa, station planning has been based on established principles of pedestrian flow and arranged to minimize unnecessary walking distances and cross-flows between incoming and outgoing passengers.

(14) Passenger handling facilities comprise of stairs/escalators, lifts and ticket gates required to process the peak traffic from street to platform and vice-versa (these facilities must also enable evacuation of the station under emergency conditions, within a set safe time limit).

(15) A list of accommodation required in the non-public area at each station is given below in Table 6.2:-

Table 6.2: Accommodation Required in Non Public Area

Non Public Area – At Station	
Station Control Room	Cash & Ticket Room
Platform Supervisor's Booth	Fire Tank & Pump room
Station Master's Office	Staff Area
Traction Substation	UPS and Battery Room
Information & Enquiries	Cleaner's Room
Signaling Room	Security Room
Ticket Office	Staff Toilet
Communication Room	Refuse Store
Ticket Hall Supervisor & Excess Fare Collection (Passenger Office)	Miscellaneous Operations Room
Station Substation	First Aid Room

6.2.1 TYPICAL ELEVATED STATION

The station generally located on the main carriageway will be initially for 90m length and subsequently increased to 140m length and will be three level structures. Passenger area on concourse will be spread throughout the length of the station, with staircases leading from either side of the road. Passenger facilities like ticketing, information, etc as well as operational areas are provided at

the concourse level. Typically, the concourse is divided into public and non-public zones. The non-public zone or the restricted zone contains station operational areas such as Station Control Room, Station Master's Office, Waiting Room, Meeting Room, UPS & Battery Room, Signalling Room, Train Crew Room & Supervisor's Office, Security Room, Station Store Room, Staff Toilets, etc. The public zone is further divided into paid and unpaid areas. Area left over in the unpaid zone, after accommodating passenger movement and other station facilities is earmarked for commercial utilization. Station concourse box length and breadth are 80 m and 28 m respectively. The station will have minimum vertical clearance of 5.5 m under the concourse. Concourse floor level is about 7.5 m above the road. Consequently, platforms are at a level of about 13.5 m from the road. With respect to its spatial quality, an elevated MRT structure makes a great impact on the viewer as compared to an At-grade station. Structures that afford maximum transparency and are light looking have been envisaged. A slim and ultra-modern concrete form is proposed, as they would look both modern and compatible with the High-rise developments along most parts of the corridor. Platform roofs that can invariably make a structure look heavy; have been proposed to be of steel frame with slopping roof. Platforms would be protected from the elements by providing an overhang of the roof and sidewalls would be avoided, thereby enhancing the transparent character of the station building.

6.2.2 PASSENGER AMENITIES

Passenger amenities such as ticketing counters / automatic ticket vending machines, ticketing gate, etc. are provided in the concourse. Adequate numbers of these facilities have been provided for system wide requirements, although the requirement of the facilities actually varies from station to station. The same applies to provision of platform widths and staircase / escalators. Maximum capacity required at any station by the year 2051 has been adopted for normal operation regarding all stations.

6.2.3 CONCOURSE

Concourse forms the interface between street and platforms. This is where all the passenger amenities are provided. The concourse contains automatic fare collection system in a manner that divides the concourse into distinct *paid* and *unpaid* areas. The *'unpaid area'* is where passengers gain access to the system, obtain travel information and purchase tickets. On passing through the ticket gates, the passenger enters the *'paid area', which* includes access to the platforms. The concourse is planned in such a way that maximum surveillance can be achieved by the ticket hall supervisor over ticket machines, automatic fare collection (AFC) gates, stairs and escalators. Ticket machines and AFC gates are positioned to minimize cross flows of passengers and provide adequate circulation space. Sufficient space for queuing and passenger flow will be allowed in front of the ticketing gates.

6.2.4 TICKETING GATES

At least three (one entry, one exit and one reversible) ticketing gates or AFC gates shall be provided at any station. Uniform space has been provided in all stations where gates can be installed as and when required.

6.2.5 TICKET COUNTERS AND TICKET ISSUING MACHINE (TIMS)

It is proposed to deploy manual ticket issuing in the beginning of the operation of the line. At a later stage, automatic TVMs would be used for which space provision has been made in the concourse. At present, ticket counters would be provided, which would be replaced with Ticket vending Machines (TVMs) in future. Capacity of manual ticket vending counters is taken to be 10 passengers per minute and it is assumed that only 40% of the commuters would purchase tickets at the stations while performing the journey. The rest are expected to buy prepaid card.

6.2.6 PLATFORMS

A uniform platform minimum width of 3.5-m wide (elevated stations) including staircases and escalators in the central section is proposed for the elevated stations.

6.2.7 STAIRS, ESCALATORS AND LIFTS FOR NORMAL AND EMERGENCY OPERATIONS

Provision has been made for escalators in the paid as well as entrance on both sides i.e. from ground to concourse and concourse to platforms. On each platform, two escalators have been proposed. In addition, two staircases with a combined width of 7.4 m are provided on each side platform connecting to the concourse. These stairs and escalator together provide an escape capacity adequate to evacuate passengers in emergency from platforms to concourse in 4.5 minutes in most stations.

6.2.8 TRAFFIC INTEGRATION

Concept of Traffic Integration - The objective of an integrated transport system and traffic movement is to offer maximum advantage to commuters and society from traffic and planning consideration. Various modes of transport need to be integrated in a way that each mode supplements the other. A large proportion of MRTS users will come to and depart from various stations by public, hired and private modes, for which integration facilities need to be provided at stations to ensure quick and convenient transfers. In order to ensure that entire MRTS function as an integrated network and provides efficient service to the commuter, the following steps are proposed:

- Suitable linkages are proposed so that various corridors of MRTS are integrated within themselves, with existing rail services and with road based modes.
- Facilities needed at various stations are planned in conformity with the type of linkages planned there. Traffic and transport integration facilities are provided for two different types of linkages:
- Feeder links to provide integration between various MRTS corridors and road based transport modes i.e. public, hired, and private vehicles.
- Walk links to provide access to the pedestrians.

6.2.9 APPROACH PROPOSED IN PLANNING TRAFFIC INTEGRATION FACILITIES

Integration facilities at MRTS stations include approach roads to the stations, circulation facilities, pedestrian ways and adequate circulation areas for various modes likely to come to important stations including feeder bus/mini-buses. Parking for private vehicles has not been proposed.

6.2.10 OPERATIONAL INTEGRATION

Integration at operational level will be required to synchronize the timings of the MRTS services and the feeder service. For an efficient interchange, walking and waiting time at these stations will need to be minimized. Introduction of common ticketing and their availability at convenient locations will be necessary to ensure forecast patronage of the system. Last but not the least will be the need for an integrated passenger information system covering all the modes through the publication of common route guides, time tables and information boards at terminals and in the train coaches for providing updated information for users of the system.

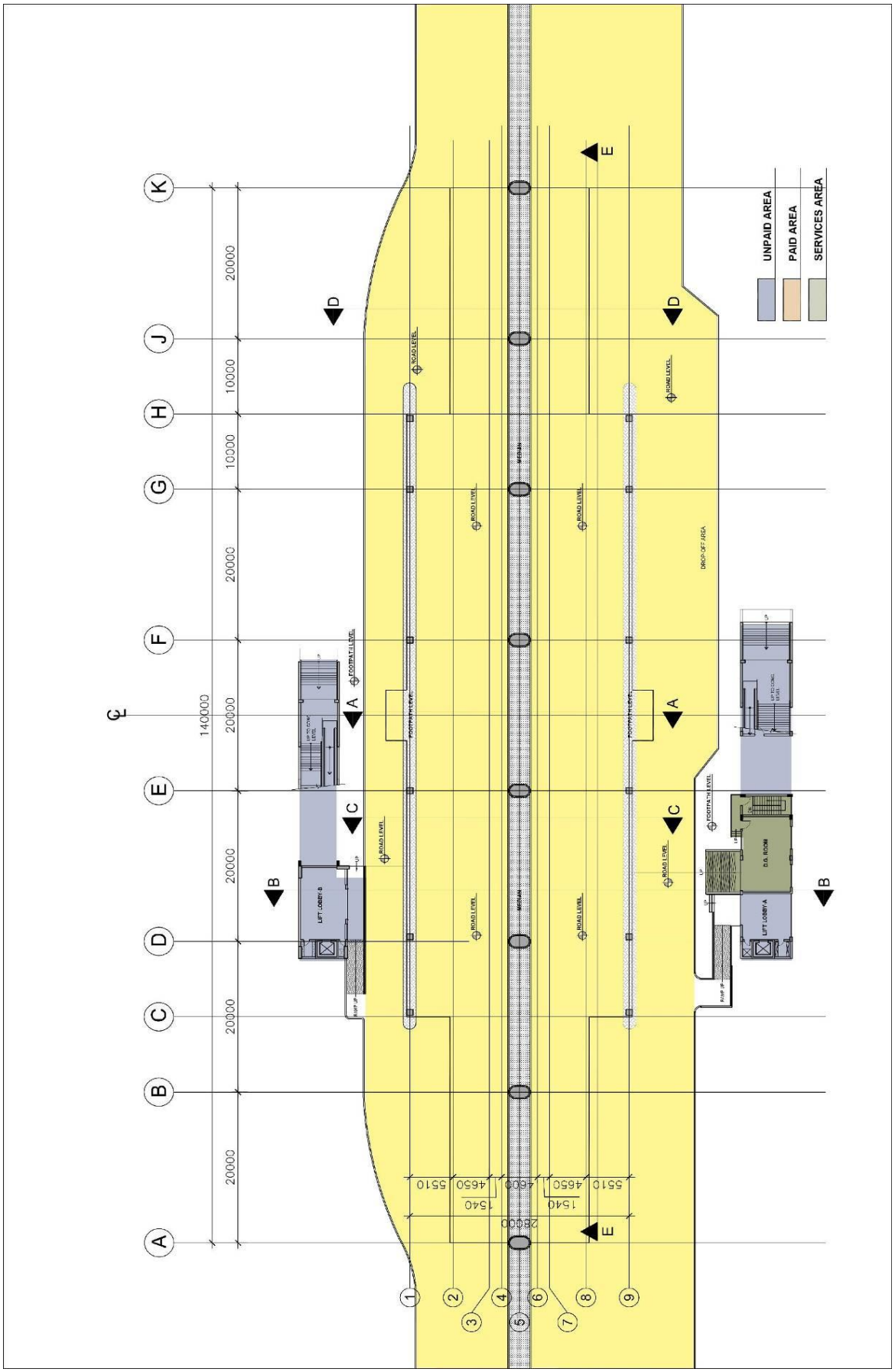


Fig. 6.1: Plan of Typical Elevated Station at Ground Level

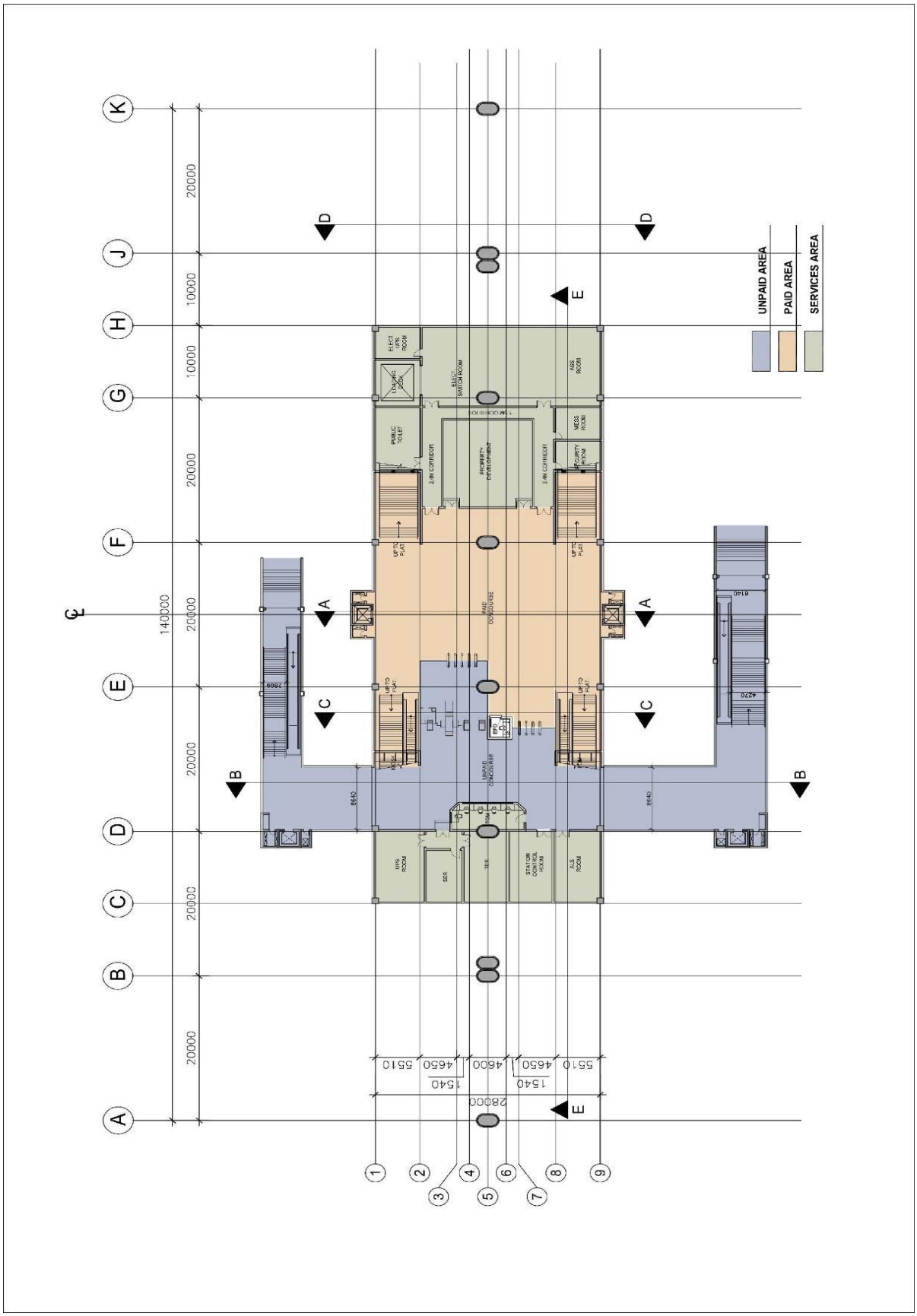


Fig. 6.2: Plan of Typical Elevated Station at Concourse Level

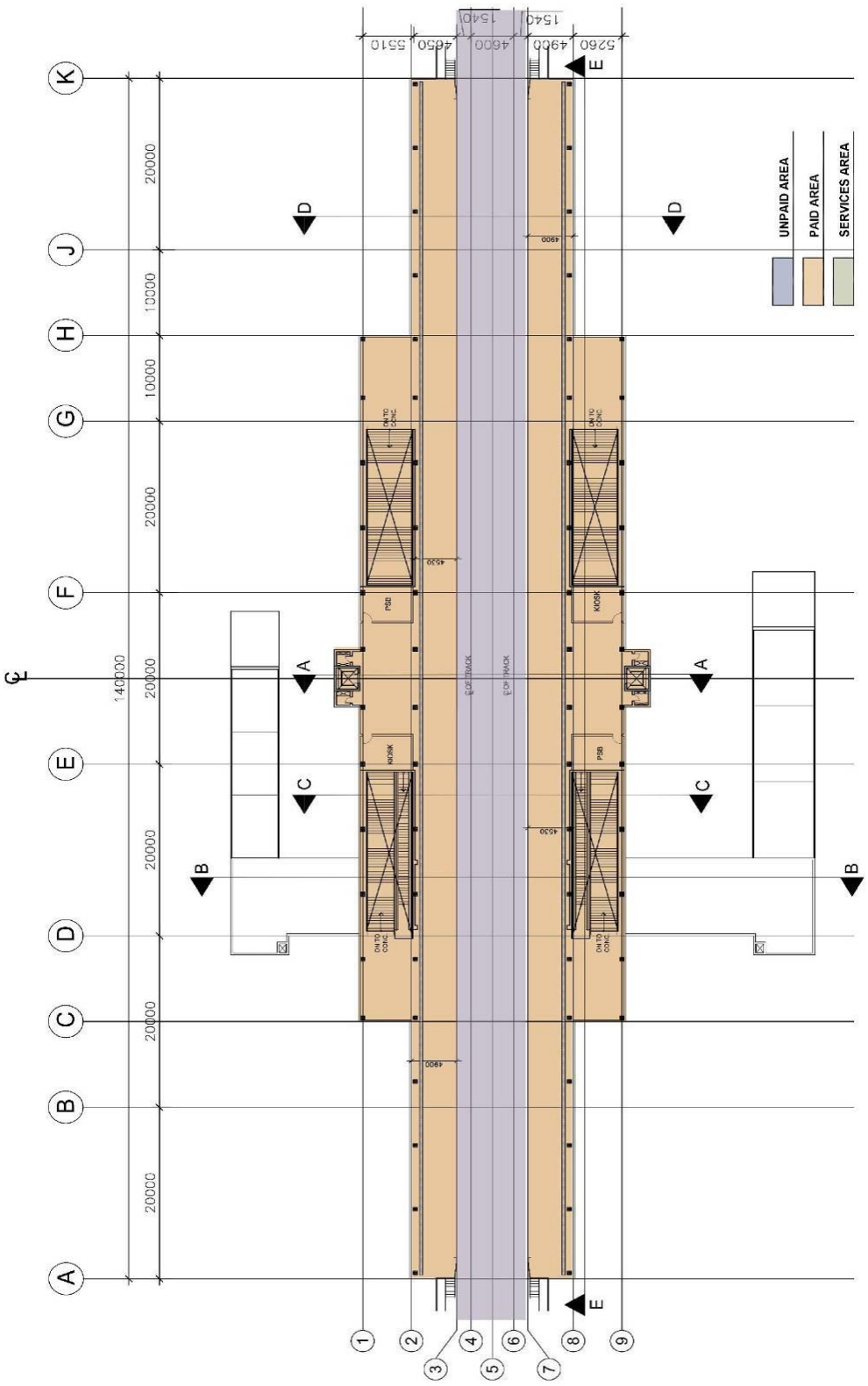


Fig. 6.3: Plan of Typical Elevated Station at Platform Level

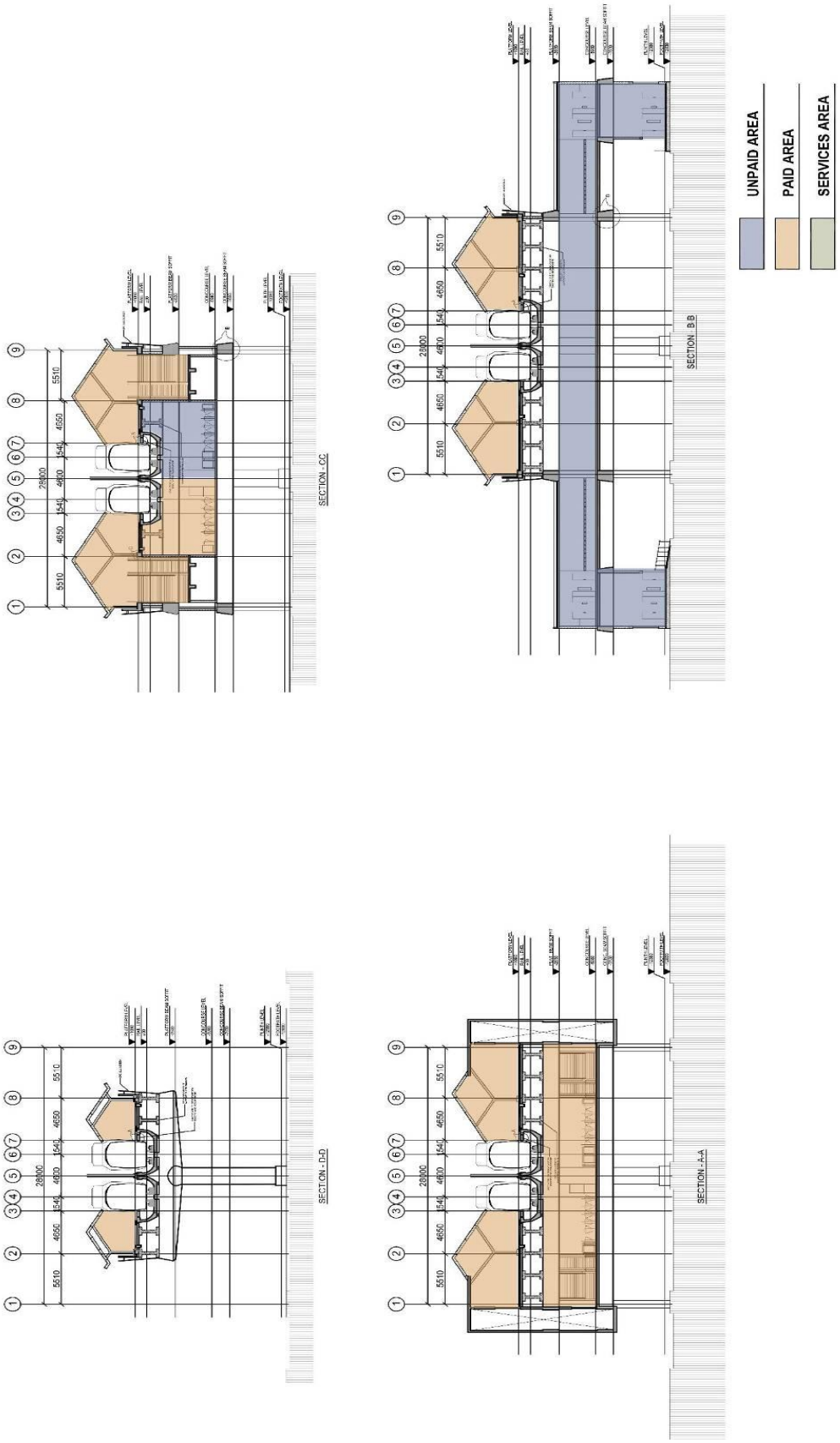


Fig. 6.4: Typical Section of Elevated Station

CHAPTER 7

COST ESTIMATE

7.0 BACKGROUND

Metro Rail Policy 2017 requires Metro Rail Administrations and States to have a greater focus on reducing the cost of construction and operations through indigenization and fostering competition along with standardization in various areas. This is in addition to the standardization being attempted for various components of the metro rail system at the level of Central Government.

The new Metro Rail Policy and Appraisal Frame work, 2017 have brought to fore the importance of sustained cost reduction in construction and operations & maintenance, have given thumps up to systemic indigenization and “Make in India” have deliberately provided for more and more standardization with sufficient leeway for innovation.

In this connection all metro organizations should continue to work proactively on their own, in association with other institutions and more particularly in active collaboration with the Central Government for further systemic improvement and cost reduction.

7.1 INTRODUCTION

Approximate cost of the corridor along **SPR** in between **Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)** has been worked out based on the rates considered for Delhi Metro Rail Project (Phase IV) duly updated to June’ 2019 price level by applying a suitable escalation factor.

While preparing this rough cost estimates, various items have generally been grouped under three major heads on the basis of:-

i) Route km. Length of alignment
ii) No. of units of that item and
iii) Item being an independent entity.

All items related with alignment, whether on elevated or at-grade construction, permanent way OHE, signaling and telecommunication, have been estimated on rate per route km basis. Cost of elevated stations includes civil work for station structures, architectural finishes, platform roofing, etc. Provisions for electrical and mechanical works, air conditioning, lifts, escalators, etc, have been worked out separately. These rates do not include cost of permanent way, O.H.E, power supply, signaling and telecommunication, automatic fare collection (AFC) installations, for which separate provisions have been made in the cost estimates. Similarly, for other items like Rolling stock, Traction & Power costs have been summed up separately.

In remaining items, viz. land, utility diversions, rehabilitation, etc the costs have been assessed on the basis of each item taken as an independent entity.

7.1.1 Unit rates of various items have been assessed on the basis of rates adopted in Delhi Metro's Phase IV project. A suitable escalation factor has been applied to bring these costs to June 2019 price level. GST as applicable, have been included in the cost estimates separately.

7.1.2 The overall Capital Cost for the proposed alignment for Metro Rail corridor along **SPR** in between **Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)** at June' 2019 price level including taxes, duties & GST is given in table 7.1.

Table 7.1: Cost Estimate

S.No.	Description of Metro Corridor	Overall capital Cost inclusive land, taxes/duties, GST etc in Cr.
1.	Metro Corridor along SPR in between Sec-56 GGN & Vatika Chowk (Haryana)	1739 crore

Details and methodology of arriving at these costs are discussed in paragraphs hereinafter.

7.2 CIVIL ENGINEERING WORKS

7.2.1 LAND

Since it is a feasibility report and detailed requirement of land is yet to be finalized, However tentative calculations for the land for the metro corridor route(s) is given in the table no. 7.2 and 7.3 given below. The ownership of the land is assumed as Government land only.

Table 7.2: Summary of permanent Land Requirement

S. N	Route Description	Length (Km)	No. of station (All elevated)	Permanent land requirements (in ha)
1.	Metro Corridor along SPR in between Sec-56 GGN & Vatika Chowk (Haryana)	6.34 kms	05	19.06 ha

Table 7.3: Summary of Temporary Land Requirement

S. No.	Description	Area (sqm)
1	Temporary Office/ Site Office	5000
2	Segment Casting Yard	10,000
	Total	**15,000 sqm**

7.2.2 FORMATION AND ALIGNMENT

The length of the routes for elevated corridor along **SPR** in between **Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)** as given in table no.7.2 are being proposed with elevated viaduct and the rates adopted are based on the rates adopted in Delhi Metro Phase IV project duly updated to June' 2019 price level.

7.2.3 STATIONS

7.2.3.1 Underground Stations: Since there is no underground station proposed, no cost has been taken.

7.2.3.2 Elevated Stations: Rates adopted for elevated stations cover works of station structures, platforms, architectural finishes, covering, etc. Provisions for Electrical and Mechanical works have been made separately. Also provisions for Lifts and Escalators, Viaduct, P-Way, O.H.E, Signaling & Telecommunication works,

Automatic fare collection installations, etc have been summed up in the cost estimates.

7.2.3.3 Mainly three type of stations are proposed for elevated alignment & rates are proposed accordingly.

Type A: Wayside station

Type B: Wayside with Signaling Type

Type C: Terminal Station

7.3 PERMANENT WAY

For elevated alignment ballastless track and for depot, ballasted track is proposed. Rates adopted are based on cost of similar works considered in Delhi Metro's Phase IV project duly updated to June' 2019 price level.

7.4 DEPOT

Maintenance Depot of 15 Ha has been proposed on the vacant land near proposed metro corridor in between Sec-56 GGN to Vatika Chowk along SPR. A lump-sum provision (civil & elect) of Rs.170 Crore has been made in cost estimate. A suitable piece of land shall be identified/ provided by Govt. of Haryana (GoH).

7.5 UTILITY DIVERSIONS, ENVIRONMENTAL PROTECTION, MISCELLANEOUS OTHER WORKS

Provisions have been made to cover the cost of utility diversions, miscellaneous road works involved, road diversions, road signages etc. and environmental protection works on route km basis, based on the experience gained from the works done in Phase-I, II and III.

7.6 REHABILITATION AND RESETTLEMENT

Provisions have been made on fair assessment basis, to cover cost of relocation of Jhuggies, shops, residential Houses on private land etc. This cost also includes cost related to provisions for barracks and security equipment for CISF and Staff Quarters for O&M Wing on the basis of average cost involved per km length in the recent past.

7.7 TRACTION AND POWER SUPPLY

Provisions have been made to cover the cost of O.H.E., Auxiliary sub stations, Receiving substations, service connection charges, SCADA and miscellaneous items, on route km basis.

Provisions towards cost of lifts, escalators for elevated stations have been made in the cost estimates. Rates provided are based on cost of similar works considered in Delhi Metro's Phase IV project duly updated to June' 2019 price level.

7.8 SIGNALLING AND TELECOMMUNICATION WORKS

Rates adopted are based on the cost of similar works considered in Delhi Metro's Phase IV project. Cost of Platform Screen Doors (PSD) for metro stations has also been added in the overall cost estimate of metro corridor.

7.9 AUTOMATIC FARE COLLECTION

Adopted rates are based on rates considered for similar work in Delhi Metro's Phase IV project duly updated to June' 2019 price level.

7.10 ROLLING STOCK

For maintaining initial service with about 10 minutes frequency, in 2025, 7.5 min. in 2031,5.5 min. in 2041 and 4.0 min. in 2051 with average speed of 35 km/hr considering a buffer for maintenance and spare operations rakes, with 3 coaches, the requirement of rakes is given under table 7.4

Table 7.4: Rolling stock requirement

Year	2025	2031	2041	2051
Frequency (minutes)	10	7.5	5.50	4.0
No. of Train	5	6	7	9
No. of cars in each train	3	3	3	3

7.11 GENERAL CHARGES AND CONTINGENCES

Provision @ 5% has been made towards general charges on all items, except cost of land, which also includes the charges towards Detailed Design Charges (DDC), etc. Provision for contingencies @ 3% (except land cost) has also been made on all items including general charges.

7.12 CAPITAL COST ESTIMATES

The overall Capital Cost for the proposed metro Corridor along **SPR** in between **Sec-56 GGN and Vatika Chowk, Gurugram (Haryana)** estimated at June' 2019 price level, based on the above considerations without Taxes, GST and duties works out to be **Rs 1533 crores**. Taxes, GST and duties have been worked out as **Rs.206 crores**. Total cost inclusive of applicable taxes/Duties, GST will be **Rs. 1739 crores** as given in table 7.5:-

Table 7.5: Estimated Cost for Bahadurgarh- Sampla Metro Corridor

S.No	Description	Estimated Amount (in crores)	Taxes, Duties & GST (in crores)
01	Metro Corridor along Sothern Periphery Road (SPR) in between Sec 56 GGN and Vatika Chowk, Gurugram (Haryana)	1533 cr	206 cr
		Grand Total	**1739 crores**

Table 7.6

Sector 56 Gurugram to Vatika Chowk (Along SPR)					
Capital Cost Estimate					
					June 2019 level
Total length = 6.34 km (Entirely Elevated)					
Total Station (All Elevated) =05					
S. No.	Item	Unit	Rate	Qty.	Amount (Rs. in Cr.)
				Without taxes	
1.0	**Land (tentative)**				
1.10	Permanent				
a	Government	ha	13.28	19.06	253.08
b	Private	ha	288.57	0.00	0.00
1.20	Temporary(For 4 years)				0.00
a	Government	ha	2.66	1.50	3.98
b	Private	ha	32.12	0.00	0.00
	Subtotal (1)				**257.07**
2.0	**Alignment and Formation**				
2.1	Elevated section including station length (Including Cost of Rain Water Harvesting)	R. Km.	37.00	6.34	234.58
2.2	Entry to depot +bypass Track+ Length of overlap	R. Km.	37.00	2.30	85.10
	Subtotal (2)				**319.68**
3.0	**Station Building**				
3.1	Elevated station (Civil including finishes) excluding viaduct in station portion	Each	26.00	5.00	130.00

3.2	Elevated Station (E&M including lift & escalator)	Each	8.00	5.00	40.00
3.3	OCC bldg.				
a	OCC bldg.- Civil works	LS			10.00
b	OCC bldg.- E&M works etc	LS			11.03
	Subtotal (3)				**191.03**
4.0	**Depot**				
4.1	Civil	Per Depot			105.00
4.2	E&M & M&P	Per Depot			65.00
	Subtotal (4)				**170.00**
5.0	**P-Way**				
5.1	Ballastless track	R.Km.	6.60	6.34	41.84
5.2	Ballasted track for Depot	T.Km.	3.90	4.00	15.60
	Subtotal (5)				**57.44**
6.0	**Traction & power supply**				
6.1	**25 kV Overhead Catenary System (OCS)**				
a	Elevated	R.Km.	7.50	6.34	47.55
b	RSS cum TSS	Each	45.00	1.00	45.00
c	Depot	T.Km.	2.00	4.00	8.00
d	66 kV double run double circuit cable from GSS to RSS	R.Km.	4.89	4.00	19.56
e	Cost of Catenery Maintenance Vehicle (CMV)	LS			6.63
	Subtotal (6)				**126.74**
7.0	**Signalling and Telecom.**				
7.1	**Signalling**				
a	Main line including OCC	R.Km.	4.40	6.34	27.90
b	Depot including DCC	T.Km.	3.20	4.00	12.80
c	On Board Equipment	Per Train	1.70	5.00	8.50
7.2	**Telecommunication**				
a	Station	Per Station	4.50	5.00	22.50
	Subtotal (7)				**71.70**
8.0	**Automatic Fare Collection(AFC) system**	Per station	3.50	5.00	17.50
	Subtotal (8)				**17.50**
9.0	**Platform Screen Doors(PSD)**	Per station	3.00	5.00	15.00
	Subtotal (9)				**15.00**
10.0	**R & R incl. Hutments etc.**	R. Km.	4.00	6.34	25.36
	Subtotal (10)				**25.36**

11.0	**Shifting of Miscellaneous Utilities**				
11.1	Civil and E&M	R. Km.	6.00	6.34	38.04
	Subtotal (11)				**38.04**
12.0	**Rolling Stock**	Per coach	8.00	15.00	120.00
	Subtotal (12)				**120.00**
13.0	**Security**	Per station	0.37	5.00	1.85
	Subtotal (13)				**1.85**
14.0	**Staff quarter for O & M**				
14.1	Civil works	R.Km.	1.35	6.34	8.56
14.2	EM works etc	R.Km.	0.32	6.34	2.03
	Sub Total (14)				**10.59**
15.0	**Multimodal Integration and Last mile connectivity**	Per station	3.00	5.00	15.00
	Subtotal (15)				**15.00**
16.0	**Total of all items except Land**				**1179.93**
17.0	**General Charges incl. Design charges @ 5 % on all items except land**				**59.00**
18.0	**Total of all items including G. Charges except land**				**1238.92**
19.0	**Continegencies @ 3 %**				**37.17**
20.0	**Gross Total**				**1276.09**
	Cost without land			**=**	**1276**
	Cost with land			**=**	**1533**

Table 7.7

Details of Taxes and Duties

Sector 56 Gurugram to Vatika Chowk (Along SPR)

Basic Customs duty =	5.1500	%
CGST Customs Duty=	9.4635	%
SGST Customs Duty=	9.4635	%
Total Customs Duty=	**24.0770**	%
General IGST=	12	%
General CGST =	6	%
General SGST =	6	%

POST GST Regime

S. No.	Description	Total cost without Taxes & duties (Cr.)	Taxes and duties							Total Taxes & Duties (Cr.)
			IMPORTED MATERIALS				INDEGENIOUS MATERIALS & SERVICES			
			CUSTOMS DUTY				GST			
			Basic Customs Duty (Cr.)	IGST (CGST portion) (Cr.)	IGST (SGST portion) (Cr.)	Total Customs Duty (Cr.)	CGST (Cr.)	SGST (Cr.)	Total GST (CGST & SGST) (Cr.)	
1	**Alignment & Formation**									
	Elevated, at grade & entry to Depot	319.68					19.18	19.18	38.36	**38.36**
2	**Station Buildings**									
	Elevated station - Civil works	130.00					7.80	7.80	15.60	**15.60**
	Elevated station - E&M works	40.00	0.41	0.76	0.76	1.93	1.92	1.92	3.84	**5.77**
	OCC bldg.- Civil works	10.00					0.60	0.60	1.20	**1.20**
	OCC bldg.- E&M works	11.03	0.11	0.21	0.21	0.53	0.79	0.79	1.59	**2.12**
3	**Depot**									
	Civil works	105.00	1.62	2.98	2.98	7.58	4.41	4.41	8.82	**16.40**
	EM works	65.00	0.67	1.23	1.23	3.13	4.68	4.68	9.36	**12.49**
4	**P-Way**	57.44	2.37	4.35	4.35	11.06	1.03	1.03	2.07	**13.13**
5	**Traction & power supply**	126.74	2.61	4.80	4.80	12.21	6.84	6.84	13.69	**25.89**
6	**Signalling and Telecom.**	71.70	2.95	5.43	5.43	13.81	1.29	1.29	2.58	**16.39**
7	**AFC**	17.50	0.68	1.24	1.24	3.16	0.39	0.39	0.79	**3.95**
8	**PSD**	15.00	0.62	1.14	1.14	2.89	0.27	0.27	0.54	**3.43**
9	**R & R hutments**	25.36					1.52	1.52	3.04	**3.04**
10	**Misc.**									
	Civil works	49.73	0.00	0.00	0.00	0.00	2.98	2.98	5.97	**5.97**
	EM works	15.75	0.00	0.00	0.00	0.00	1.42	1.42	2.84	**2.84**
11	**Rolling stock**	120.00	5.44	9.99	9.99	25.43	1.30	1.30	2.59	**28.02**
12	**Rent on Temporary Land**	3.98					0.36	0.36	0.72	**0.72**
13	**General Consultancy charges**	59.00					5.31	5.31	10.62	**10.62**
	Total	**1242.91**	**17.48**	**32.12**	**32.12**	**81.73**	**62.10**	**62.10**	**124.21**	**205.94**
	Total taxes & Duties							**SAY**		**205.94**
	Rate of Taxes & Duties on Total cost without taxes & duties									**16.57%**
	Total Central GST & Basic Customs duty									111.71
	Total State GST									94.23
	Total State Taxes & Duties									**205.94**

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 Government of Haryana has envisaged the metro connectivity along SPR i.e. **Sector-56 Gurugram to Vatika Chowk, Gurugram (Hry).** Haryana Mass Rapid Transport Corporation (HMRTC) vide their letter No. HMRTC/FO/2018/767 dated 30-11-2018 requested Delhi Metro Rail Corporation (DMRC) to prepare Techno-Feasibility Report (TFR) in respect of Metro Rail connectivity along SPR in between Sec-56 and Vatika Chowk, Gurugram (Haryana).

DMRC vide letter No. DMRC/CE/CS/NPR-SPR-TF/2017/280, dated: 17-12-2018 submitted terms of reference (TOR) for carrying out the techno feasibility study. Consequent to acceptance of TOR, HMRTC vide their letter no. HMRTC/2019/FO/559 dated 30-05-2019 released mobilization advance and conveyed to start undertaking work for above cited feasibility study.

The proposed metro connectivity along SPR i.e.Sector-56 GGN and Vatika Chowk, Gurugram, (Haryana) would cover areas such as Sector 56 GGN, Sushant Lok, Sushant Lok Phase-3, Rosewood City and Vatika Chowk etc.

8.2 Traffic and Transportation study in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana** has been done and included in this techno feasibility report which indicates total daily ridership (passengers) as 17706, 34459, 47347 & 66296 in horizon years 2025, 2031, 2041 and 2051 respectively under moderate scenario. And optimistic scenario shows the total daily ridership (passengers) as 19477, 37905, 52081 and 72927 in the horizon years 2025, 2031, 2041 and 2051 respectively. Accordingly, PHPDT is also on very low side as per details given in table below:-

Table 8.1: Showing PHPDT under moderate and optimistic scenarios

Target Year	PHPDT(under Moderate Scenario)	PHPDT(under Optimistic Scenario)
2025	961	1057
2031	1666	1833
2041	2604	2864
2051	4070	4477

8.3GUIDE LINES FOR CHOICE OF MODE OF TRANSPORT

In their report on **Urban Transport for 12th Five Year Plan**, the Working Group of Urban Transport has set the guidelines for the choice of different modes is as follows:-

Table 8.2: Guidelines for Choice of Different Modes

SYSTEM	PHPDT IN 2021	POPULATIONIN 2011	AVG. TRIP LENGTH
Metro Rail #	>=15000 for at least 5km continuous length	More than 20 Lakhs	More than 7 Km
LRT primarily at grade	=<10,000	More than 10 Lakhs	More than 7 Km
Monorail @@	=<10,000	More than 20 Lakhs	About 5-6 Km
Bus Rapid Transit System	>=4,000 and upto 20000	More than 10 Lakhs	>5 Km
Organised City Bus Service as per urban bus specifications		>1 lac, >50,000 in case of hilly towns	>2 to 3 Km

 # for having Metro Rail, the city should have a ridership of at least 1 million on organized public transport (any mode)

@@ Monorail is desirable only as a feeder system or where the narrow roads are flanked on either side by high rise buildings. In monorail while the cost of construction, operation and maintenance is almost the same as elevated metro rail, the carrying capacity is much lesser.

Keeping the above guidelines of Urban Transport dett viz-a-viz PHPDT figures in view, the provision of Rail based MRTS does not appear to be justified & viable.

8.4 The overall rough Cost estimate for the Metro corridor in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana** has been formulated at June'2019 price level, based on the above considerations without Taxes, GST and duties works out to be Rs1533 crores. Taxes, GST and duties have been worked out as Rs.206 crores. Total cost inclusive of taxes & duties will be Rs.1739 crores.

8.5 Due to extremely low ridership demand/forecast in the horizon year 2025 worked out from traffic and transportation studies conducted in between **Sector-56 GGN and Vatika Chowk, Gurugram, Haryana. DMRC recommends not to implement Rail based MRTS project such as metro rail, monorail, Light metro**

etc at this stage as this shall not be economically and socially viable at all. However as seen from following table in year 2025 daily boarding figure is 17706 & PHPDT 961 for moderate scenario and for optimistic scenario daily boarding figure is 19477 & PHPDT 1057. To meet this demand Conventional Bus/ ITS enabled E-Bus System is sufficient. However, the traffic figures may be re-assessed after a gap of 05 years considering the development along this corridor.

Government of Haryana (GoH) vide their letter No. HMRTC/2019/AO/707 dated 01-07-2019, has envisaged to run Faridabad-Gurugram direct metro connectivity via Southern Peripheral Road (SPR) and shall terminate the same at Vatika Chowk in Gurugram. The aforesaid Faridabad-Gurugram metro corridor shall also cover this small portion of 6.34 kms spanning in between Sec-56, GGN and Vatika Chowk along SPR. Or another option is to serve Golf Course extension road by way of extending the existing rapid metro from Sec-56 Gurugram to Vatika Chowk along SPR.

Therefore, it may not be prudent to implement this Rail based MRTS project (short spanned) as a **'Stand Alone'** metro project, which may not be justified and viable. Alternatively, this corridor could be implemented as an integral part of Faridabad- Gurugram metro corridor for which study (DPR) is being undertaken separately.

In case, decision is still taken to implement the proposal by Government of Haryana (GoH) the same may be done as a 'public project' and run on subsidy.

8.6 Techno-Feasibility Report (TFR) is a document only to assess the technical and financial viabilities of the proposed metro corridor. Therefore, in the event of implementation of the above cited Rail based MRTS project, a Detailed Project Report (DPR) need to be prepared.