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BUS KARO

Route Rationalization and Mass Transit Feeder Route Design

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

A product of WRI Ross Center for Sustainable Cities

About Shakti:
Shakti Sustainable Energy Foundation works to strengthen the energy security of India by aiding the design and implementation of policies that support renewable energy, energy efficiency and sustainable transport solutions.

About WRI India Ross Center:
WRI India Ross Center is part of WRI Ross Center for Sustainable Cities. WRI Ross Center for Sustainable Cities works to make urban sustainability a reality. Global research and on-the-ground experience in Brazil, China, India, Mexico, Turkey and the United States combine to spur action that improves life for millions of people.

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1. BACKGROUND AND INTRODUCTION

With increasing deployment of metro rail projects in Indian cities, the need for effective first-and-last mile connectivity options has gained significant traction. In this regard, city bus systems have great potential in serving as feeder services to metro and other rail-based forms of mass transit in India. In the context of Bengaluru, the expansion of the city's metro rail network has resulted in increased ridership and hence, higher demand for feeder services to the metro. The Bengaluru Metropolitan Transport Corporation (BMTC), operator of bus services in Bengaluru, has been exploring the possibility of running feeder bus services to metro rail lines in the city. It had even started a few services on the Purple Line (east-west), the first phase of the Bengaluru metro network.

However, several of the metro feeder routes thus deployed failed to gain significant ridership and soon became heavily loss-making services for the operator, resulting in these services either being scrapped or made extremely infrequent. These feeder bus routes failed due to a combination of reasons, one of which was a lack of adherence to the principles of planning a feeder bus route to an upcoming rail network. In this context, WRI India assisted BMTC to design and implement a few pilot feeder bus routes on the Green line (north-south) corridor of the Bengaluru Metro based on scientific feeder design principles. The overview on the methodology and process by which feeder routes were proposed, is summarized below.

2. FEEDER ROUTE DESIGN METHODOLOGY

The methodology followed to design a metro feeder route is explained below:

(a) Identify appropriate metro stations; either (a) high-boarding/alighting stations or (b) stations with latent demand[1]

(b) Assess the catchment area around the metro station; a radius of 5-6 kilometers; identify major trip generation points in the vicinity and which times of the day they tend to generate travel demand;

(c) Understand the occupancy ratio and viability of existing bus routes within the focus area; assess which sectors within the focus area are poorly connected by existing bus routes to the metro station;

(d) Examine the road network within the focus area and identify which roads are wide enough to successfully support the operation of frequent buses;

(e) From steps (b), (c) and (d), assess whether demand exists for the proposed route. If existing bus routes run close to the proposed Metro Feeder route and exhibit poor occupancy levels or ridership, then it might be more appropriate to suggest rerouting/rationalizing these routes to cover these areas and link the metro station, rather than proposing a new, dedicated service;

(f) Identify the ideal routing to minimize the number of 'dead' kilometers operated as part of the route (i.e. from depot to the first stop of the route).

The optimal conditions for the introduction of a Metro Feeder are graphically represented in the Venn diagram in figure 1.

[1] This refers to metro stations within the vicinity of high trip-generation locations which still exhibit low boarding and alighting patterns, suggesting that potential demand for feeder services does exist.

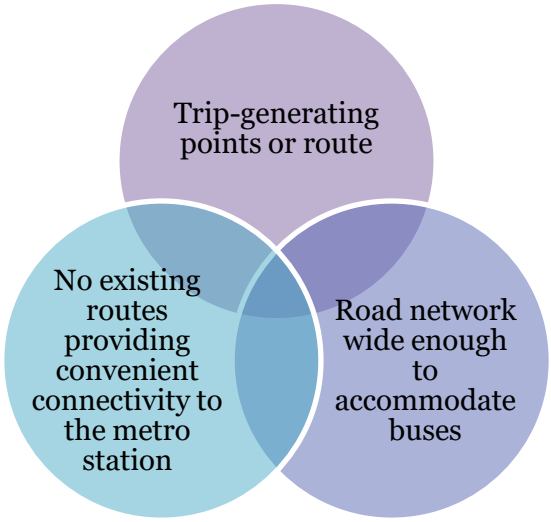

Figure 1: Conditions favoring introduction of metro feeder service

3. CASE EXAMPLE - METRO FEEDER ROUTE DESIGN 1

The feeder route design methodology was used to propose a metro feeder bus service for stations on the green (north-south) metro line.

1. Finalizing the metro stations for metro feeder service

First, the boarding-alighting patterns on all metro stations of the green line were examined. It was seen, as indicated in figure 2, that the last three metro stations - Banshankari, JP Nagar and Yelachenahalli (shown in figure 3) attract the maximum number of passengers. As such, these stations were chosen for planning one metro feeder bus service.

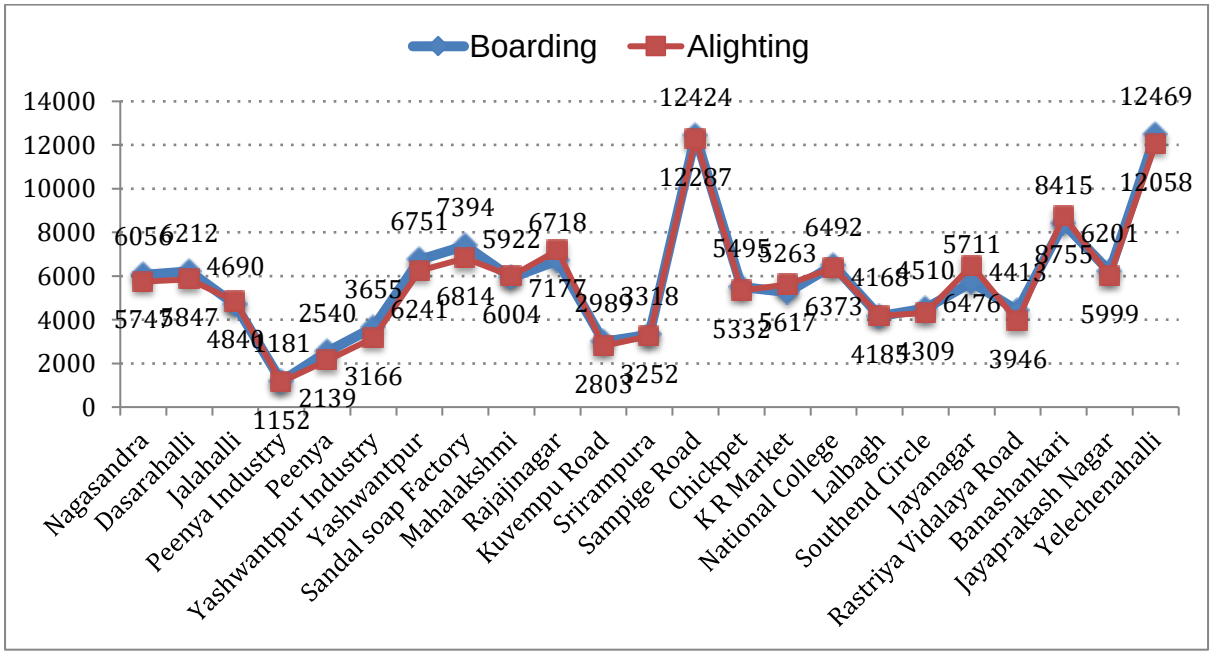

Figure 2: Average Total Daily Metro Ridership - Green Line - Weekdays: 26 - 30 Jun

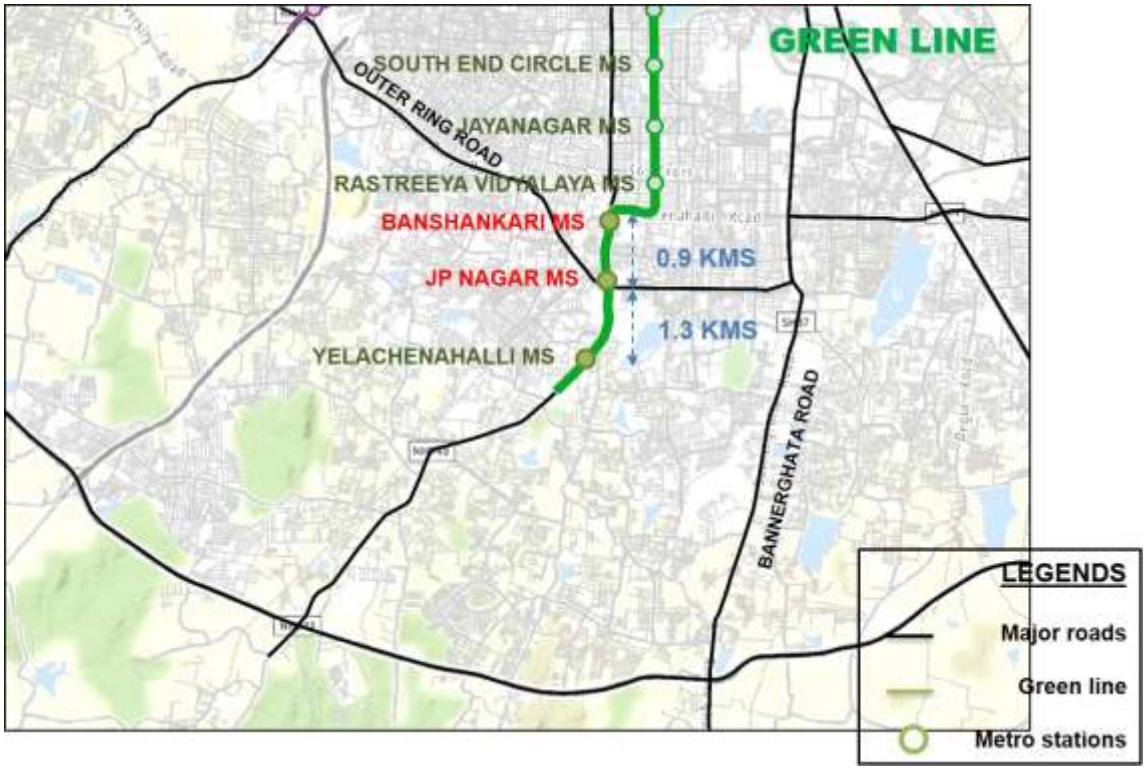

Figure 3: Banshankari, JP Nagar and Yelachenahalli Metro Stations on the Green Metro line

2. Deciding the catchment area for the metro stations

Catchment area comprises of neighborhoods and establishments around the metro stations from where passengers will access the metro service. The catchment area for the three-metro station was determined using the thumb-rule of 5-6 km influence radius around the Yelachenahalli Metro Station, which is the last metro station, and 3 km influence radius around the JP Nagar and Banshankari Metro Stations. The final catchment area around the metro stations which was analyzed for proposing the metro feeder services is determined by taking its edges along the major roads in close proximity to the influence radii. The final catchment area is marked in figure 4.

The three metro stations were also gauged for their connectivity with existing bus stops. This was done by mapping all bus stops within 5 minutes and 10 minutes walking distance from each of the three metro stations – shown in figure 5. As detailed in table 1, currently there are 18 bus stops within a walking distance of 5 minutes from the three metro stations and 43 bus stops within the walking distance of 10 minutes.

Table 1: Number of bus stops within walking distance of 5 minutes and 10 minutes

Metro station	Number of bus stops	
	5 mins walking distance	10 minutes walking distance
Banshankari	7	20
JP Nagar	6	14
Yelachenahalli	5	9
Total	**18**	**43**

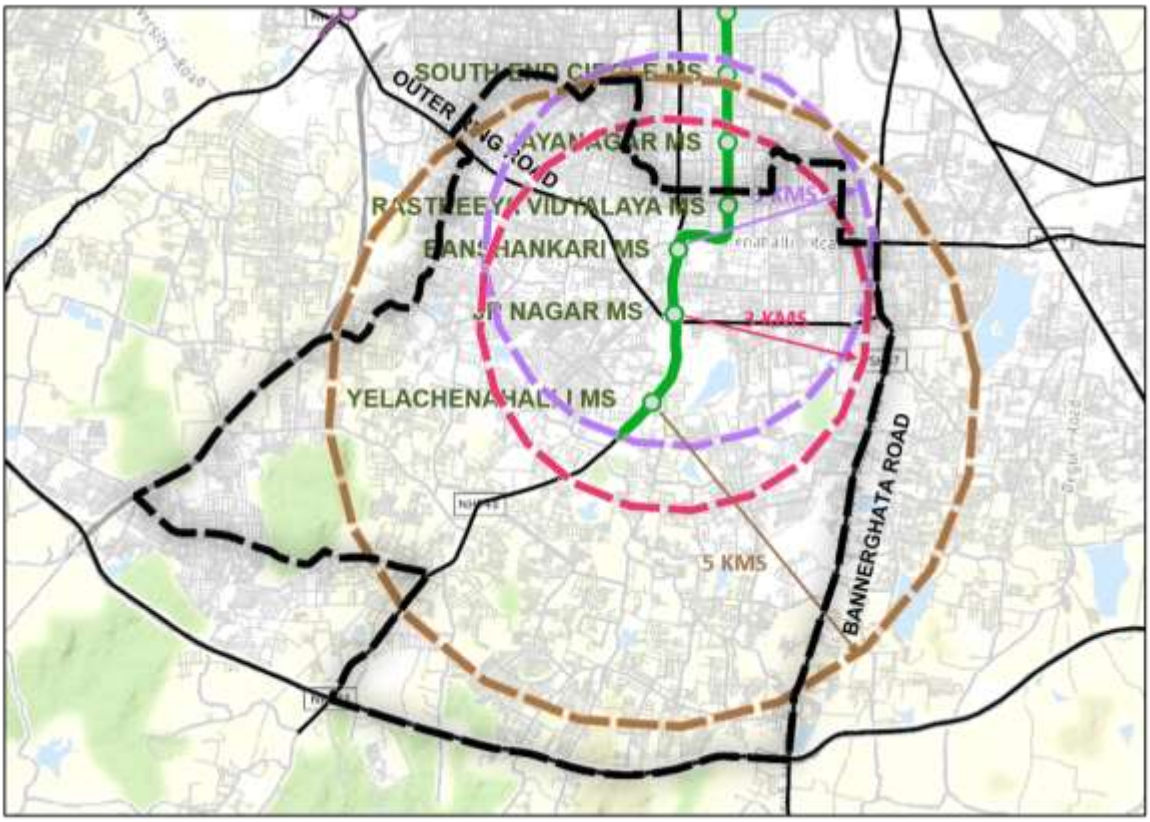

Figure 4: Catchment area around the three metro stations

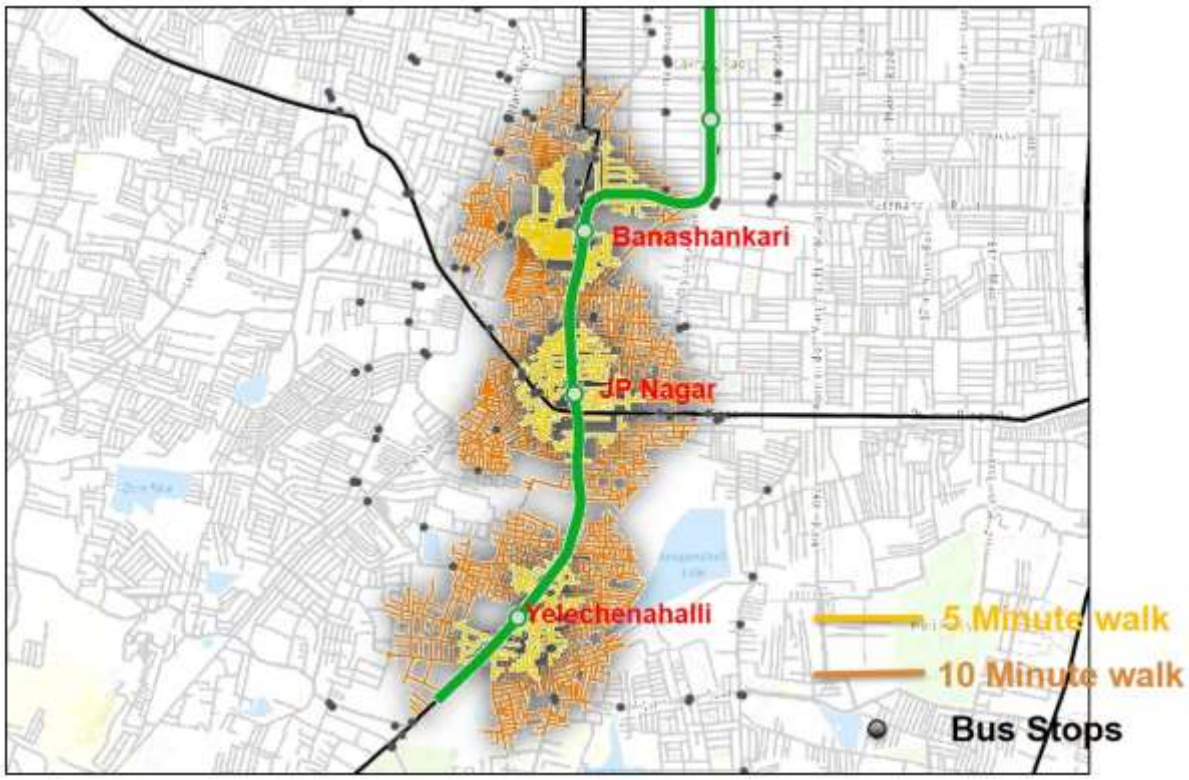

Figure 5: Bus Stops within 5 mins and 10 mins walking distance from the metro stations

3. Understanding the occupancy ratios and viability of existing bus routes in the catchment area

The area identified as catchment area was analyzed to assess the existing bus services being operated by BMTC that connect it to the rest of the city and the three metro stations. For this, the existing bus routes being operated in the area, their occupancy ratios and their viability to serve as a metro feeder service was examined. It was found that barring a specific section of the catchment area – shown as focus area in figure 6, the remaining zones were well connected by existing bus routes to other parts of the city and to the metro stations.

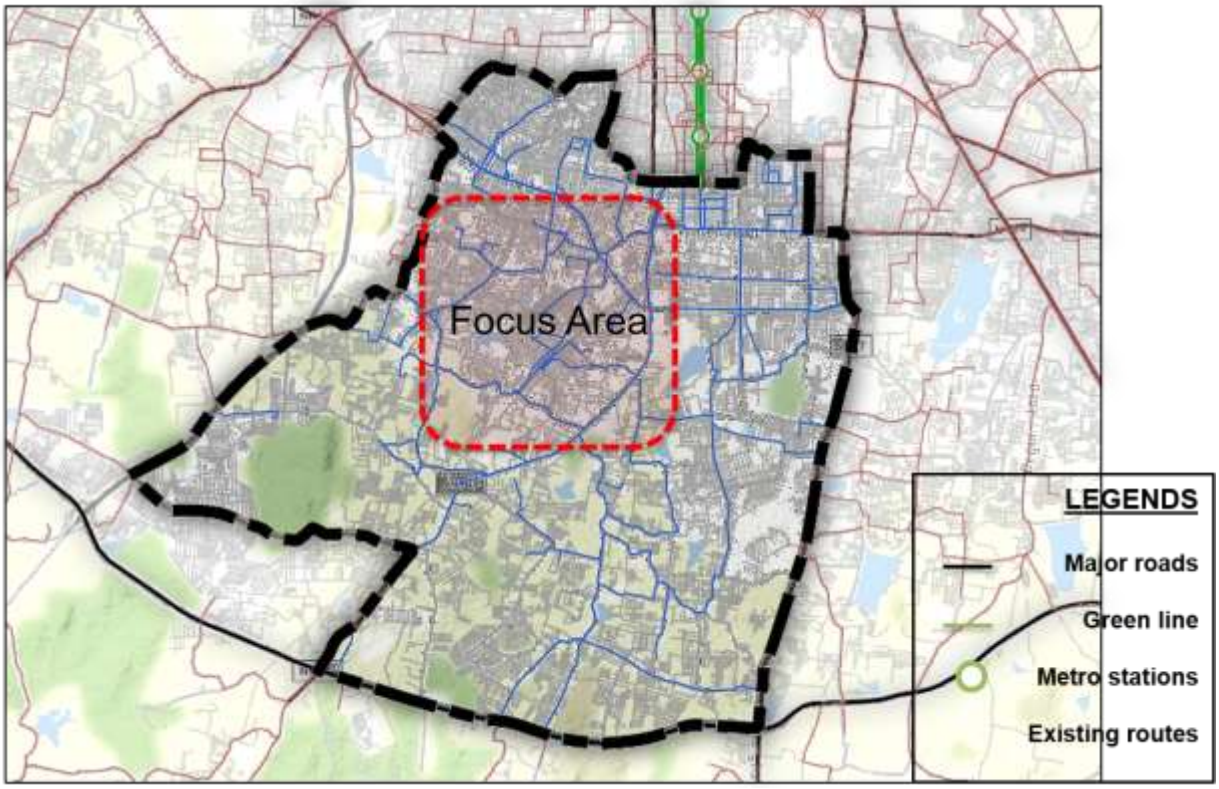

Figure 6: Zones within the catchment area poorly connected to the metro stations

The focus area had two key issues in terms of connectivity with the metro stations through bus services:

1. No existing bus route serving the area pass through the metro stations. The nearest bus stop from where the bus routes pass is at a distance of 650 m from the Banashankari Metro Station- shown in figure 7 and 8. This stretch, however, has inadequate pedestrian infrastructure which prevents the commuters from using it to reach the metro stations.

2. The existing bus routes in the area (mentioned in table 2) are inadequate to serve as a metro feeder due to the following reasons. First, the routes originate at different stages in the area- connecting only limited neighborhoods. With the exception of the infrequent 210-G and 210-AA services, routes listed above do not link neighborhoods like Kumaraswamy Layout, ISRO Layout and Vasanthapura to a Metro Station. Second, availability of the bus services by capacity and frequency is inconsistent. Detailed in table 3, the frequency of bus services varies between 8 minutes to more than 30 minutes during the morning peak hour. Third, analysis conducted to compare the cost of operations and revenue generated, indicated that most of the routes in this area are generating losses for the operator.

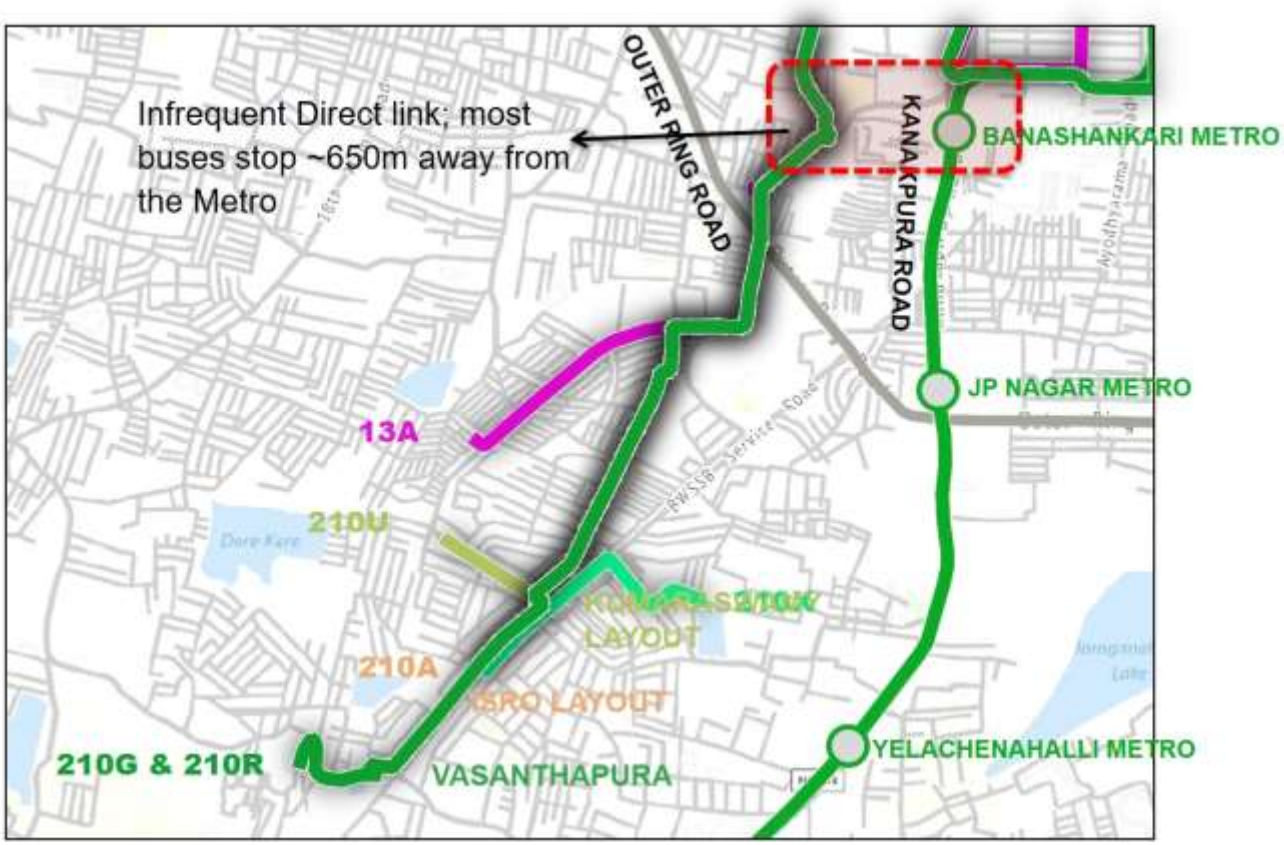

Figure 7: Lack of adequate last mile integration between the bus services and metro station

Figure 8: Pedestrian infrastructure leading to the Banshankari metro station from nearest bus stop

Table 2: Existing routes in focus area

Routes	Schedules	Trips per day
210-A	2	15
210-AA	2	16
210-G	4	16
210-R	5	36
210-U	4	40
210-X	2	16
Total	**17**	**123**

Table 3: Frequency of existing bus services in focus area during morning peak-hours

	8-9 am	9-10 am	10-11 am
Kumaraswamy Layout	8 mins	8 mins	8 mins
ISRO layout & Vasanthapura	12-15 mins	12-15 mins	25 mins
Subramanyapura	15-20 mins	15-20 mins	>30 mins

4. Proposing the metro feeder bus service

Based on the above findings and the widths of the existing roads in the focus area to operate BMTC buses, a metro feeder route as shown in figure 9, linking Kumaraswamy layout, ISRO layout, Vasanthapura, Uttarahalli and Chikkalasandra to two metro stations - Banashankari and JP Nagar was proposed. The total length of the route is 11.45 km.

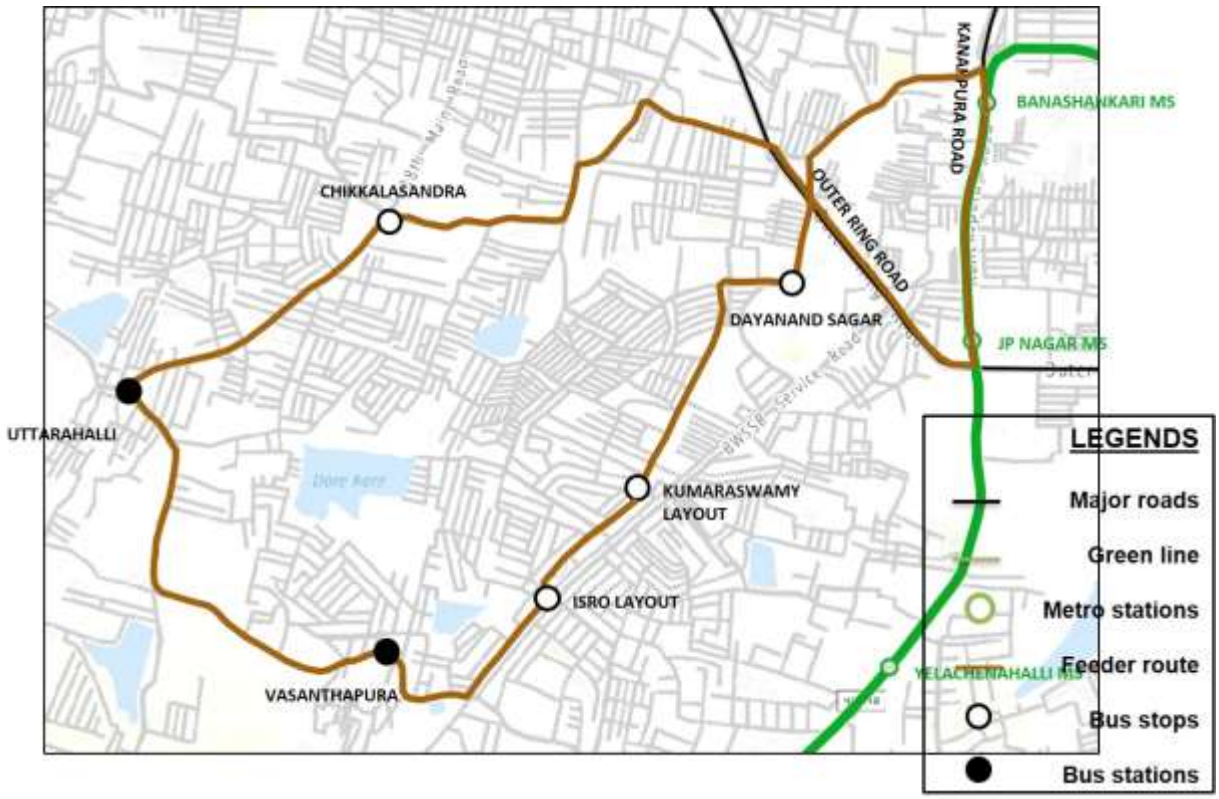

Figure 9: Proposed Metro Feeder Route

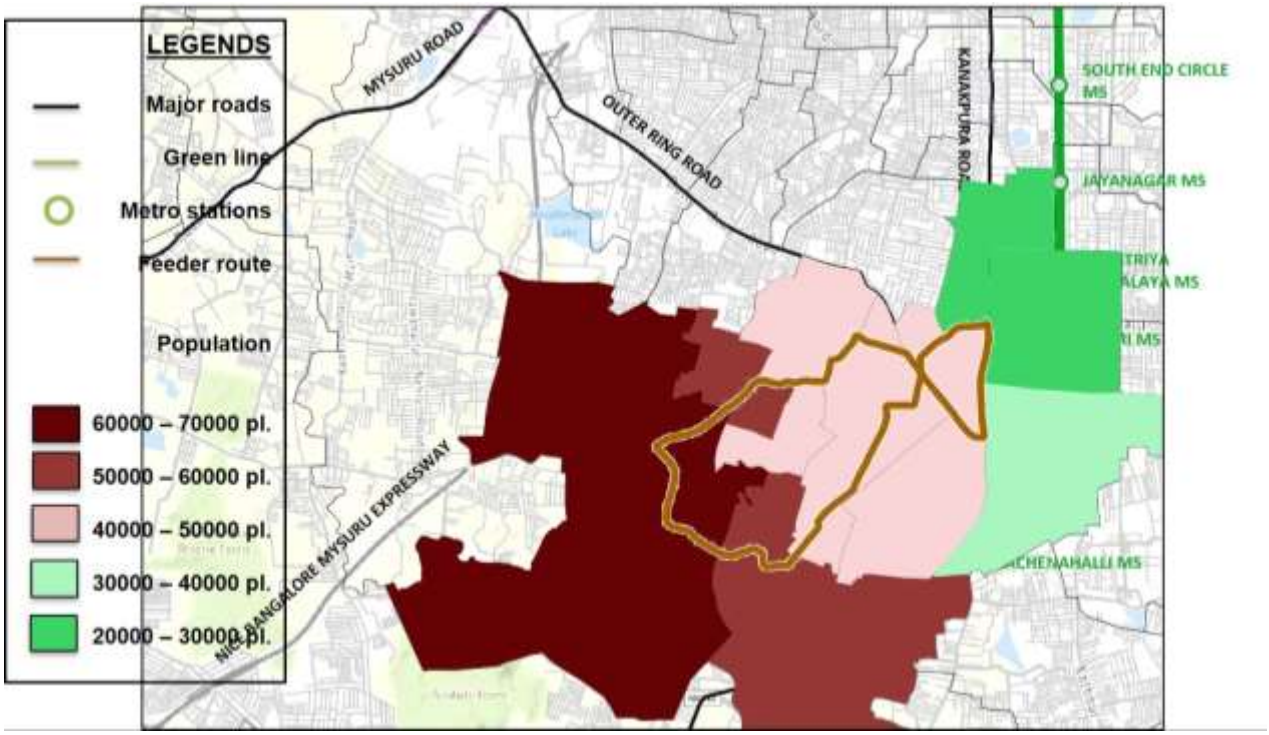

Figure 10: Population served by the proposed metro feeder route

The routing also minimizes the number of 'dead' kilometers operated as part of the route (i.e. from depot to the first stop of the route), as indicated in table 4.

Table 4: Proximity of the route from the nearest depot

	Location (Depot No.)	Nearest Stage/stop on the proposed route	Distance (km)
1	Banashankari	BSK Metro	0.25
2	Poornaprajna Layout	Uttarahalli	0.85

Cycle time of the proposed metro feeder and its operational hours are shown in Table 5 and 6.

Table 5: Cycle time of the proposed metro feeder route

	Peak	Off peak
Cycle Time	50-55 mins	35-40 mins
Crew Time	15 mins	15 mins
Total	65-70 mins	50-55 mins

Table 6: Number of trips for the proposed route

	Peak	Off peak
Time	i) 7:30 – 10:30 am ii) 5-8 pm	Rest of the day
Duration	360 minutes	480 minutes
Max round trips/day	360/65= 9 trips	480/50 =9 trips

This route, however, was not implemented due to BMTC's decision to reduce its metro feeder services as the other existing metro services did not attract enough ridership and desired revenues.

4. CASE EXAMPLE - METRO FEEDER ROUTE DESIGN- 2

Using the metro feeder route design methodology, one of the first routes WRI suggested to BMTC in the southern corridor of the Bengaluru Metro was a circular route linking JP Nagar and Yelachenahalli metro stations to localities to their east (JP Nagar, Kothanur, Ayodya Nagar, Puttenahalli and Anjanapura). This route was introduced with slight modifications by the BMTC, which extended the length of the route further east to connect Hulimavu, off Bannerghatta Road. The revised route is represented in figure 11.

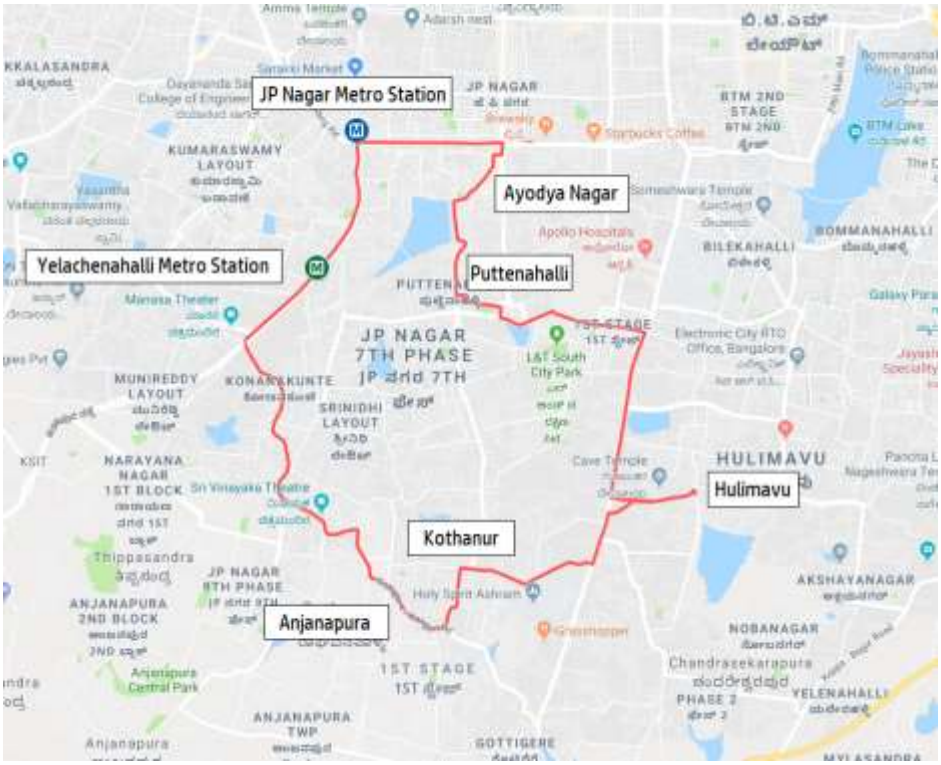

Figure 11: Metro feeder Route - MF 20 implemented by BMTC

Unfortunately, despite serving as a feeder service providing connectivity to several underserved areas around JP Nagar and Yelachenahalli Metro stations, the feeder service eventually failed to yield the desired revenue for BMTC, which then progressively reduced the frequency of the service until it became almost unusable as a Metro Feeder service. This is in line with trends for several of the operator's other Metro Feeder services in the city.

1.1 PROBLEM ASSESSMENT

Existing Metro Feeder services introduced by the operator (BMTC) have failed to meet their desired revenue and occupancy targets. An analysis of the existing situation revealed the following issues:

- **Poor route planning**: In several cases, the metro feeder routes planned by the operator follow other existing bus route patterns rather than connecting adjoining underserved areas to the metro station. These routes tend to be short-loop duplicates of extant routes and are not very well patronized. Even in cases where patronization is high, the major usage of the route is not to connect to/from a metro station, defeating the purpose of branding it a Metro Feeder service.
- **Lack of information**: Several metro feeder services (including the MF-20 route) were launched without adequate information dissemination to commuters on service's route

and frequency. As such commuters were unaware of metro feeder services. This was particularly detrimental to the operations of buses providing first-time connectivity to areas adjoining metro stations – the MF-20 route a good example in this case as well. As commuters did not adopt these services, BMTC further reduced their frequencies.

- **Frequency**: This draws from the previous point – as ridership on various Metro Feeder routes stayed low, BMTC responded by reducing their frequencies, making the services far less reliable. Given that commuters travelling on work are highly time-sensitive, infrequent feeder bus frequencies (such as a bus every half-hour) were unlikely to create a base of regular commuters willing to depend on the service.
- **Current Metro Ridership and Feeder Bus Size**: Given the relatively low capacity and ridership of the Bengaluru metro at present, the buses being operated as Metro Feeder services (32 and 42 seater buses respectively) represent overcapacity for these services. This has two implications: 1) that the buses are unlikely to fill to capacity, furthering the impression that there is no demand and; 2) these buses, being larger, are likely to be difficult to maneuver through narrower streets than smaller variants.

Convincing the operator as to the importance of a good communications campaign in areas where new Metro Feeder services are being introduced – along with the provision of necessary information – has proved a significant challenge. This aside, as the design of Metro Feeder routes represents a radical change from the operator's conventional approach to designing routes in the city, it has proved challenging to break internal resistance to change. At this point, BMTC has shown reluctance to introduce any more feeder services, given the loss-making propensity of existing Metro Feeder services. This is unlikely to change until metro ridership increases enough to provide greater demand at stations.

1.2 LEARNINGS

This project provides several learnings for Metro Feeder route designs in the future. Given that the potential clientele for Metro Feeder services may differ from conventional bus users, the provision of adequate information about services gains greater prominence than would have otherwise been the case. In working with other STUs and operators, the importance of information provision and adequate fleet planning – both in terms of scheduling and bus specifications – will need to be given primacy before the actual implementation of new feeder services.