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Efficient Feeder System for Nashik Metro Neo Transit

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Abstract: *The global scenario is changing swiftly, so is the need to change approach toward the urban transportation system. Global warming is the major problem that needs to be addressed immediately. To address the same, we need to introduce of mass rapid transit in all big cities. But mere introduction of mass rapid transit is not sufficient, the more integrated system will be substantive. The first/last travel service play a key factor for the success of feeder system and also metro system. Feeder system effectiveness will not only increase the ridership but also improve operating cost of the system.*

Metro or regional rail system or light rail system will not fully utilize its potential if we build it alone .We need to consider its interaction, one with the city, and the other one with other transit lines. The two types of feeder system, fixed and flexible try to fill the service gap that is created by rail transit effectively extending the range. Yet they fail to entirely capture the potential user.

This paper addresses the gap that helps in the upgradation in the existing feeder system. The paper proposes the sub feeder system to the main feeder system thus extending the reach of existing feeder system.

Keywords: **mass transit, feeder system .first to last mile connectivity ,commuters.**

1.INTRODUCTION

Transportation is pulse of any city development. Many cities in India are expanding rapidly most of which are Tier 2 and Tier 3 including Nashik , which reflects that they are soon embracing urbanization .So public transit is the mode of transportation which will cater the need of long-term sustainable development. To address the same the government of India has already introduced Metro Neo in many Tiers 2 and Tier 3 cities .But these transit systems work only on some limited route network and are integrated with feeder system which run on fixed routes in conventional methods .This has laid to low turnout for metros also increasing the cost efficiency. Increasing ridership is possible only by increasing area coverage and provide maximum accessibility for the riders.

It's important to understand feeder system in Indian context .Most of the Indian cities are not planned cities. It has led to neighborhoods with very narrow internal road where the feeder buses are unapproachable. This has left internal area or low-density areas deprived of metro service Eventually indicating that the existing infrastructure does not support conventional feeder system like Fixed route transit, Flexible route transit .

The cities also lack proper Non-motorized Transport (NMT) infrastructure with no paving, provision of sidewalks, safe crossing ,landscape planting NMT plays a key role for last mile connectivity (LMC). The significant time spent and cost incurred is in last mile connectivity (approx. 40%) as suggested in earlier studies.

So, the study aims to include Intermediate Public Transport (IPT) as sub -feeder system and also integrating it with conventional feeder system .The study focus on analyzing this new model on local context. To validate the feasibility of proposed model ,the study area was selected along the proposed Metro Neo corridor .

2.LITERATURE REVIEW

The recent years many studies have been conducted to understand the success of metro service. S. Vydhianathan (2003) has listed out the reasons for failure of metro in Chennai metro in spite of huge investment 269 crores with no returns. The reasons listed out by him are higher tariff structure and absence of intermodal transport facility at the station

Mukti Advani , Geetam Tiwari (2005) has discussed the importance of public transport service to fulfil the need of commuter. In their evaluation of Delhi metro that suggested limit to access to metro is 0.5km. Further increase in distance will also increase passengers' dependence on feeder system for transfer. The studies have also suggested that 40% average time spent and average cost sustained in LMC is significantly high .Unsafe walking and cycling condition also make them the least favorite as last mile connectivity (LMC).

Feeder system effectiveness is determined by various elements of feeder system like design of feeder bus route network, type of feeder system routes (fixed or flexible routes), integration and coordination of operational schedules and adaptation of integrated model which not only facilitate rider but also decrease the operating cost .Feeder system which mainly consist of fixed route .Their shape have impact on functioning of the system Geometric shape like linear,Y-shaped Spoon-shaped line have different accessibility under the similar state of the line length, stop spacing, vehicle fleet size, and other given parameters as illustrated by Peng Du (2020) Linear accessibility also provides travel efficiency of all riders.

To focus on the best operational strategy for feeder bus by people who provide different services between metro and residential area; Shixiong Jiang , Wei Guan and Liu Yang and Wenyi Zhang (2020) have analyzed four types of strategies like Fixed Route Transit (FRT) with fixed stops, FRT without fixed stops, DRT with a loop line, and DRT with separate routes based on expected travel time to every station to measure accessibility along with varied influence factor like size of feeder bus service ,travel demand and travel demand direction.

Mohammad Hadi Almasi et al(2014) have discussed the growing concern for the transit system's failure to channelize from private to public transport. He suggested that an integrated intermodal system might lead to minimizing cost. Also expressed that it will increase the profit .Xueping Dou and Xialin Gong also suggested that schedule coordination method for transfer problem between a metro and its feeder bus service

Qing Tang and Peng Du (2020) concluded by explaining the attempt by public transit managers efforts to further develop procedures to heighten the construction and operation and refining the first/last mile transport connectivity between urban rail stations and origin-destination (residences or offices).They also highlighted the way of working to enhance the competitiveness of public transport. Mukti Advani emphasized on accessible or reachable stations with least reasonable time loss at interchanges, safer and reliable services. He also suggested 500mt as an ideal distance for walking to the metro and as the highest accessibility to metro.

3.METHODOLOGY:

Based on the objective the methodology is designed and as shown in table 1 below

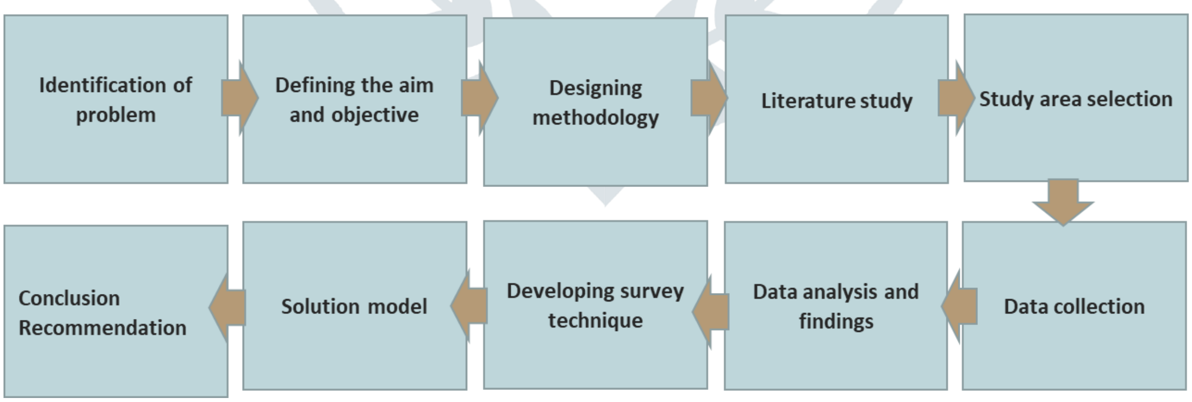

Figure 1 :Figure explaining methodology

- Identification of problem, defining the aim, objectives and methodology are as discussed above.
- Analyzing findings and solution models (both mathematical and heuristic) in earlier research studies and case studies.
- Selection of study area based on data availability and literature study
- Primary data :questionnaire collecting data regarding people's preference ,current mode of travel, real street network topological structure, and real-world data-based demand.
- Evaluation of data available of traffic volume, land use ,O-D routes model split, current mode of transport .

- The overall aim of the study was to understand the people's trip making details like O-D details and existing choice for mode of transport, and their outlook towards public transport
- Solution model based on heuristic method by understanding city context.
- Recommendation : Needs of supporting infrastructure .

4.ANALYSIS

To develops a new solution model where IPT/shared auto is used as a sub-feeder system for the areas where the conventional feeder system is not easily accessible Using the solution model below allows an integrated model of feeder system will enhance the efficiency in the existing feeder system. The solution will provide the nearly first last mile connectivity. Using the IPT will not only helps us to provide last mile connectivity but also avoid duplication of route. If similar zoning and routes are developed like in study area, we will be increasing the accessibility to metro.

The delineation of the study areas was based on context of real-life model .Kale Nagar is one of the stops on the proposed corridor 2 of Metro Neo service. So, study area was selected along Kale Nagar stop as illustrated in figure 1.

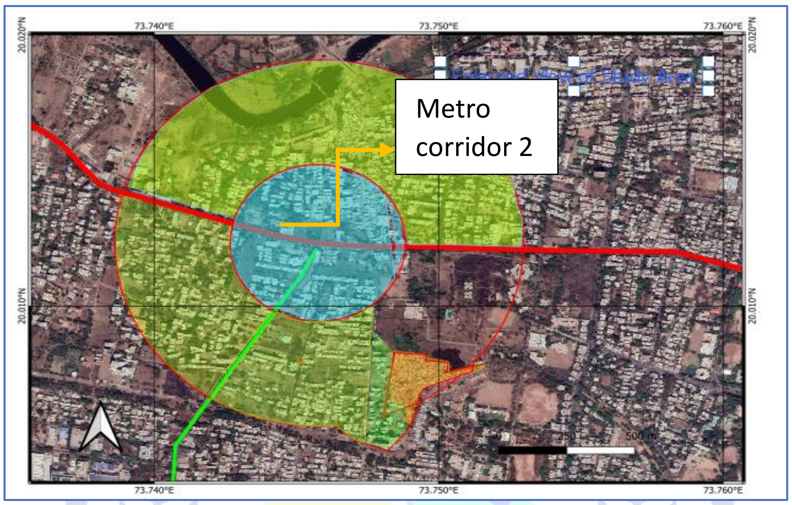

Figure 2 :Delineation of study area

Solution 1

Solution model are carried out taking into consideration two important factor critical in analyzing the impact of the model. They are time and cost factors .Model development is showcased in two different scenario .Both solution 1 and solution 2 are schematically illustrated below.

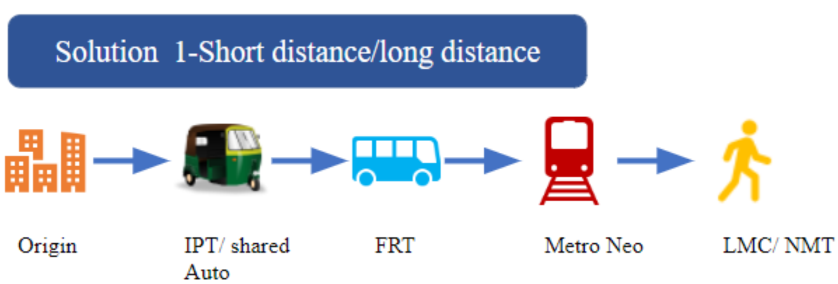

Figure 3: Schematic illustration of Solution Model-1

Step 1: Analyzing details of existing neighborhood and also understanding the existing road network.

Step 2: Understanding O-D sets of the residents and connecting them to respective fixed feeder system

Step 3:Next, we need to developed the route for fixed route as shown in figure 3.0

Considering the speed of bus 25 to 30 km /hr and the fixed route length .we need to calcuate the time taken from time taken from the fixed route stop to metro stop

Figure 4 : Route developed for Fixed and sub-feeder

Step 4**:** Determining service area and understanding critical issue to develop the new model of fixed- flexible feeder system. Demarking the neighborhood into smaller zones of appx size 500mx500m.

Figure 5:Demarking the study area

Locating the center of these zones and finding the ideal spot of pick-up point preferably at center of each zone for sub feeder system. Passenger residing in respective zone will gather at the nearest pick up-dropping off point, thus ensuring the closet door to door services, The walking distance to the pick-up stop is more than not 300m from origin.

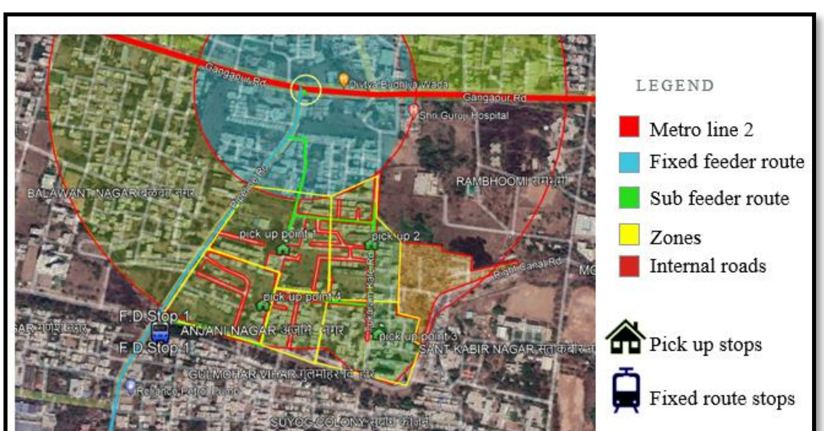

Figure 6:Showing existing road network and planned route

The IPT will act as a sub feeder system by picking up the passenger from all the zones. The above image demonstrates the position of all the pick-up stops at the center of each zone marked in green icons and also shown is the fixed route stop.

Step 5: Develop a route for the sub feeder system using IPT /Share auto where it covers all the pick-up stops and drop at fixed feeder line and find the distance .Calculate time taken for the IPT to cover the distance and also the cost for the route.

Figure 7.0:Showing sub feeder route

Time factor

Step 6: To calculate the transfer travel time 1 and transfer travel 2 as the passenger needs to make a minimum one transfer or two transfers in different modes in their total journey. Some assumptions are made because delay time is variable. Assumed tranter time vary 1 to 2 min

Transfer time =walking time +delay time.

Step 7: Next, we need to calculate the time taken in metro journey. The two main constraints in the simulation models includes running times and dwell times(the time a person stands at the platform for the purpose of allowing passenger to board or alight) .Assumption of dwell time for the same we need to consider the origin as study area and destination as Thatte Nagar for short trip and study area to CBS as long distance trip. Considering the Metro Neo speed is 90 km /hour we need to calculate the running time of the metro. Dwell time is assumed as 30 sec for intermittent station and 60 sec at main station. The sum of the two(running times and dwell times) gives us final metro journey time

Step 8 Waiting time depends on the frequency of the metro and dwell time. The frequency may vary for peak hour and non-peak hours .Headway of 10min with frequency of 6 trips/hr.is assumed. The average waiting time is assumed as 4.1 (based on earlier studies)

Step 9: Finally, we need to calculate the complete framework of total journey which includes journey duration and also number of transfers required from origin to destination for both short distance and long distance.

Total journey time for short distance = walking time from origin to pick up stops + transfer time 1+ time take by sub feeder route + transfer time 2+ time taken on fixed route from the stop to the metro stop + transfer time 3+ waiting time+ metro journey(running time +dwell time) +walking time from metro to destination

So, the total journey time is equal to respondent's existing travel time. This solution helps in integrating all the modes by including IPT, buses with additional advantage of avoiding duplication of routes.

Cost factor

The cost factors are calculated based on cost of existing metro charges in other places in India and proposed bus charges by Nashik RTO. The proposed IPT charges are pricing based on current pricing of shared auto. The costing for the new model should ensure realistic cost based on the existing cost of the different mode.

Table 4.1: Metro fare chart

Zone 1	Zone 1	Zone 1	Zone 2	Zone 2	Zone 2	Zone 2	Zone 3	Zone 3	Zone 3
Gangapur	Jalpur	Ganpat Nagar	Kale Nagar	Jehan circle	Thatte Nagar	Shivaji Nagar	Panchavati	CBS	Mumbai Naka
10 Rs	10 Rs	10 Rs	20 Rs	20 Rs	20 Rs	20Rs	30Rs	30Rs	30Rs

Step 10 The cost calculated from the origin to destination includes the metro tariff based on the table above and the FRT charges which are based on the article published in Times of India on June 4,2021, Nasik RTO's approval for the fare collection by the commuters for the proposed city bus service according to which the first 2 km will be charged 10 Rs followed by Rs 2 km. The cost of IPT from the pick-up point to Fixed route shop is based on shared auto charges.

Total journey cost:

Cost spent on first mile connectivity (Proposed IPT) + cost spent on fixed route feeder system +cost spent in actual metro journey + cost spent on last mile connectivity

Solution 2:

Solution completely eliminate the FRT by feeder bus .The IPT/Shared auto can be used as completely as a feeder system .Flexi route can be developed in this model .The IPT can be also be used for LMC .As earlier studies have indicated that people prefer to walk for their last mile connectively . The solution 2 is schematically illustrated in figure below.

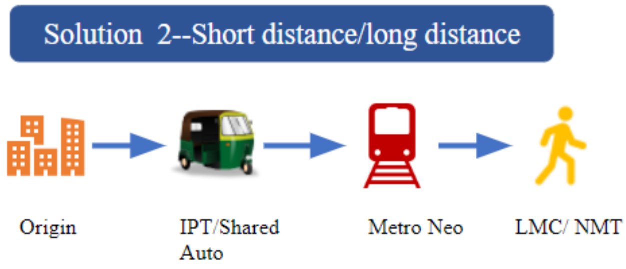

Figure 8.:Schematic illustration Solution Model 2

<u>Time factor</u>

Step 1: Analyzing details of existing neighborhoods and also understanding the existing road network.

Step 2: Understanding O-D sets of the residents

Step 3: To develop a new flexible model we need to divide the study area into different zones and plan a pick-up point at each zone. The distance from the origin to the pick-up points should not be more than 250 to 300 mts.

Step 4**:** Based on demand at each pick-up point, the IPT is dispatched from the Auto Rickshaw stand. Thus, covering from the demand-oriented pick-up points and dropping to nearest the metro stop. The route can be planned before the service trip begins, thus encouraging flexi -route model. This model eliminates one of the transfers.

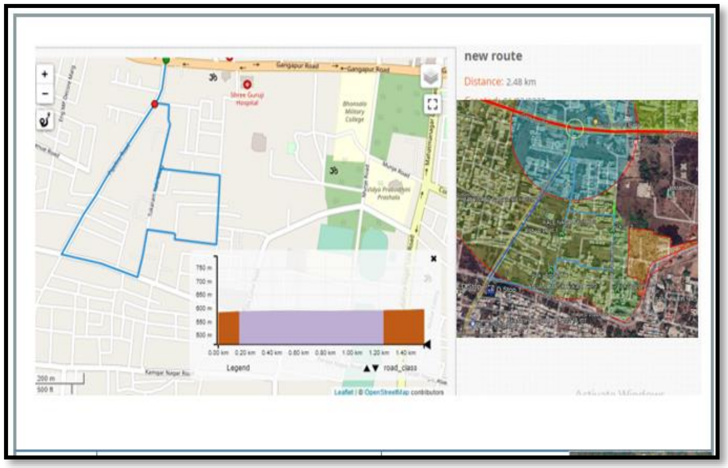

Figure 9 :Map showing route for IPT as sub feeder route

The above image helps to understand this model in which the feeder system trip begins/ ends at the stop nearest metro stations. Pick up information can be collected before the trip begins via telephonic media.

Figure 10:Map showing flexi route for feeder route

Step 5**:** Multiple flexi-routes can be developed depending upon the demand response. The above maps demonstrate two alternative routes. Travel time depends on the pick-up stop numbers and also the number of demand concentration at each point. The IPT can be dispatched accordingly

Step 6***:*** Once the flexi routes are designed, we need to calculate the time taken for the entire journey. The time taken can varies for different flexi routes. Calculations are carried out for both short distance and long distance.

Total journey time (model 2) = *walking time from origin to pick up stops* **+** *transfer time 1 +time take by sub feeder route + transfer time 2+metro journey(running time +dwell time +walking time from metro to destination*

Cost factor

The cost factor can be analyzed by totaling the entire journey expenses. Assuming the rider's journey from study area to Thatte Nagar to understand the cost factor.

Total journey cost(model 2) *=cost spent on first mile connectivity (Proposed IPT)* **+** *cost spent in actual metro journey* **+** *cost spent on last mile connectivity*

5.CONCLUSION

The table below shows the comparison of trip time in current scenario to proposed new models. The results are satisfactory as the time taken currently is more than the proposed solution model. With proper integration and coordination of operational schedules will ease the transfers between the modes.

Table 5.1:Comparision of trip time in different scenario

Comparison of trip time in different scenario						
Current short trip time	Current Long trip time	Solution Model-1 short trip time	Solution Model-1 Long trip time	Solution Model-2 short trip time	Solution Model-2 Long trip time	Results
Less than 30min	60 to 90 min	23 min	25min	20min	23min	Time spent on the short and long journey is comparatively less than current trip timing

The table below shows the comparison of trip cost in current scenario to proposed new models. The expenditure on the trip will be the nearly the same as their current spending which may encourage more people to switch to metro.

Table 5.2:Comparision of trip cost in different scenario

Comparison of cost spend on trips in different scenario						
Current short trip cost	Current Long trip cost	Solution Model-1 short trip cost	Solution Model-1 Long trip cost	Solution Model-2 short trip cost	Solution Model-2 Long trip cost	Results
15 to 30 Rs	More than 50 Rs	30 Rs	52 Rs	25Rs	45Rs	Expenditure for the integrated solution Model will be nearly same as the current expenditure

6. FINDINGS AND DISCUSSION

Each designed model features an integrated operational system ,which allows to selects nearest pick up point (approx., 300m)from the origin. The model is applied to real world case for the proposed Metro Neo's Kale Nagar stop to Thatte Nagar as short distance trip and Kale Nagar to CBS as long distance trip .The model is accessed based on two major factor that is time and cost's impact on usage of feeder system and metro itself. The model performance is investigated on both short and long route.

The models take nearly the same time as rider's existing trip time .Cost incurred for the trip is slightly more for short trip .but holds reasonable for longer trips when compared with existing trip cost. It is negligible from the perspective of social benefits and providing First/mile connectivity. Both solution model will work precisely if the pick-up time of the commuter ,timing of feeder bus and metro timing all are well integrated . It also facilitates metro to run on its full capacity. It improves the cost efficiency of metro.

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