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FEASIBILITY STUDY OF METRO RAIL PROJECT IN PUNE CITY

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Abstract – *Rapid industrialization and intense commercial developments in the past decades have resulted in step rise in travel demand, putting pune's transport infrastructure to stress. With the projected increase in the city's population, strengthening and augmenting the existing transport infrastructure has assumed urgency. As India is one of the fastest developing country in the world. The metro rail network plays an important role in the cities transport system so it is now need of future to have an efficient and well effective metro rail network in the city. Public transport system is an efficient user of space and with a reduced level of air and noise pollution. Evaluation of modern transportation framework of metro rail facility proposed in pune city is the primary aim of this study. The objective of this study paper is to study the two lines of metro rail project and feasibility study of new proposed line.*

Key Words: Feasibility study, Metro, Technical details, station connectivity, NLRI (Network length related indicators), SNRI (Station number related indicators).

1. INTRODUCTION

Pune city is known in the world map because of its educational, research etc. Also The District has an importance as an important military base and most industrialised district in western Maharashtra and a famous IT Hub in The Country. It is also known as Queen of Deccan. In India there are currently 13 operational rapid transit systems in 18 cities. As March 2019, India has 638.91 km's of operational Metro Lines and 496 stations. Further 500 plus kilometre of lines are under construction. All the metro rail line projects composed of mainly standard gauge out of that only Kolkata metro and Delhi metro used broad gauge. The first rapid system in India is the Kolkata Metro which started operations in 1984 and the newest metro opened is Nagpur metro on 8th March 2019.

The following metro lines in Capital cities of India are in working service up to April 2019 such as Kolkata, Delhi, Bengaluru, Mumbai, Jaipur, Chennai, Kochi, Lucknow, Hyderabad, Ahmadabad, Nagpur etc. Also Metro lines are in under construction such as navi Mumbai, Pune, Kanpur, Bhopal, Indore etc.

Also some metro lines in planning such as Agra, Patna, Surat, Meerut, Vishakhapatnam, Varanasi, Dehradun etc. Also some metro lines in proposed Coimbatore, Guwahati, Gwalior, Jabalpur, Srinagar, Bareilly, Ludhiana, Prayagraj, Gorakhpur, Ranchi etc.

1.1 Route Alignment

Corridor-1: Pimpri Chinchwad (PCMC) – Swargate

In Pune-Pimpri Chinchwad metro from end of Pimpri Chinchwad Municipal Corporation station to end of swargate station, the total length of corridor first is 16.589 km, out of which 5 km is under ground and remaining 11.570 km is elevated including length of switch over ramp (SWR). Total 15 numbers of stations have been planned along this corridor out of which 9 are elevated and 6 are under ground stations.

Corridor-2: Vanaz (Kothrud) – Ramvadi

From end of Vanaz station to end of Ramvadi station, the length of corridor two is 14.66km. Total 16 numbers of elevated stations have been planned along this corridor.

Table 1: length of route

Description	Elevated km	Underground km	Total km
Corridor 1- Pcmc - Swargate	11.570	5.019	16.589
Corridor 2- Vanaz - Ramvadi	14.665	NIL	14.665
Total	26.235	5.019	31.254

Table 2: Number of stations

Description	Elevated	Underground	Total
Corridor 1- Pcmc - Swargate	9	6	15
Corridor 2- Vanaz - Ramvadi	16	NIL	16
Total	25	06	31

Table 3: Pune city metro rail characteristics

Pe	A	D	L	S	Le	Rd
68.9	700	9853.41	54.58	53	03	350

Table 4: Determined NLRI and SNRI

Length	Stations	NLRI	SNRI
54.58	53	2.415	0.862
80	30	2.654	0.917
100	80	1.447	1.05
120	100	1.199	1.184
130	70	1.208	1.247
130	60	1.264	1.247
140	90	1.21	1.319
140	80	1.13	1.091
140	70	1.15	1.091

2. TECHNICAL DEATAILS

2.1 Standard gauge length-1435mm

During the last decade, 20 new metros have been constructed in various cities of the world. All these metros have gone in for Standard Gauge even though the national gauge for national gauge for main line railways in some of these countries was different from standard gauge.

2.2 Route length of corridor first -16.589
2.3 Route length of corridor second-14.665
2.4 Design speed of metro-80 kmph
2.5 Scheduled speed of corridor 1-33 kmph
2.6 Scheduled speed of corridor 2- 31kmph
2.7 Maintenance depot for corridor 1- Near hill range station
2.8 Maintenance depot for corridor 1- Near Vanaz station
2.9 Construction technology- Elevated viaduct consisting prestressed concrete box shaped girders on single pier with pile/ open foundations, and underground section with tunnel boring and station in underground station cut and cover.

The proposed viaduct structure for Pune Metro is Pre-cast segmental box girder, carrying two tracks supported on single pier located on the median of the road. Road clearance of 5.5 m is ensured below the viaduct structure. The foundation shall be pile foundation at most of the locations. Open foundations are possible at certain isolated locations. The superstructure shall be pre-cast segmental construction.

2.10 Elevated sections – A vertical clearance of minimum 5.5 m above road level. For meeting this requirement with the 'Box' shaped pre-stressed concrete girders, the rail level will be about 9.8 m above the road level. However, at stations which are located above central median, the rail level will be 12.5 m above the road level with concourse at mezzanine.

2.11 Underground sections- Rail level at midsection in tunneling portion shall be kept at least 12.0 m below the ground level so that a cover of 6m is available over the tunnels. At stations, the desirable depth of rail below ground level is 12.5 m; Track center in underground section to be constructed by Tunnel Boring Machine (TBM) is 15.05 m to accommodate a 12 m wide island platform.

3. METRO STATIONS AND THEIR CONNECTIVITY TO CITY BUSES

3.1 From katraj-**SWARGATE METRO STATION**-To PCMC (Tilak road, Lokmanya nagar, Sinhgad road, Sahakar nagar, Upper Indira nagar, Market yard, Lulla nagar, Shankar sheth road)

3.2 From Swargate-**MANDAI METRO STATION**-To PMC (Budhwar chowk, Bajirao road)

3.3 From Mandai-**PMC METRO STATION**-To Shivajinagar (Rasta peth, bajirao road)

3.4 From PMC-**SHIVAJINAGR METRO STATION**-To Range hills (f.c road, university road)

3.5 From Shivajinagar-**KHADKI METRO STATION**-To Dapodi (holkar bridge Deccan College, Mumbai Pune road)

3.6 From khadki-**DAPODI METRO STATION**-To Fugewadi (Pimple Gurav)

3.7 From kasarwadi-**BHOSARI METRO STATION**-to sant Tukaram Nagar (Bhosari gaon)

3.8 From sant tukaram nagar-**PCMC METRO STATION**-to nigdi (chinch wad gaon)

3.9 From Bavdhan-**VANAZ METRO STATION**-to Anand nagar (Kothrud gaon)

3.10 From Garware college-**NALSTOP METRO STATION**-to karve road (ideal colony)

3.11 From Deccan gymkhana-**GARWARE COLLEGE METRO STATION**-to nal stop (laxmi road, tilak road, nav sahayadri garage)

3.12 From ASI-**DECCAN GYMKHANA METRO STATION**-to garware colleges (lokmanya Nagar, tilak road, F.C road, model colony)

3.13 From Ruby hall-**PUNE RAILWAY METRO STATION**-to RTO (East Street, power house, Rasta peth city area)

3.14 From Ruby hall-**BUND GARDEN METRO STATION**-to yerwada (Deccan College)

3.15 From Bund garden-**YERWADA METRO STATION**-to kalyani nagar (Deccan College, airport road)

3.16 From kalyani nagar-**RAMWADI METRO STATION** (viman nagar, Nagar road)

4. METHODOLOGY

Based on the available data of ongoing in the service of metro rail and construction of metro rail the following steps are adopted while conducting feasibility study of metro rail by using NLRI (Network Length Related Indicators) and SNRI (Station Number Related Indicators)

4.1. Population influenced (P) is the ratio between network length (L) and the reference territory population (Pu) that is basically the city's population located in the reference territory surface (Su) that is the city's urban area

$$P=L/Pu$$

4.2 Network extension (Π) is the ratio between network lengths (L) and the network diameter (D) where network diameter (D) is the length of the shortest route connecting the farthest stations of the network

$$II=L/D$$

4.3 Network density (Nd) is the ratio between network length (L) and the reference territory surface (Su) that is basically the city's urban area

$$Nd=L/Su$$

4.4 Access density (Ad) is the ratio between the number of stations (ST) and the reference territory surface (Su) that is the city's urban area

$$Ad=ST/Su$$

4.5 Served surface (S) is equal to the territory extension where the network is attractive and it is computed by multiplying the number of stations with the average range of influence of each station (R) minus the surfaces counted several times or else the overlap areas of the stations' ranges of influence

$$S = ST \bullet [\pi \bullet R2] - [(S1 \cap S2) \cup (S2 \cap S3) \cup]$$

The variables, e.g., S1 and S2, are the surfaces served by the stations, e.g., 1 and 2, while average range of influence (R) is a standard range indicating the largest distance Accepted on average by a walker to access a generic metro Station. A generic station is a station with a geographic position in the zone between the city center and the suburbs. For a station in the city center, the distance accepted on average by a walker is much shorter than 500 m, while for a station in the suburbs, it can be much longer. The proper way to calculate the served surface would be to assign weights, i.e., 0.5 to stations in the city center, 1.5 to stations in the suburbs, and 1 to stations in the intermediate zone, to the stations' range of influence according to the stations' geographic position but since this would require geographic information system (GIS) mapping of all metro networks analyzed, it was impossible to be done in the framework of this research. Therefore, assuming that each network's stations are distributed almost equally among the three zones of the city center, suburbs, and in between, the generic type of station was chosen.

4.6 Spatial accessibility or network covering degree (As) is the ratio between the served surface (S) and the reference territory surface (Su) that is basically the city's urban area

$$As=S/Su$$

4.7 Traffic density (T) is the ratio of annual (usually) network ridership (RD) per kilometer of line

$$T=RD/L$$

5. ECONOMIC ANALYSIS

5.1 Pune metro rail as Public Transport system is an efficient user of space and reduced level of air and noise pollution.

5.2 Saving in fuel consumption of road vehicles with effect of metro are included in those of vehicle operating cost.

5.3 Reduction of number of accident and decrease in pollution by the introduction of metro.

5.4 Time saved by the communicators using the metro over the existing mode of transportation because of faster running speed of metro.

6. CONCLUSION

The objective of this study paper is to study the two lines of metro rail project and feasibility study of new proposed line. We concluded from this paper to study the details of pune metro rail project and feasibility analysis steps which is applied for estimation of the degree of adequacy of the Athens, Greece metro network in relation to city's needs. The table number 4 shows that length 140km and stations 80 the NLRI 1.13 and SNRI 1.091 are enough. Hence it is more compared to sanctioned plan. For current scenario not feasible to construction of metro work hence it is increasing length and statins of metro.

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