Multi-Modal Integration around Metro Networks- Learnings from the Bengaluru Metro MMI Plans

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ARCADIS | IBI GROUP

Sub - consultants

UP International · Knight Frank · iihs

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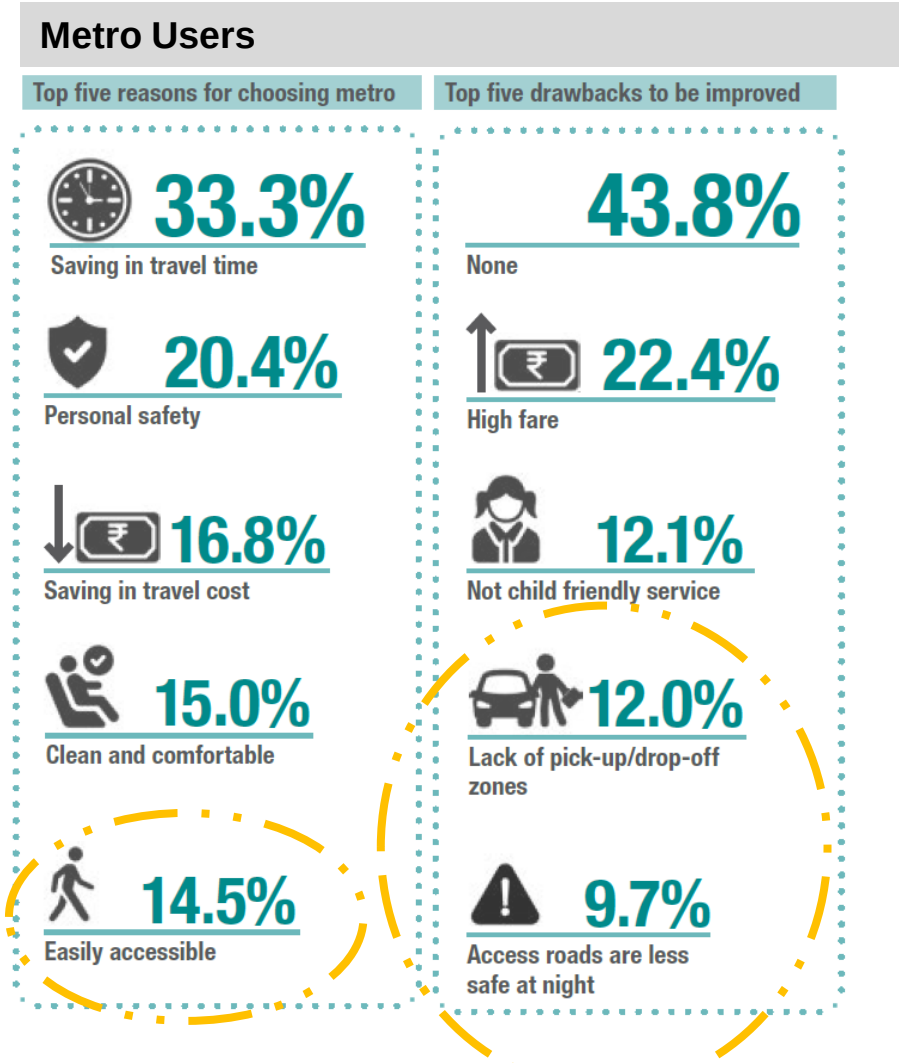
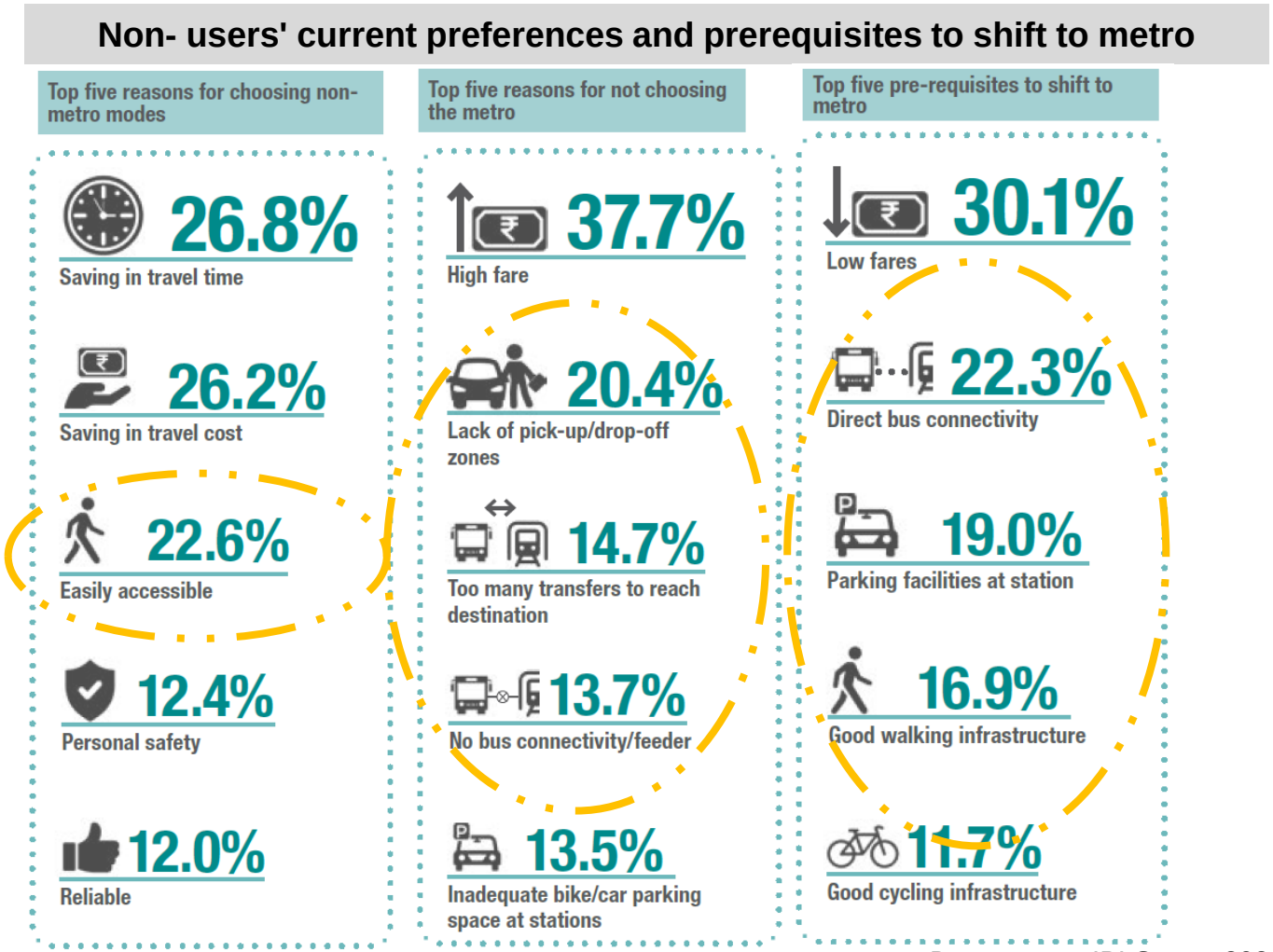
DIRECTORATE OF URBAN LAND TRANSPORT, Urban Development Department, Government of Karnataka — shaping the way cities move

ADB

What do metro users need?

- User satisfaction surveys of current users and non-users of Bengaluru metro provide interesting insights
- Facilities within metro satisfactory to most users, although fares are repeatedly identified as ‘too-high’
- Safe, convenient and economical access to metro by bus, walk and cycle highlighted as a key improvement area by both users and non-users





Data source: IBI Group, 2022

How do users access the metro now?

RESPONSES FROM METRO USERS

WALKING

61%
of metro users walked to access the metro station

Average distance for access trips by walking = 1km

For access distances up to 1km, more than 96% of all age groups walked to the metro station

77%
of metro users walked as a means of egress from the station

53%
of metro users walked for both access and egress

TWO-WHEELER

19%
metro users used two-wheelers to access metro stations

Average distance for access = 4.4km

BUS

8.9%
metro users used BMTC buses to access metro stations

94%
of these respondents had a first mile trip of more than 2km

3.6%
metro users used BMTC buses as a means of egress from the station

AUTORIKSHAW

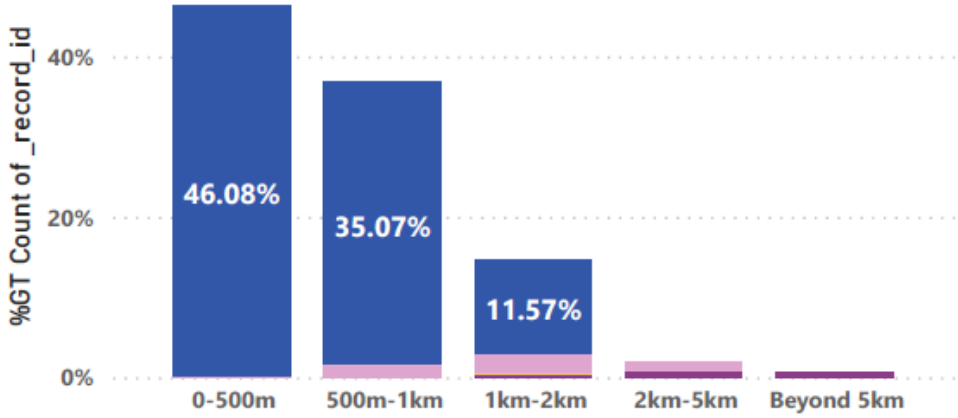
7.5%
metro users used auto-rickshaws for the last mile

Average distance for access = 4.15km

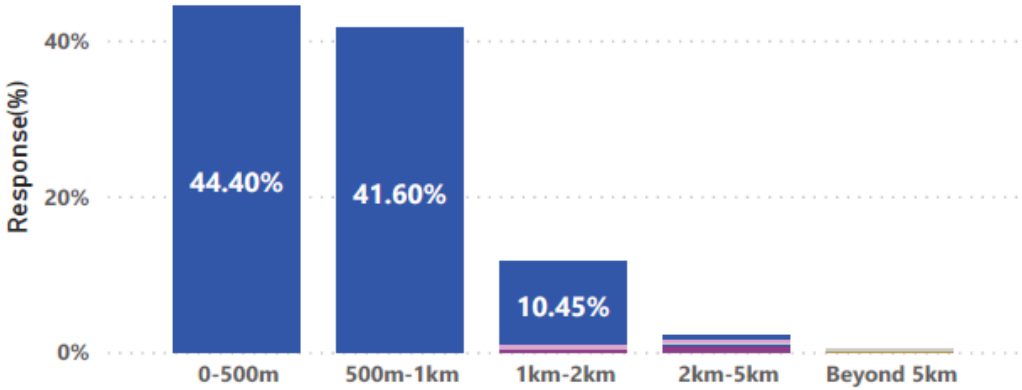
The 50-65 age group is more inclined towards autorickshaws (with 18% of the age group making use of this mode) and public buses (13%) when compared to younger age groups

Reliable feeder services to the metro station could be an attractive option for this group

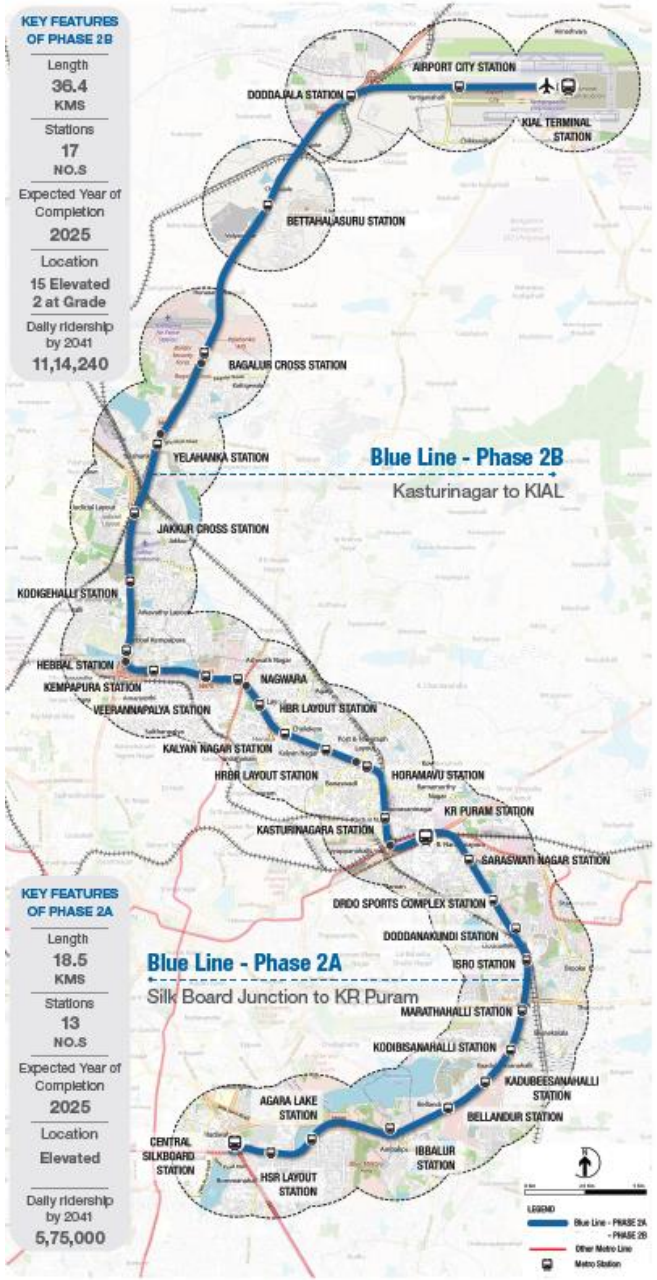
Responses (%) for Access Mode by Distance



Responses (%) for Egress Mode by Distance



The Phase 2A and 2B Corridors of Bengaluru Metro



DEMOGRAPHY

Estimated 2021
2.2 Mill
Projected 2041 with TOD
3.3 Mill

Over 2 million people will benefit from improved urban environment. TOD will **increase population holding potential** of the corridor by **15-20%**

ECONOMY

60%
of Bengaluru Urban district's IT and Professional Services employment is located along the corridor

IT, the largest growth driver for the city since 2000, has major presence along the corridor. TOD is an opportunity to improve the urban experience and **attract the best talent and best investment to the city**.

DEVELOPMENT

50-60%
Share of corridor in commercial office space transactions in the city

Highest demand for commercial development is along this corridor. TOD is an **opportunity to increase housing options** for people working here.

ENVIRONMENT

4.57%
of the city is under blue cover

22.8%
of the city is under green cover

Largest extent of loss of blue and green cover in the city has been along this corridor. TOD is an opportunity to **restore the corridor's blue and green assets.**

5 Big Moves on MMI

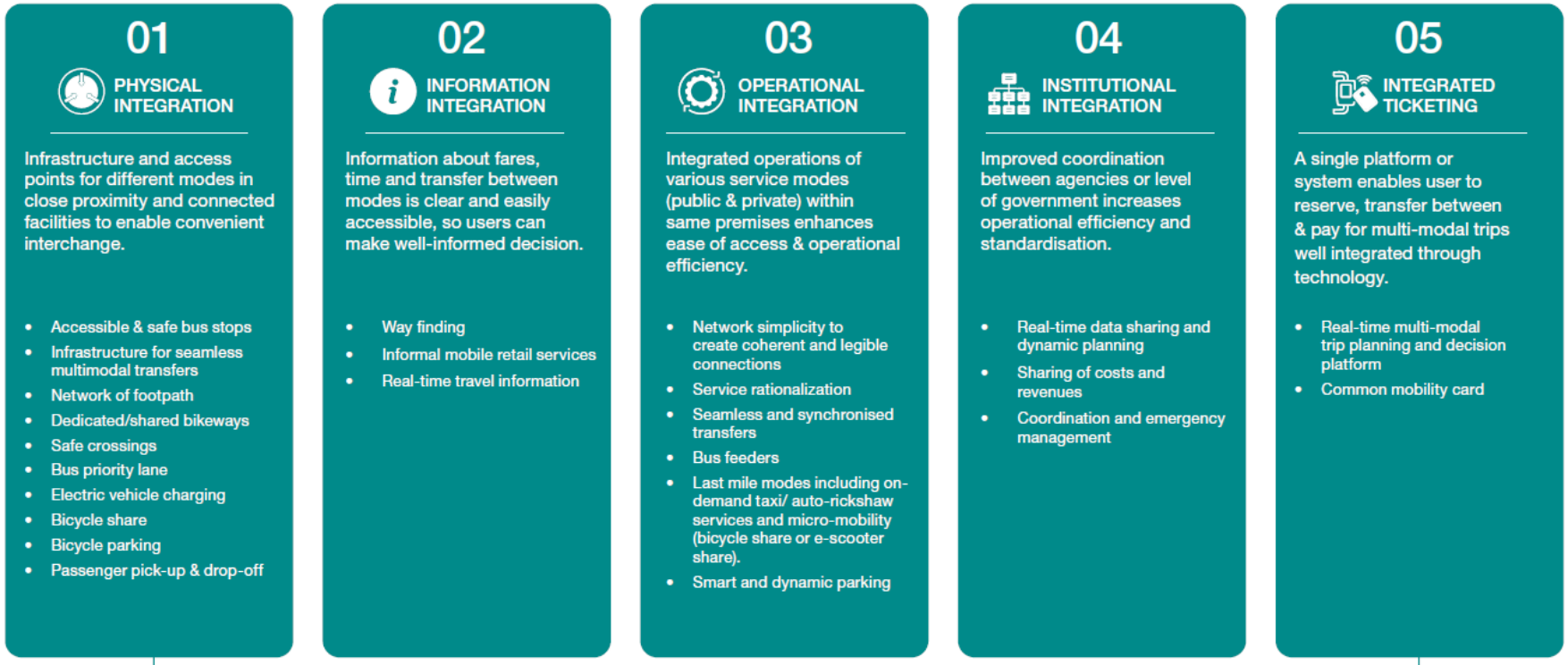
FIVE BIG MOVES	KEY STRATEGIES	PROJECT COMPONENTS
1  CUSTOMER CENTRIC INTEGRATED TRANSIT NETWORK	• Integrate metro, bus & rail as a cohesive network of high quality services • Adopt a customer-first approach to ensure high levels of service across the network • Build in flexibility to adapt to the growth & changes in demand patterns • Phase out plans to incrementally strive towards enhanced & efficient public transit service	Institutional integration Operational Integration Measures
2  MULTI-MODAL TRANSIT HUBS AS "THIRD PLACE"	• Create hierarchy of transit nodes to integrate variations in transit diversity & commuter preferences • Integrate attractive public realm, placemaking & ancillary facilities	Operational Integration & Physical Integration
3  ENHANCE & EXPAND FIRST- LAST MILE CONNECTIVITY	• Promote healthy streets by prioritizing walking & cycling infrastructure • Integrate active transportation into blue-green networks • Promoted regulated, flexible & shared mobility options	Physical Integration at access sheds and station vicinity Operational Integration
4  PLAN FOR CUSTOMER CONVENIENCE	• Adopt integrated journey planning with common ticketing & real-time information sharing • Monitor commuter satisfaction through regular feedback mechanisms • Design for universally accessible & seamless transfers with a strong focus on commuter experience	Technological Integration Physical integration at stations
5  STRATEGIC PARKING MANAGEMENT	Discourage private mobility by introducing travel demand management strategies: • Adopt reduced parking provision norms • Encourage & regulate shared parking facilities • Adopt parking pricing strategies	Parking Management Plans & MMI Plans where appropriate

What is Multi Modal Integration (MMI)?

MMI refers to improving the end to end journey experience of public transport users such that they're encouraged to prefer public transport over personal travel modes

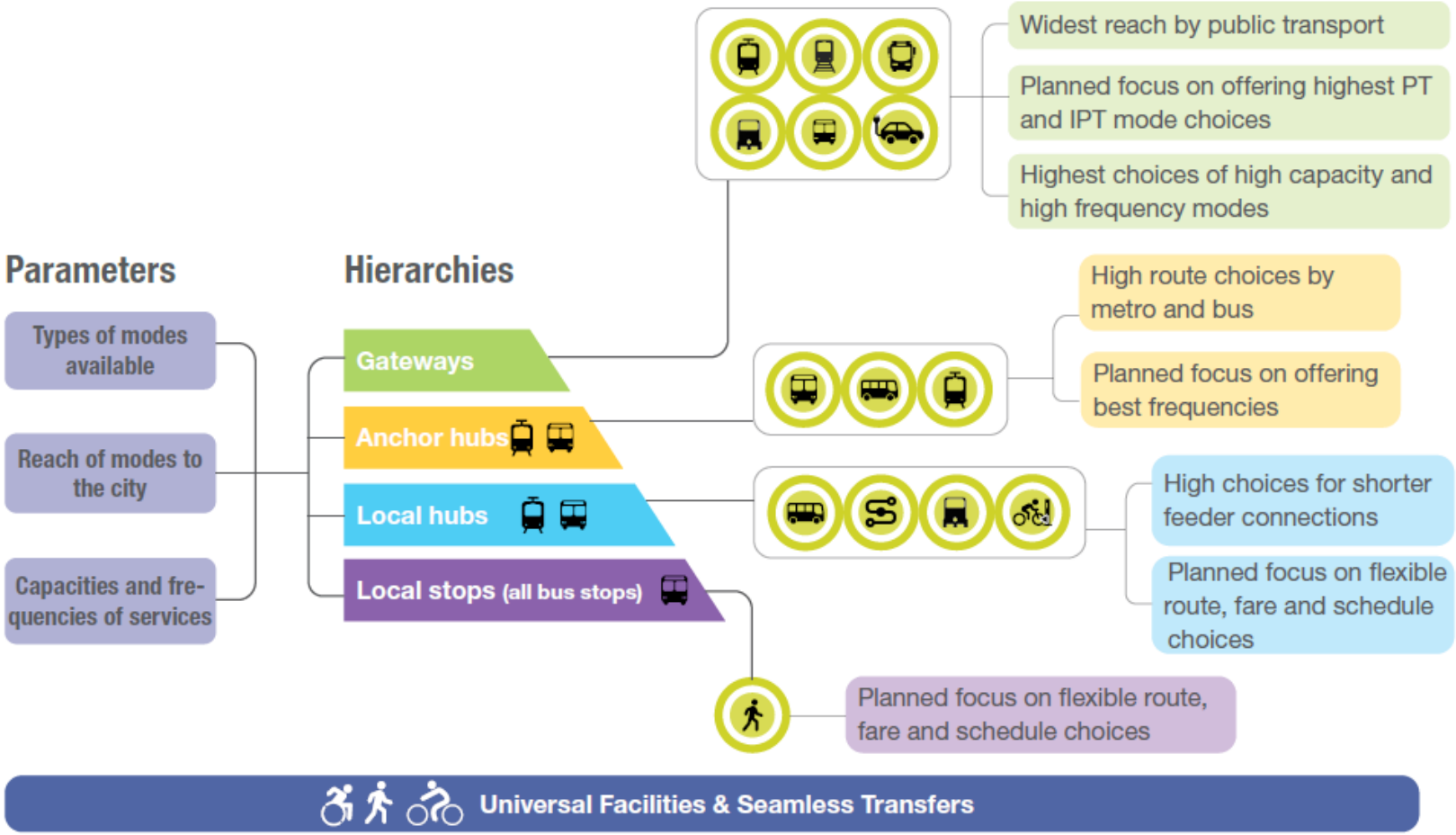
Effective MMI will expand the access area of metro rail systems and will help in retaining current users and attracting more ridership

MMI is typically evaluated across the following 5 pillars

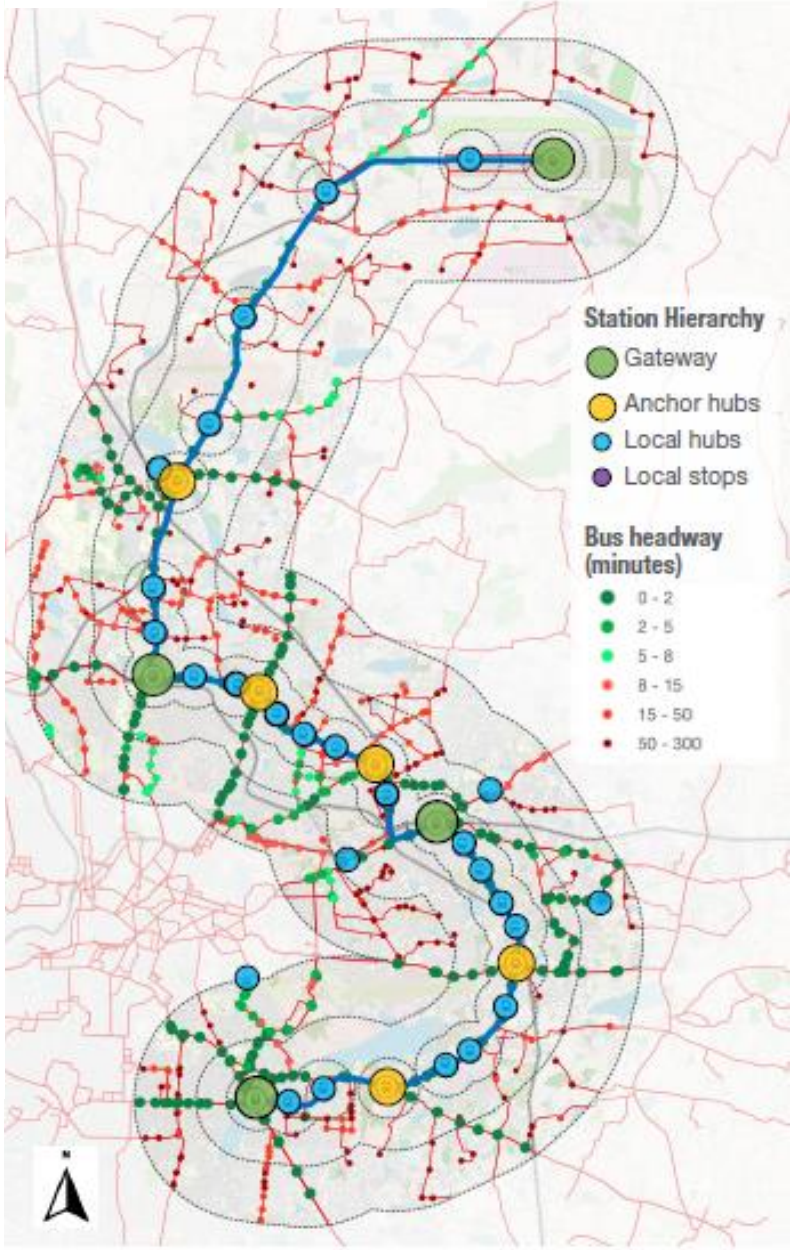


Proposed MMI hierarchy

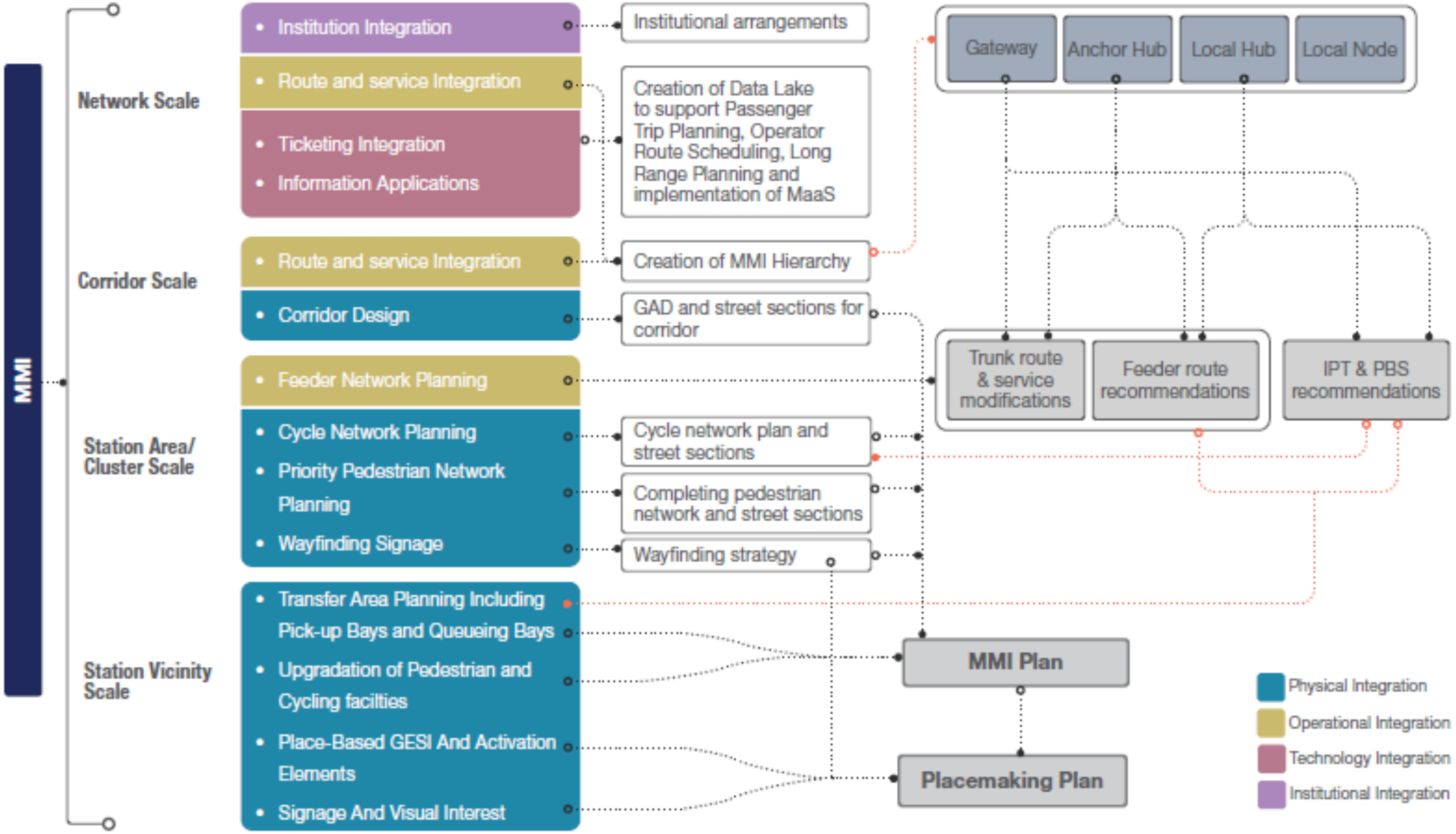
Stations along the phase 2A-2B corridors are segregated into categories



Station Hierarchy and bus headway for 4kms



MMI Planning Scale



1 Physical MMI proposal framework

Network | Street | Station Vicinity

Function

- Universal access
- Walk
- Cycle
- Feeder: Bus
- Feeder: Shared Mobility
- Feeder: Private Mobility
- Urban Design

Intended goals for each function

Recommendations

- Design parameters for universal accessibility
- Location of station entrance structure
- Proposal of new links for walking and cycling
- Improvement of existing routes for walking and cycling
- Footpath widths
- Pedestrian and cyclist crossing locations
- Pedestrian grade separated facilities
- Pedestrian and cyclist crossing control
- Cycle lanes network
- Cycle lane alignments
- Location and sizes of: cycle parking stands; bus shelters; PPUDO bays for autos, two-wheelers and four-wheelers; two-wheeler rental bays and passenger parking
- Traffic detours and median openings
- Geometric improvements and junctions
- Street furniture (benches,lighting)
- Signage (identification, informational, directional, regulatory)
- Landscape
- Bus shelter design
- Cycle stand
- Amenities (toilets/changing room, etc)

Methods of evaluation

- Design principles
- Empirical Analysis/Simulation
- GIS analysis
- Qualitative analysis
- Parking needs analysis
- Performance indicators

Preliminary goals for MMI within the broader vision

Mode/ User	Intended Outcomes	Project Planning Goals	MMI pillar to be served				
			Phy	Op	Infm	Inst	Tckt
Universal	Unlocking potential connectivity to the entire public transport system	• Stations and station vicinities should promote seamless connectivity to other connecting public transport modes with amenities and information for all types of users (genders, ages, abilities).	✓		✓	✓	
	Appropriateness of Entry and Exit Locations	• Station entry and exits should be located such that dispersal from these points is safe, direct and convenient.	✓				
Walk	Ensuring continuity, directness, and legibility of the walking infrastructure	• Pedestrian networks surrounding the station should offer maximum, continuous and direct, safe, connections to surrounding neighbourhoods. • Wayfinding and access to information should be prioritized for pedestrians, to make walking a reliable choice.	✓		✓	✓	
	Enhancing walkability to major activity generators	• Streets connecting to major origins and destinations should be safe, comfortable, and attractive, such that walking is the most preferred choice within a 6 min walking distance. • These connecting streets should be well-lit and activated to enhance personal safety for women, children, and other vulnerable groups at all times of the day.	✓		✓		
	Ensuring adequate footpath widths and safe pedestrian crossing near stations	• Footpath widths surrounding the station should be sufficient to support dispersal of passengers during peak utilization of metro. • Pedestrian priority should be maintained at intersections surrounding the station that connects to the complete network of streets,	✓				
Bicycle	Ensuring continuity, directness, & legibility of the cyclable infrastructure	• Cycle networks to be planned to offer maximum, continuous and direct connections for cyclists to surrounding neighbourhoods. • Wayfinding for cyclists should be available across the cycle shed to promote use of cycles for the first/last mile.	✓		✓	✓	
	Enhancing cycling safety & comfort to major activity generators	• Cycling tracks or lanes or cycle shared lane marking to be provided on all roads identified in the cycle network, and prioritized for the roads connecting the metro station.	✓		✓	✓	
	Ensuring safety of cyclists in cycle lane alignments near stations	• Protected cycle lanes to be provided near stations to protect cyclists from conflicts and potential crashes and connect back to the complete network of streets,	✓				
	Adequacy of cycle parking or PBS station locations	• Cycle parking and PBS stations should be conveniently located so as to be within a quick 300m walk from any where within the cycle shed	✓	✓	✓	✓	
Feeder modes	Ensuring adequate bus route alignments serving surrounding catchments	• Bus routes should provide connectivity from high demand locations that are beyond 1km from the metro station.	✓	✓	✓	✓	
	Ensuring adequate bus service frequencies for high demand areas	• Bus service frequencies should be high for identified feeder routes to attract commuters to buses for the first and last mile.		✓	✓	✓	
	Ensuring availability of essential information about bus/ other modes schedules & arrivals at decision points	• Information about bus routes, schedules and real-time location of buses should be easily available to commuters and allow them to plan their journey in an integrated manner.			✓		
	Prioritization of bus stop location compared to other transfer facilities	• Where feeder routes are to be prioritized, bus stops should be located very close to station exits with displayed dynamic information about expected bus arrival time. • Shared ride and pick-up zones should be provided where feeder routes are not possible, and or to be planned to be a longer walk from station exits.	✓		✓		
	Appropriateness of auto stands, EV 2W parking, & pick-up/drop-off locations	• IPT and shared electric mobility options should be available as safe and comfortable, high quality choices where feeder options are needed. • Pick-up/ drop-off and parking facilities for private vehicles should be provided at peripheral stations and other stations where public and/or shared feeder mobility options are not freely available and should be located so as to not conflict or interfere with pedestrian or bus transfer movement.	✓		✓		

Physical MMI proposal by mode

Sl. No	Mode	Recommendations on	Source of Analysis	Applicable Standards	Measures of Effectiveness (MoEs)						
					Pedestrian travel times	Pedestrian-vehicle conflicts	Pedestrian density on footpaths	Vehicular Queue Length*	Vehicular average delay	% Coverage**	MMLOS**
1	Universal	Station entrance structure	Simulation								
2		Design parameters for universal accessibility	Design Principles	• IIRC:SP:117-2018: Manual on Universal Accessibility for Urban Roads and Streets							
3	Walk	Continuity and directness	Pedshed and Barrier Analysis	• IRC 103-2012: Guidelines for Pedestrian Facilities • IRC 86-2018: Geometric Design Standards For Urban Roads And Streets • Tender SURE							
4		Walkability to activity generators	Shortest Route Analysis and Walk LOS								
5		Footpath widths	Simulation								
6		Pedestrian crossing locations	Simulation								
7		Pedestrian grade separated facilities	Simulation								
8	Cycle	Continuity and directness	Cycleshed Analysis	• IRC 11-2015: Recommended Practice for the Design and Layout of Cycle Tracks							
9		Cyclability to activity generators	Bicycle LOS								
		Cycle lanes network	Cycleshed & Barrier Analysis								
		Cycle lane alignments	Simulation								
		Cycle parking and size	Emperical Analysis	• Indo HCM							
	Feeder - Bus	Bus shelter location and size	Simulation	• TOD Guidance Document, MoHUA 2016 • IRC:70-2017 Guidelines on Regulation and Control of Mixed Traffic in Urban Areas							
	Feeder: Shared mobility	Auto PPUDO bay location and size	Simulation	• TOD Guidance Document, MoHUA 2016 • Indo HCM							
		Two-wheeler rental bay location & size	Simulation	• Indo HCM							
	Feeder: Private mobility	Two and four wheeler PPUDO bay location and size	Simulation	• Indo HCM							
		Traffic detours & median openings	Simulation								
		Geometric improvements and junctions	Design principles								
	Urban Design Elements	Street furniture (benches,lighting)	Design Principles	• IRC 103-2012: Guidelines for Pedestrian Facilities • IRC 86-2018: Geometric Design Standards For Urban Roads And Streets							
		Signage (identification, informational, directional, regulatory)	Design Principles	• IRC: 67-2012: Code of Practice for Road Signs							
		Landscape	Design Principles	• IRC 103-2012: Guidelines for Pedestrian Facilities							
		Bus shelter design	Design Principles	• ITDP Better Streets Better Cities							
		Cycle stand	Design Principles	• ITDP BRT Planning Guide, 4th Edition							
		Amenities (toilets/changing room etc)	Design Principles	• IRC 103-2012: Guidelines for Pedestrian Facilities							

Legend: Scales of recommendations

Access shed Corridor Station vicinity

Note: LOS is not evaluated for Vehicular Queue Lengths; instead, this is evaluated in terms of queue length at the junction up to the PPUDO zones outside the station entrance structure*

*Note**: % Coverage and MMLOS are evaluated as part of the access sheds*

Physical MMI proposal by mode

Exhibit 4.349: Conceptual visualisation of Kalyan nagar metro station (service road south)

Physical MMI proposal by mode

B. BASE SCENARIO - 2031

On the same station alignment as the existing situation map, the BMRCL proposal has been overlapped and the MMI behaviour has been analysed for the year 2031. The exhibit below shows the base scenario of Bellandur. A simulation has been done on this scenario and the extracted issues and inferences have been highlighted on Exhibit 4.59 below.

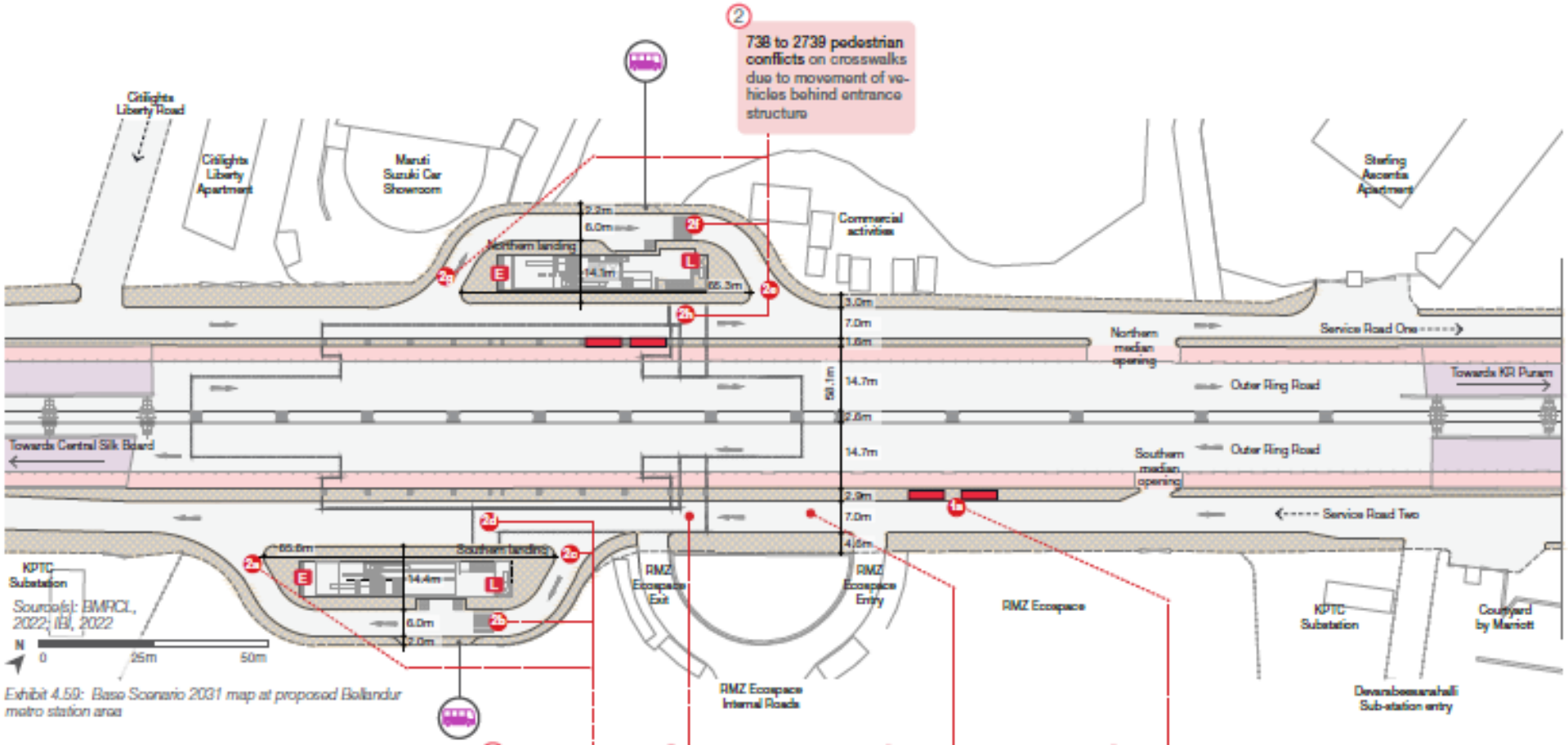


Exhibit 4.59: Base Scenario 2031 map at proposed Bellandur metro station area

Physical MMI proposal by mode

C. PROPOSED SCENARIO

The proposed scenario addresses the issues highlighted in the Base scenario-2031 and further improves them to create a more efficient MMI plan. Exhibit 4.60 below shows the proposed scenario of Bellandur. A simulation has been done on this scenario and the improved results has been highlighted on the map.

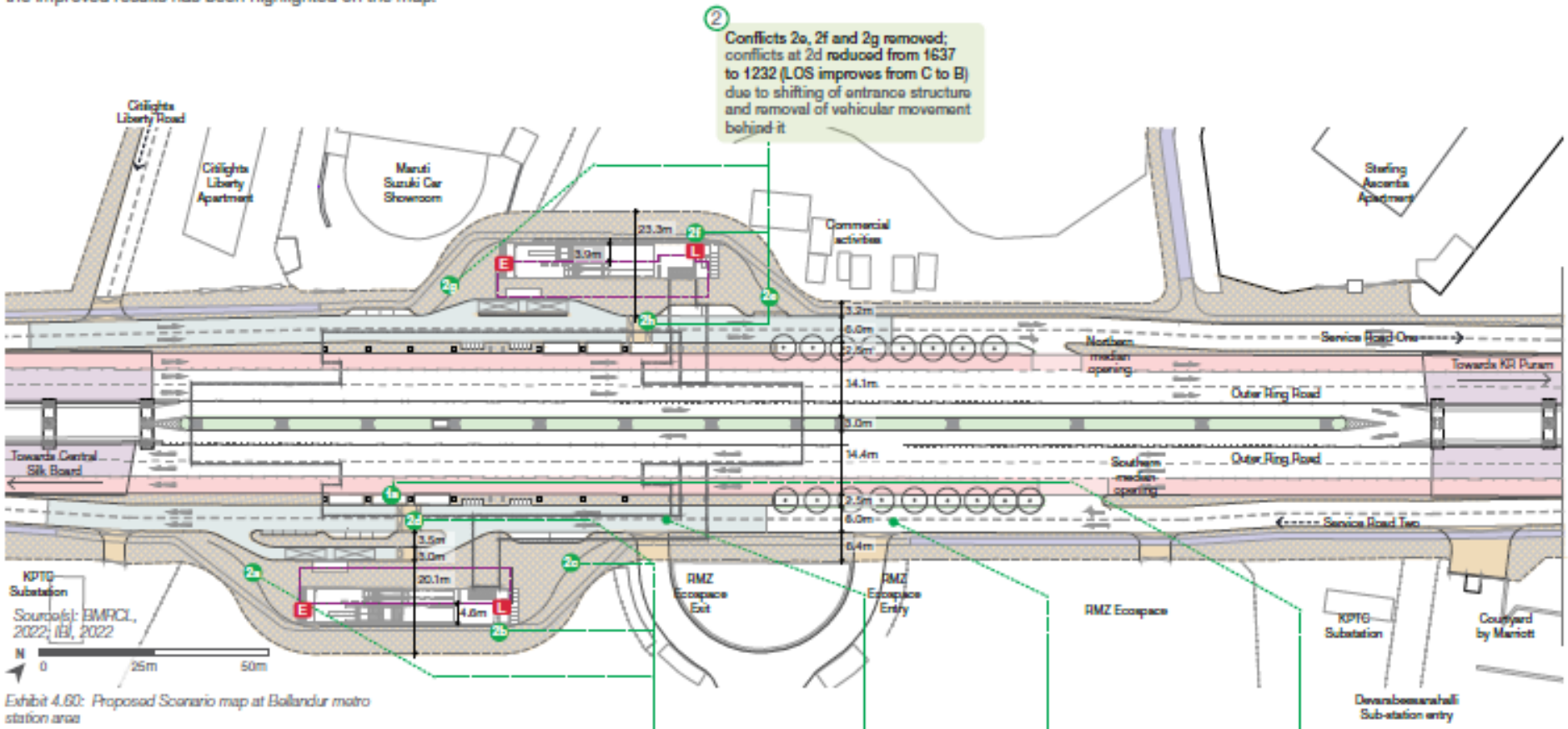


Exhibit 4.60: Proposed Scenario map at Bellandur metro station area

Legend

- Footpath
- Landscaped Bioretention area
- Central Median
- Bus Priority lane(BPL)
- BPL opening
- Cycle track (1.5m wide)
- Slow speed zone
- Escalator
- Lift
- Entrance
- Staircase
- Proposed Trees
- Existing position of station entry structure
- Priority Streets

(2) **Conflicts 2e, 2f and 2g removed;** conflicts at 2d **reduced from 1637 to 1232 (LOS improves from C to B)** due to shifting of entrance structure and removal of vehicular movement behind it

(2) **Conflicts 2a, 2b and 2c removed;** conflicts at 2d **reduced from 5619 to 3141 (LOS improves from D to C)** due to shifting of entrance structure and removal of vehicular movement behind it

(5) Vehicular delays of **74s (LOS F)** at south station entrance due to heavy traffic from tech parks on Service Road South and high pedestrian conflicts

(4) Vehicular queue length **reduces to 390m** on Service Road South, thereby **preventing disruptions on the southern landing,** due to the Smart Lane strategy, varying operation of the southern median opening, and geometric corrections

(1) Pedestrian travel time at ORR bus shelter 1a is reduced to **167 sec (LOS improves to C)** as ORR bus stop is moved closer to station entrance structure on south

1 Physical MMI proposal by mode

MMI DESIGN PROPOSAL

The design proposal along with the details of all MMI facilities have been shown below in Exhibit 4.61.

Note: The quantity requirements for PPUDO bays have been achieved through demand estimation method as explained in the Annexure. In the MMI plan in Exhibit 4.61 , these quantities have been adjusted according to the prioritisation of modes as per the MMI hierarchy of the station.

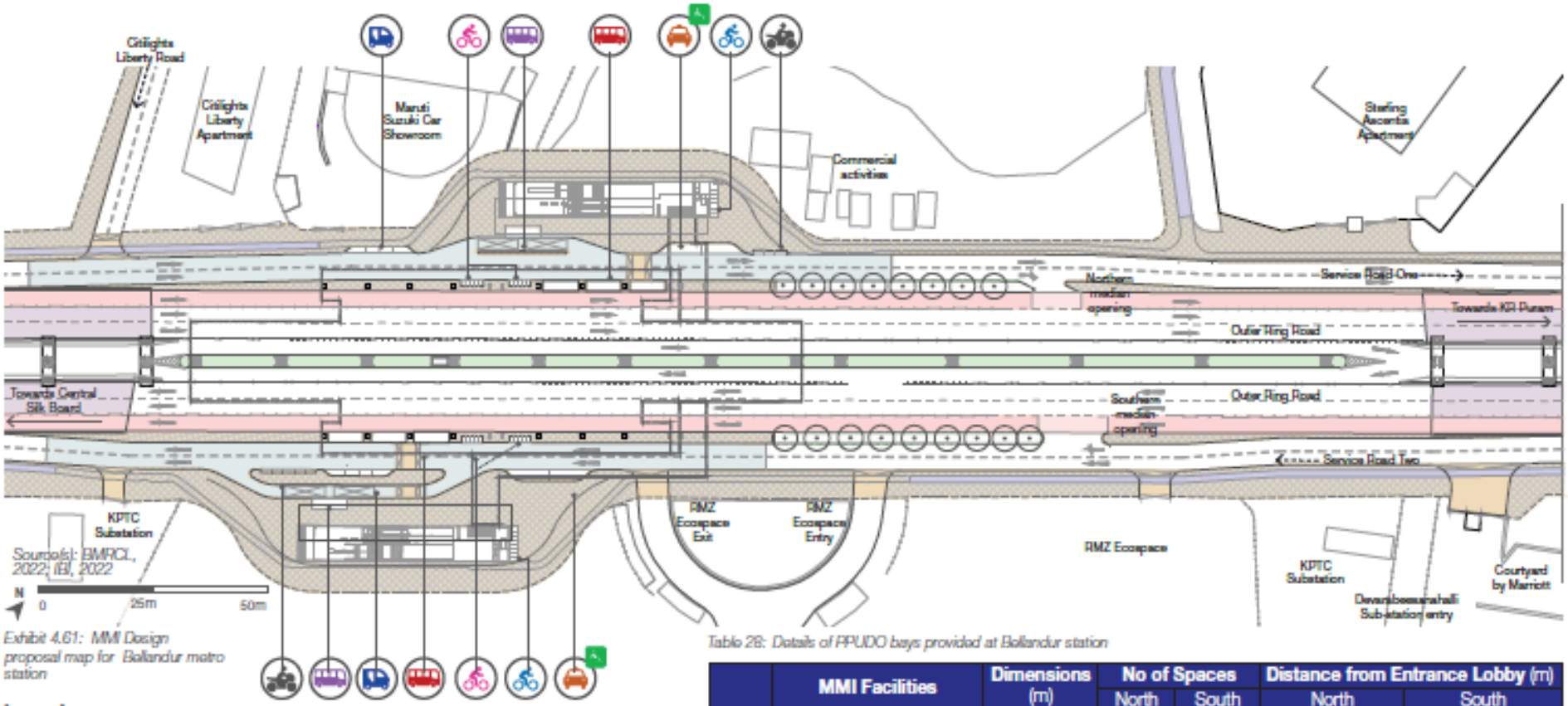


Exhibit 4.61: MMI Design proposal map for Ballandur metro station

Legend

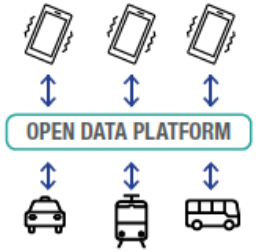
- Footpath
- Landscaped Bioretention area
- Central Median
- Bus Priority lane(BPL)
- BPL opening
- Cycle track (1.5m wide)
- Slow speed zone
- E Escalator
- L Lift
- E Entrance
- S Staircase
- Proposed Trees
- Existing position of station entry structure
- Priority Streets

Table 28: Details of PPUDO bays provided at Ballandur station

	MMI Facilities	Dimensions (m)	No of Spaces		Distance from Entrance Lobby (m)	
			North	South	North	South
	Pvt cycle/PBS Stands	2 x 1	8	8	66	63
	Rental E- scooter Stands	2 x 1	10	10	87	70
	Feeder Bus Shelter	8 x 2.5	2	2	14	15
	ORR Bus Shelter	8 x 2.5	3	3	55	50
	Auto Bays	3 x 1.5	4	4	38	54
	2W Bays	2.5 x 0.8	3	5	78	70
	Shared Taxi/Private Car	6 x 2.5	2	2	60	73

City level information and ticketing integration strategy

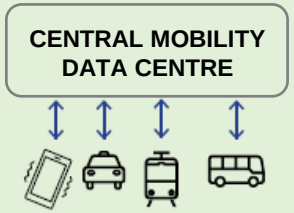
Alternative 1
Centralized Open Data Platform



Advantages
- Allows multiple players to innovate the market
- Coordination between participating organizations is streamlined

Disadvantages
- Financial & regulatory management of open data platform

Alternative 2
Data Aggregation by one single authority

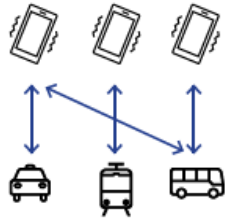


Advantages
- Data Centre can facilitate faster customer-centric solutions
- Builds on the existing trust & relationship with the authority

Disadvantages
- Rules are set by the Data Centre
- Less innovation-centric as data is restricted

RECOMMENDED STUCTURE

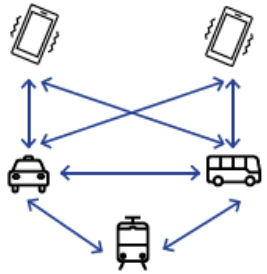
Alternative 3
Direct Data Sharing Between Operators & Agencies



Advantages
- Solution providers can have preferential contracts with individual mobility agencies
- Faster solution implementation due to direct interaction

Disadvantages
- Potential bias in mode suggestion due to nature of contract with mobility agency
- Tedious for mobility agencies to get into multiple contracts

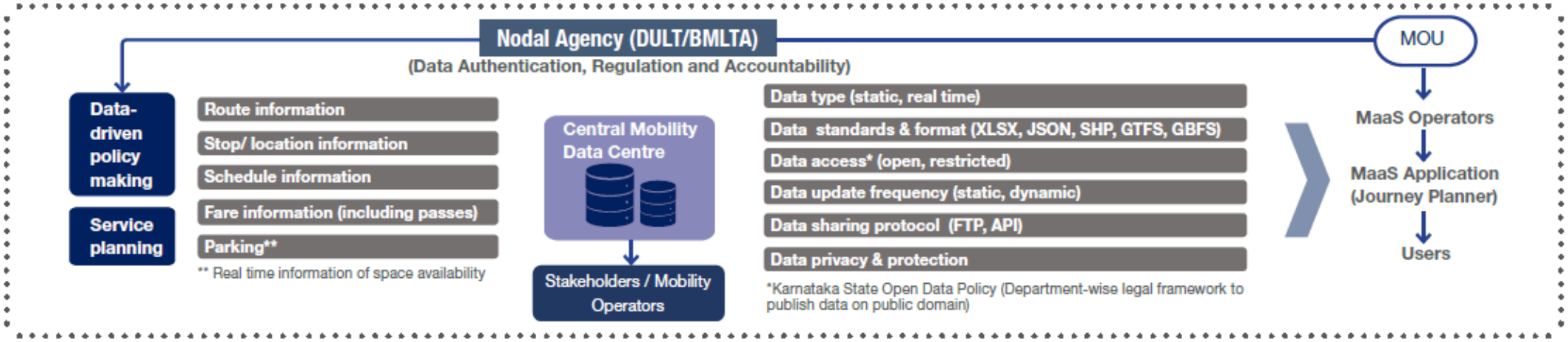
Alternative 4
One-to-One Data Sharing without any central platform



Advantages
- Each mobility agency can develop their own information dissemination system

Disadvantages
- No easy way for small innovative market players to enter the market
- No single all-encompassing source of information for consumers

- MaaS enables better institutional & ticketing integration
- Data centre is envisioned to create the platform on which MaaS can be developed going forward



2 Integrated Information & Ticketing for BMRCL and BMTC

Information Systems

Current Status
- BMTC deploying ITS system with the vendor developing GTFS data and can be shared with DULT
- BMRCL (and KRIDE) need to develop GTFS data

Actions needed
- DULT/ BMLTA to build an open data portal across transit agencies
- Staff to be recruited for GTFS data creation and maintenance for BMRCL (and KRIDE)
- Open data portal needs to sign data-sharing agreements with APIs (Google/ Moovit etc.)

Smart card based ticketing

Current Status
- BMRCL has an open-loop card vendor and acquirer bank to collect revenue. Yet to launch the card
- BMTC deployed ETMs which can read open loop cards. Looking for a vendor to issue smart cards

Actions needed
- Explore using BMRCL smart card for BMTC
- Revenue sharing protocols to be identified (direct money transfer to BMTC instead of T+ 1)
- Transaction fees to be renegotiated in coordination with BMTC

Mobile ticketing

Current Status
- QR code reading enables in both BMTC and BMRCL
- BMTC and BMRCL piloting mobile ticketing with separate vendors
- No integration planned currently

Actions needed
- Develop an open-ticketing layer covering BMTC and BMRCL with revenue reconciliation protocols
- E.g. Delhi's DTC+ DIMTS integration can be a model
- The open ticketing layer can be shared with any vendor (Paytm/ Tummoc, RBL etc.)
- Issue one QR code which can be read in both BMTC and BMRCL

Integrated journey planning and multimodal ticketing are key priorities for users

Learnings from the UK BODS example

Bus Open Data Service (BODS)

Department for Transport

- "World first" to make national schedule, real-time, and fares data openly available
- Over 500 private bus agencies and ~26,500 vehicles in scope
- Digitally transformative to the government and the wider industry
- Data standards legally mandated
- Currently in first full year of adoption (regulations came into force 7 January 2021)
- Proper aggregated approach – rather than a simple 'index'

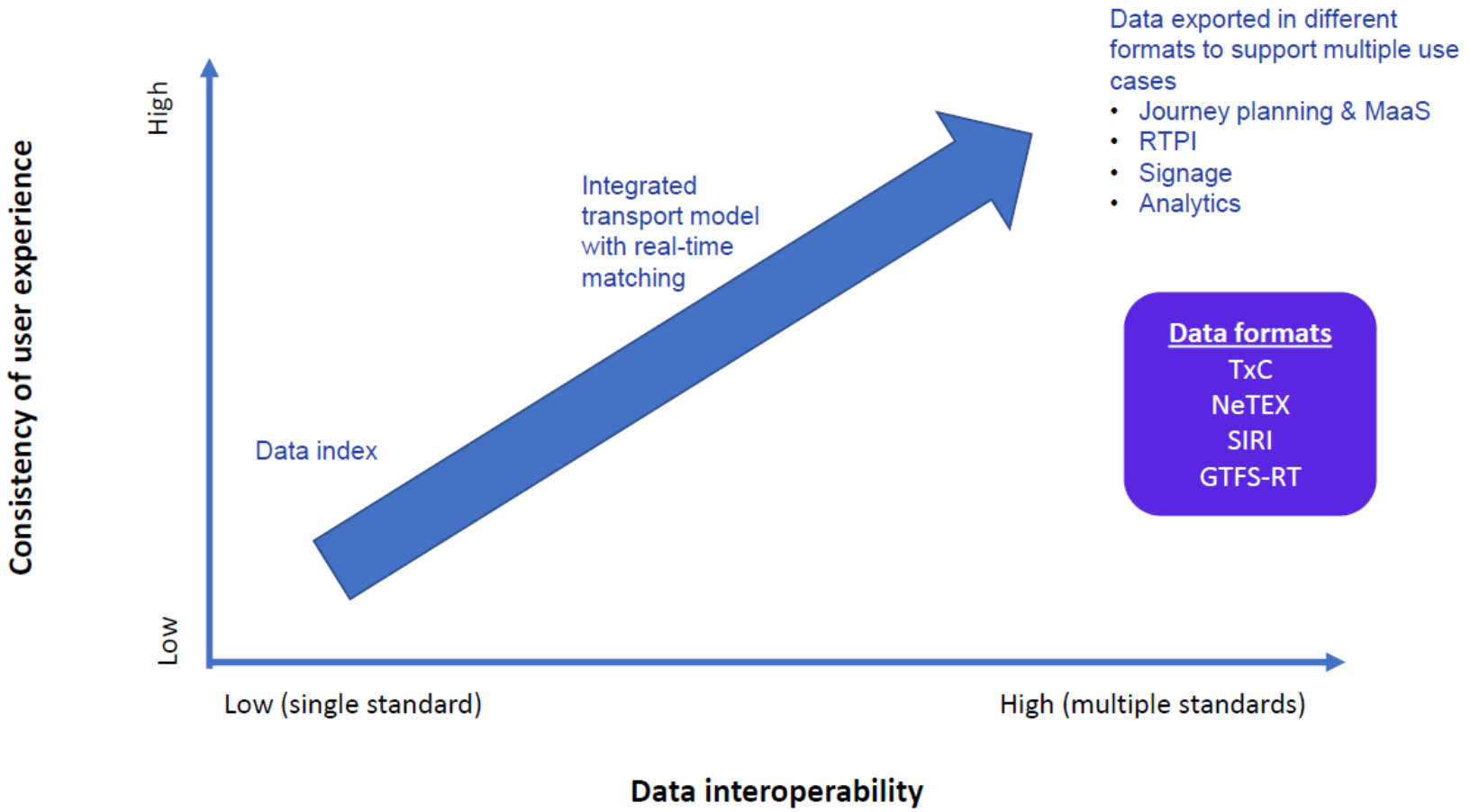
"The Bus Open Data Service will digitally transform bus services – high quality open data will help passengers plan journeys, find best value tickets and get real time service updates whatever part of England they are in."

- UK Department for Transport

itc world

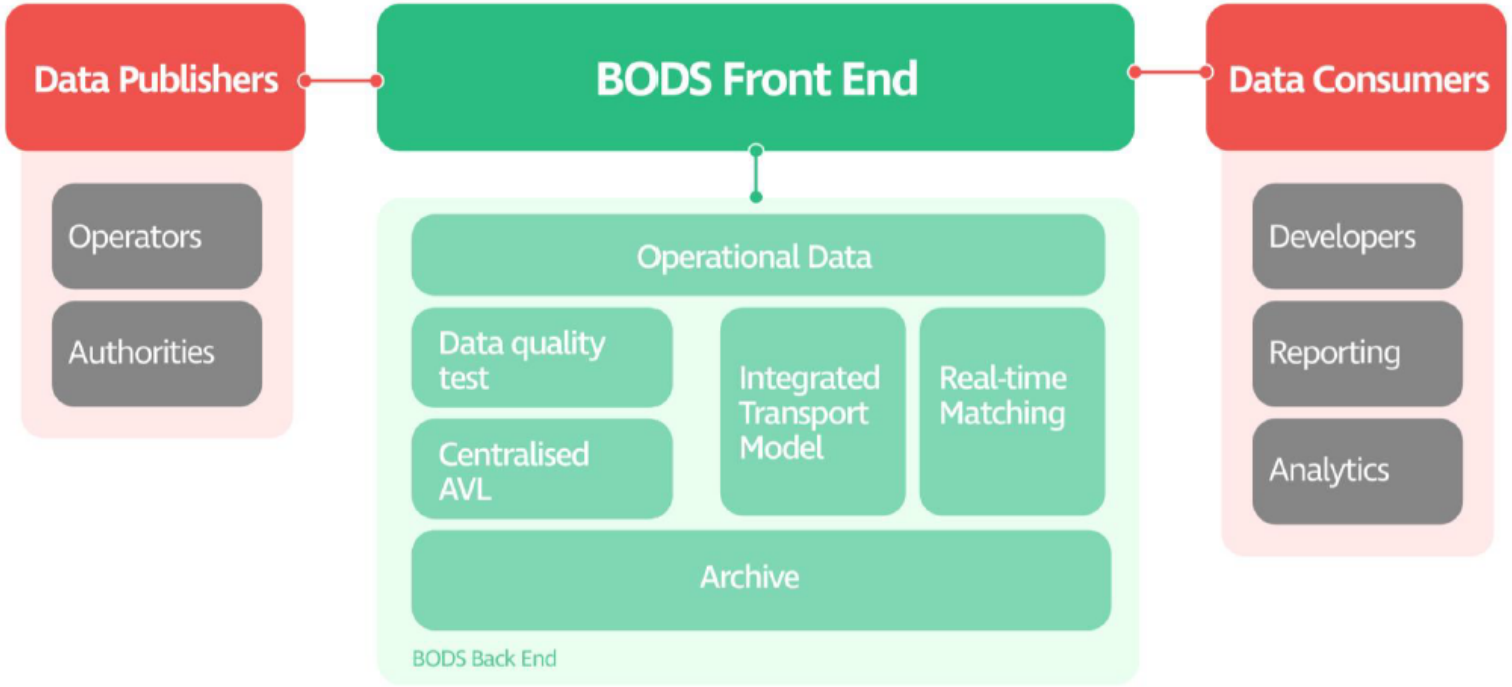
Learnings from the UK BODS example

Data standards & interoperability



Interoperable standards makes data easier to use/ reduces friction

Implementation



Implemented through continuous process of industry consultation and specific user research

Providing a unique national dataset

3 Operations Integration with bus

Approach for bus and metro network Integration

1 ANALYSE IMPACT OF PHASE-1 METRO ON BMTC

1.1 Service supply of BMRCL and BMTC

- Network analysis
  - *Network mapping in GIS*
  - *Metro and bus service area overlap*
  - *Overlapping and feeder routes*
- Service analysis
  - *Bus routes in metro influence area*
  - *Supply before and after metro (Jan 2017 Vs Jan 2020)*
  - *Supply before and after Covid (Jan 2020 Vs March 2021)*
  - *Hourly service volumes planned and delivered*

1.2 Travel demand characteristics of BMRCL and BMTC

- BMRCL ticketing data analysis
- BMTC ticketing data analysis
  - *Data from Intelligent Transport Systems (ITS)*
  - *Travel demand within and outside metro influence*
- Comparison of bus and metro travel demand characteristics
  - *Ticket (token) vs pass (smart card) users*
  - *Daily and Hourly variation in demand*
  - *Trip length characteristics of users*

2 IDENTIFY OPPORTUNITIES FOR BUS-METRO INTEGRATION

2.1 Route network improvements

- Identification of parallel and feeder routes
- Travel demand on overlapping routes
- Routes to be rationalised
- Location of bus terminals near metro stations
- New areas of service coverage

2.2 Service improvements

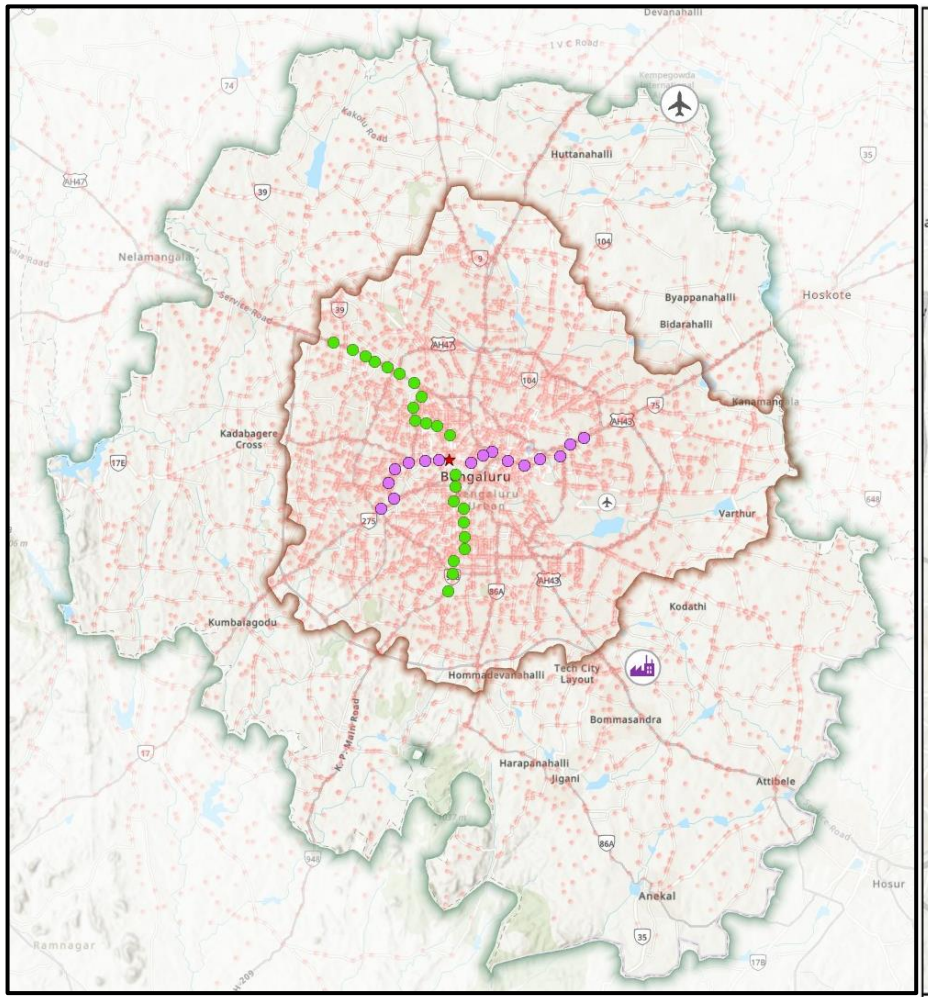
- Peak hours of supply for better integration
- Improved schedule adherence
- Location of bus terminals near metro stations

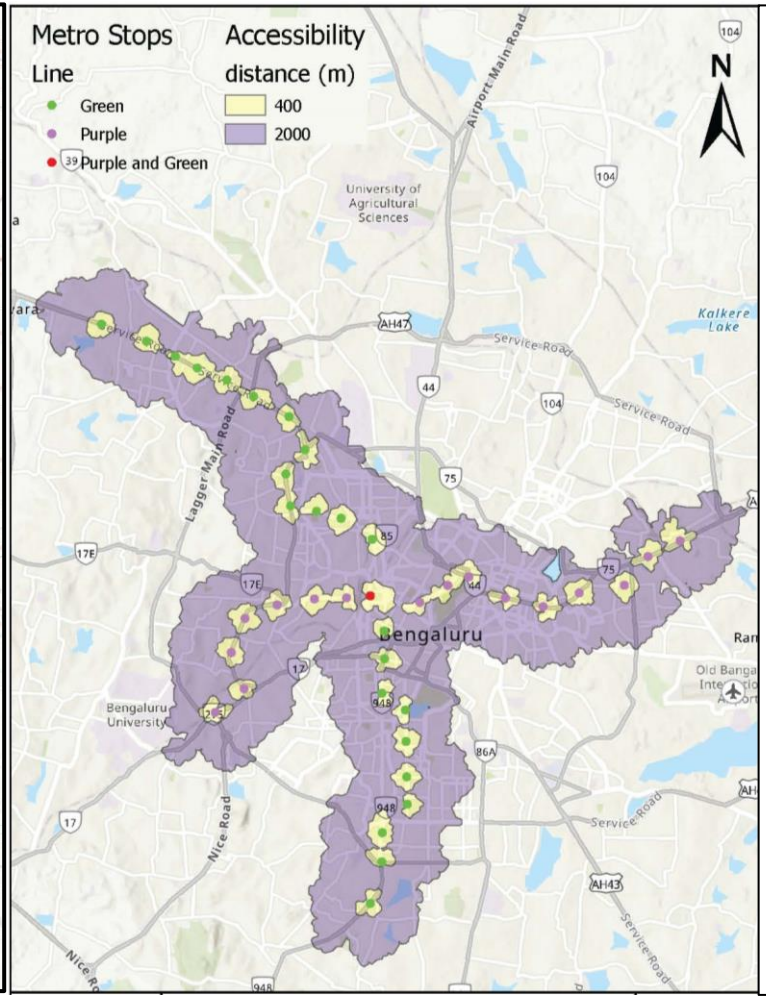
BMTC network coverage

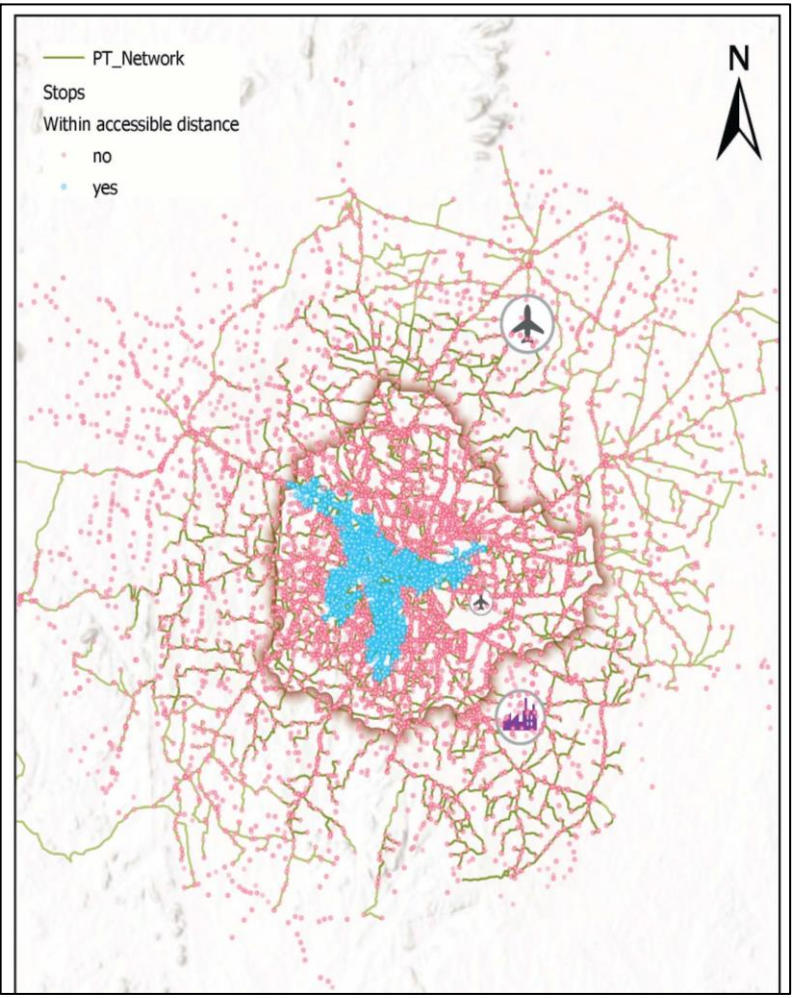
- BMTC routes and stops mapped using the ITS network database and Form four data
- BMTC serves the Bangalore metropolitan region
- However, bus stop density decreases significantly beyond BBMP boundaries and even further beyond Bangalore urban district boundaries

Bus network mapping in Bengaluru's metro influence area

- 2 km service area from metro stops considered as the catchment for the metro
- All bus stops, routes and their schedules in this area were identified through ITS database mapped in GIS

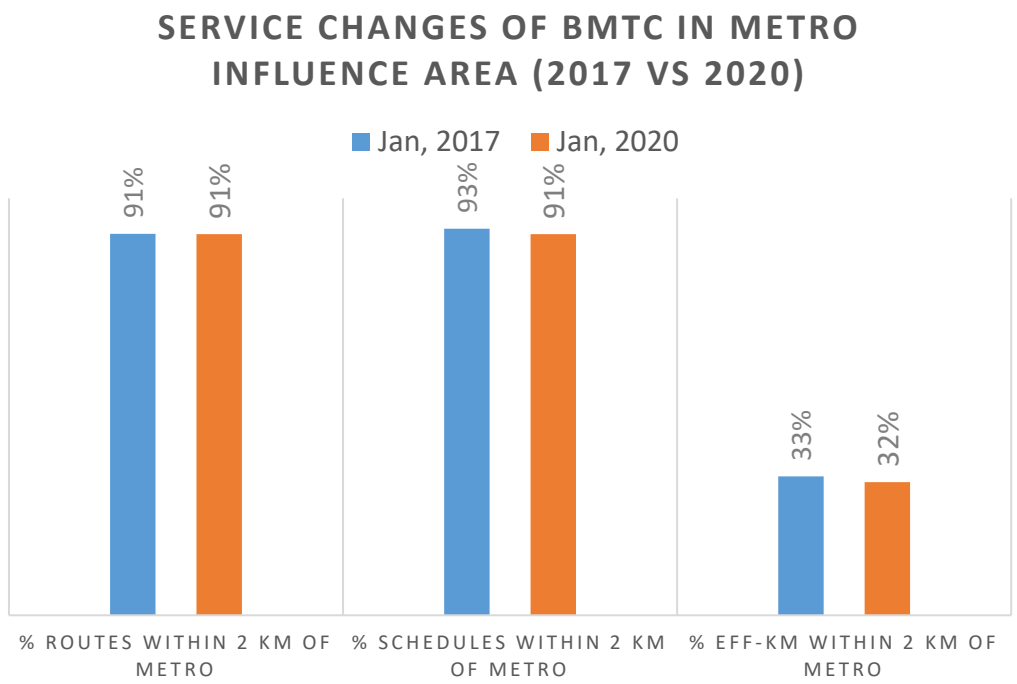


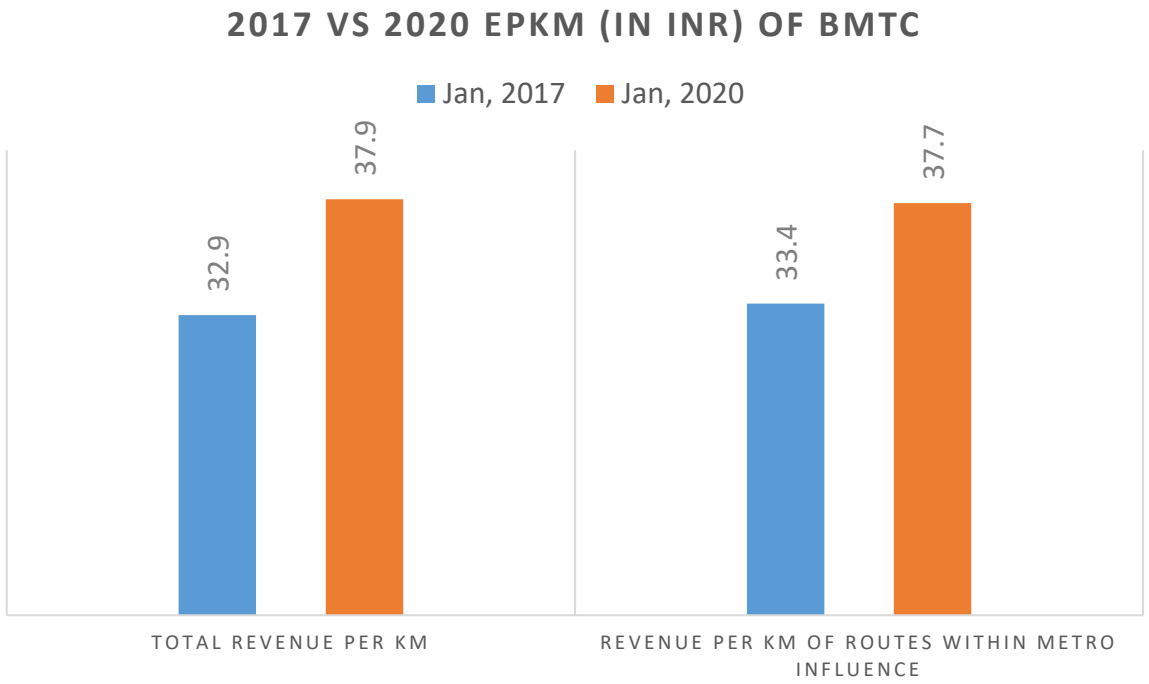




Bus service supply in metro influence area

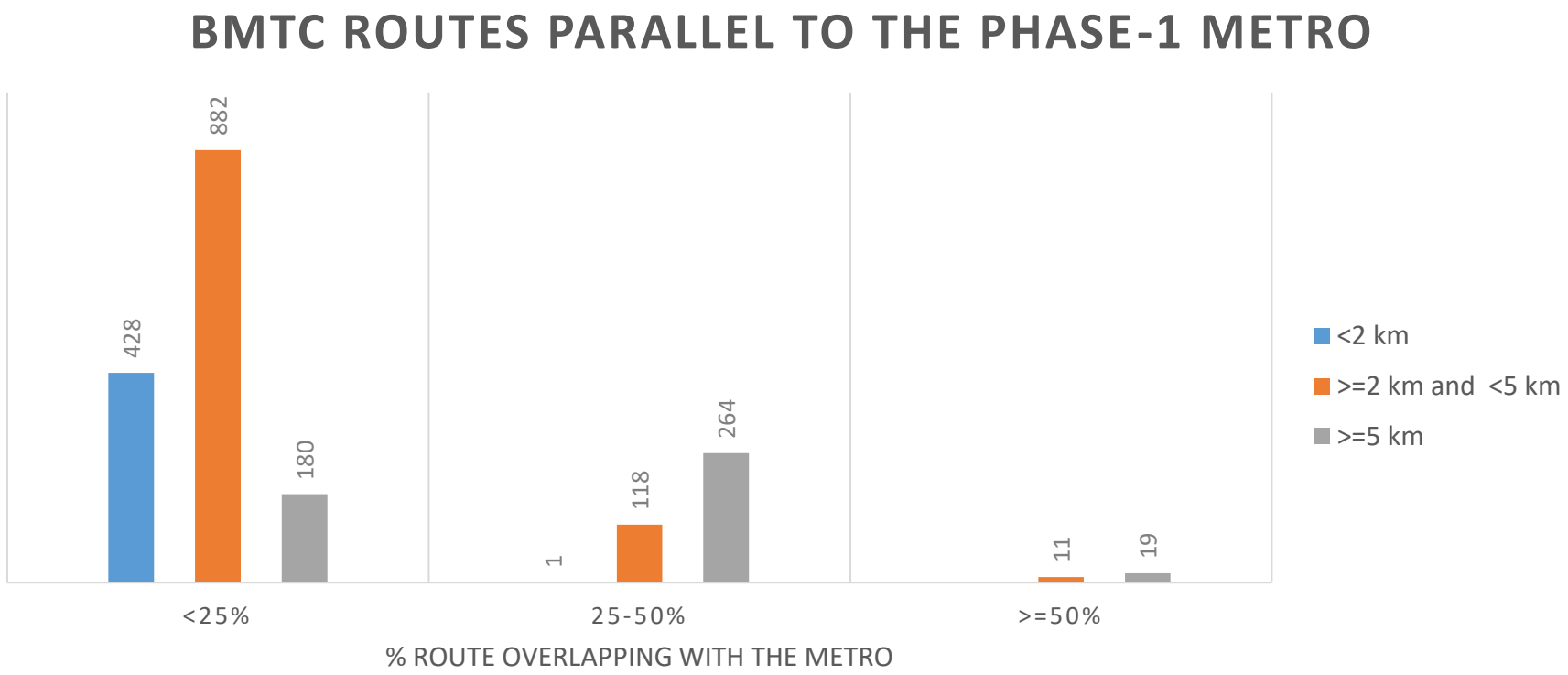
- BMTC's services in the 2km influence area of the metro haven't been significantly impacted by the phase-1 metro
  - 91% of all routes operating in the metro influence area for some length.
  - Between January 2017 and January 2020, the number of buses operating on these routes increased by 11% increase
  - Increase in fleet led to just 2% increase in bus service-km within the metro influence area
- The revenue patterns of metro influence and the remaining network essentially similar and growing at 13-15% every year





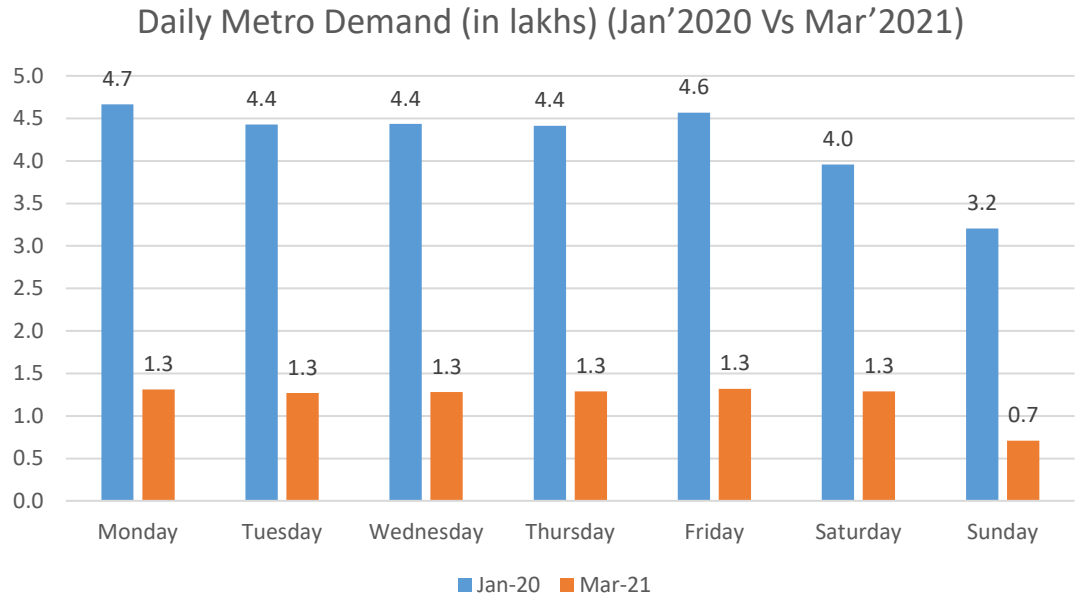
Bus network parallel to the metro

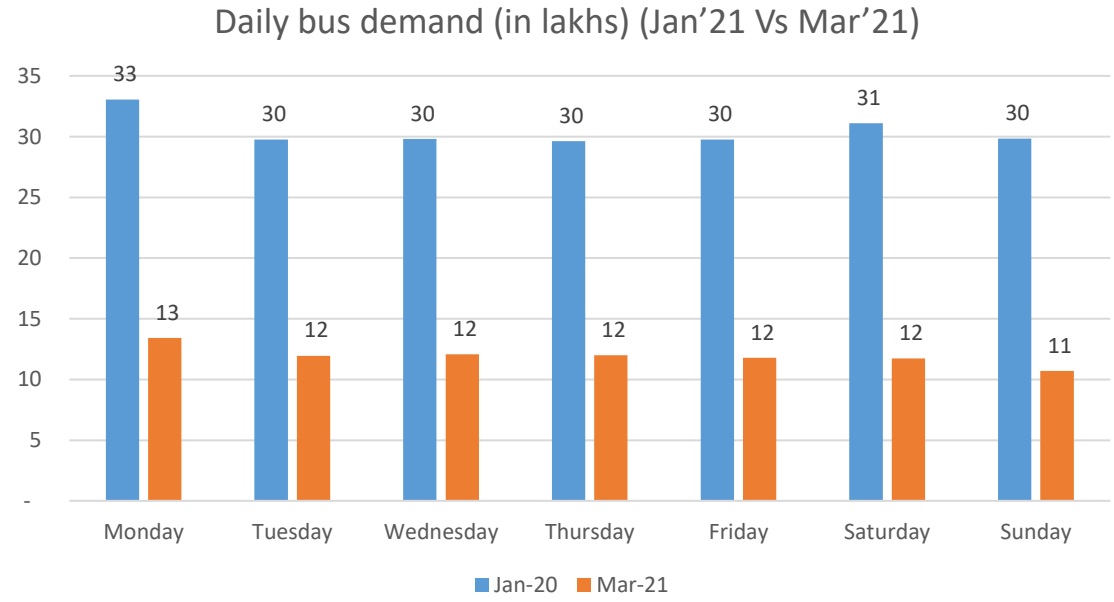
- Despite 91% rotes within a 2 km radius of metro, routes along the metro corridor are limited
- Definition of ‘along the metro’: Route has more than one stop within 400m from metro stations
- 78% of the routes overlap for less than 25% of their length
  - 40 routes have more than 50% of their length and at least 5km of overlap
  - 382 routes in the 25-50% overlap category
- Travel demand on these routes needs to be analysed to decide on their rationalisation



Travel demand characteristics: Covid impact

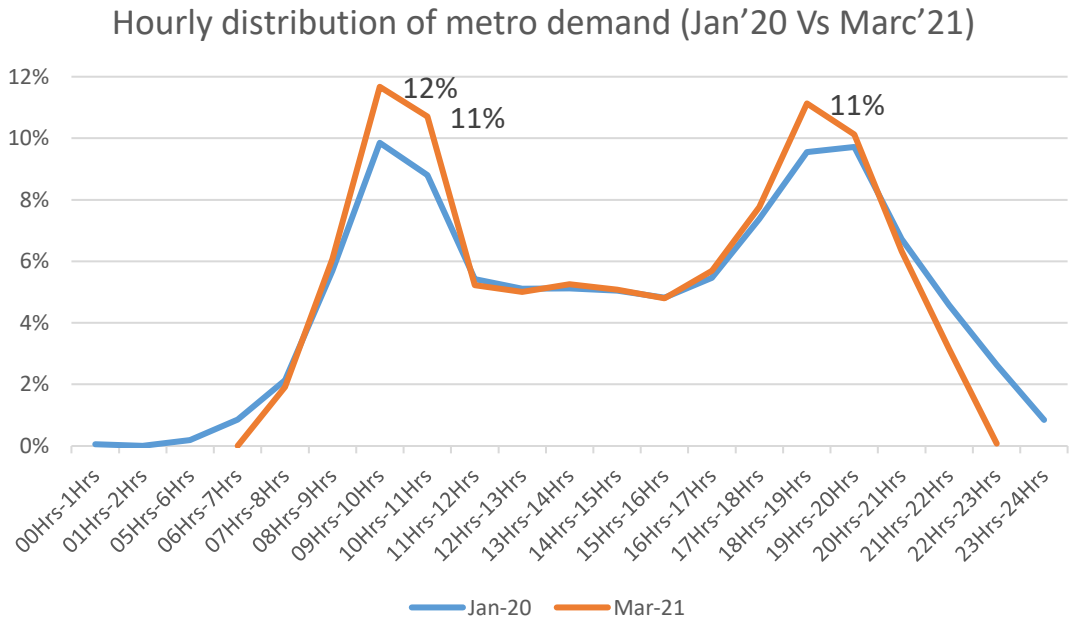
- Demand data for March 2021 compared with January 2020 to understand impact of Covid-19
- Metro demand dropped to 28% of pre-Covid daily ridership
- Bus demand dropped to 37% of pre-Covid daily ridership
- Bus demand in BMTC 7-8 times metro demand pre-Covid, increased to 10 times post-Covid

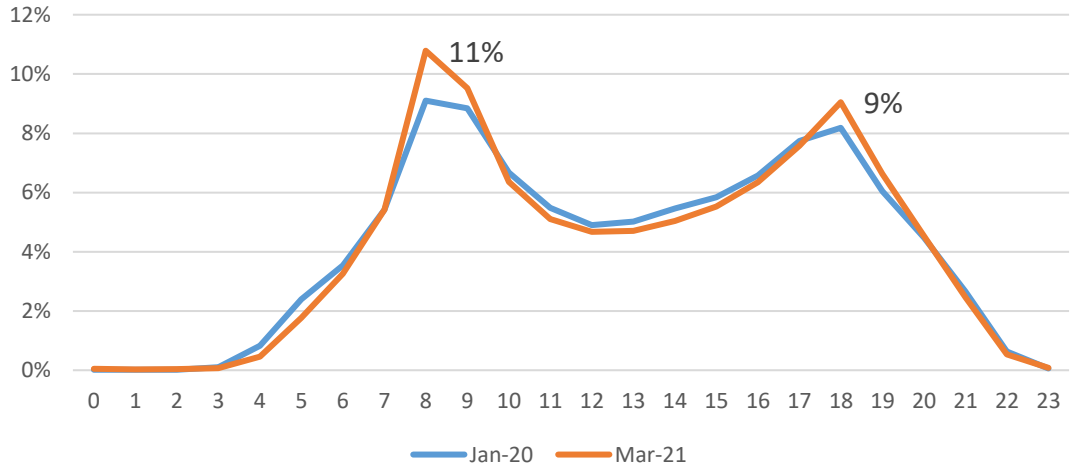




Hourly distribution of bus and metro trips

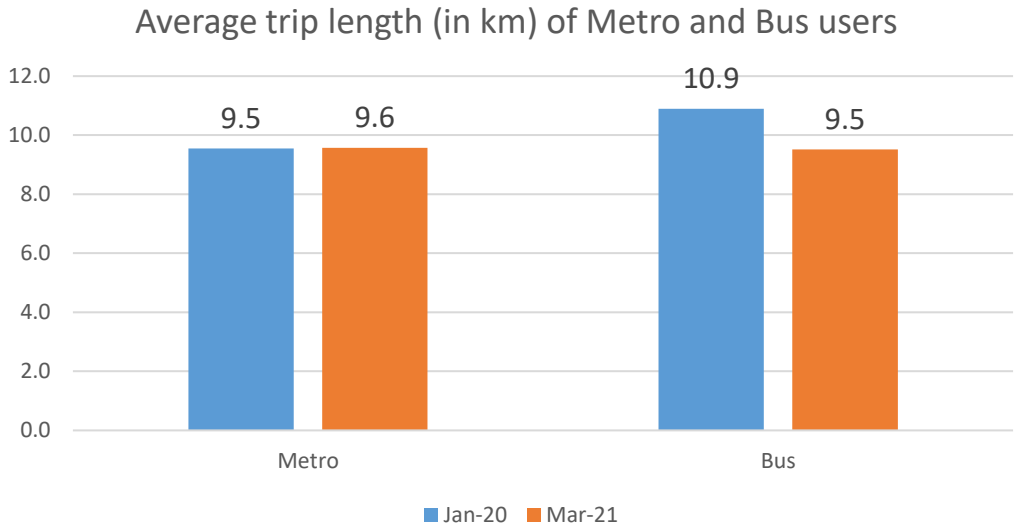
- Both metro and bus have sharp 2-hour peaks in the morning and evening
  - Only Sundays have a spread-out demand throughout the day
- Morning peak occurs between 7AM-9AM for both modes
- Evening peak for metro spread between 6PM-8PM, while for buses demand drops sharply after 6 PM
  - Evening peak for buses lower than morning peak
- Peak spread similar before and after COvid

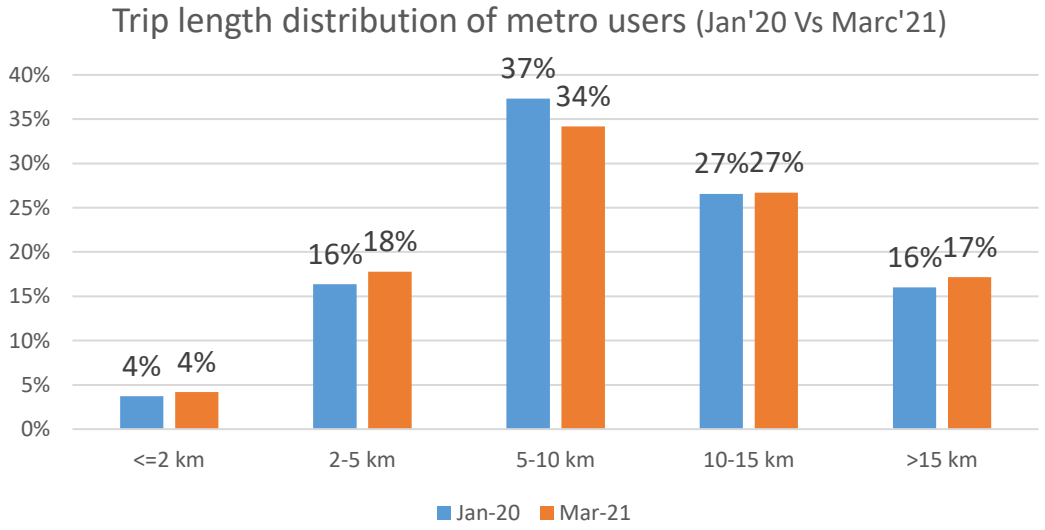


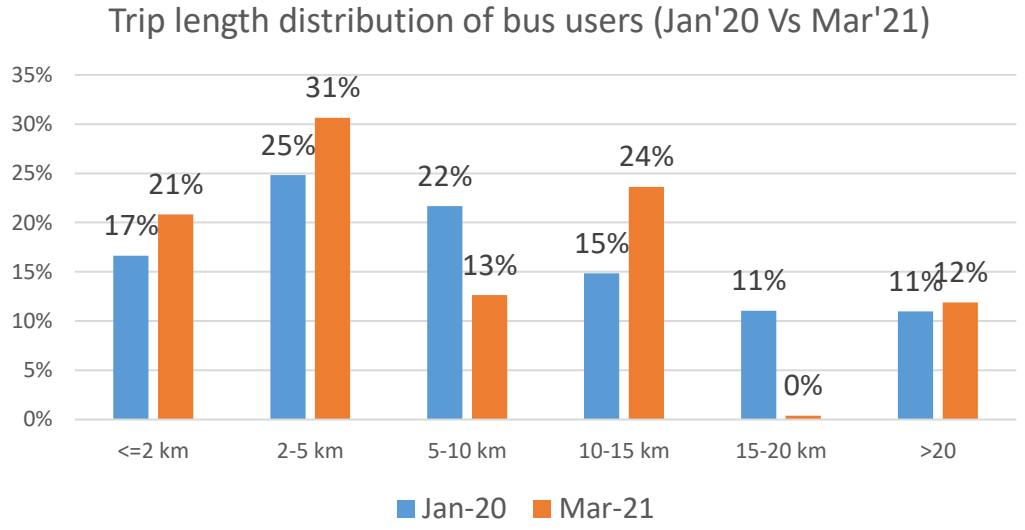


Trip length of bus and metro users

- Average trip length of metro and bus users similar at 9.5-10 km
- 40-50% of bus trips shorter than 5 km
  - Average skewed by >20 km long suburban trips
- 63-64% metro trips between 5-15 km
  - >15 km trips small due to limited network connectivity



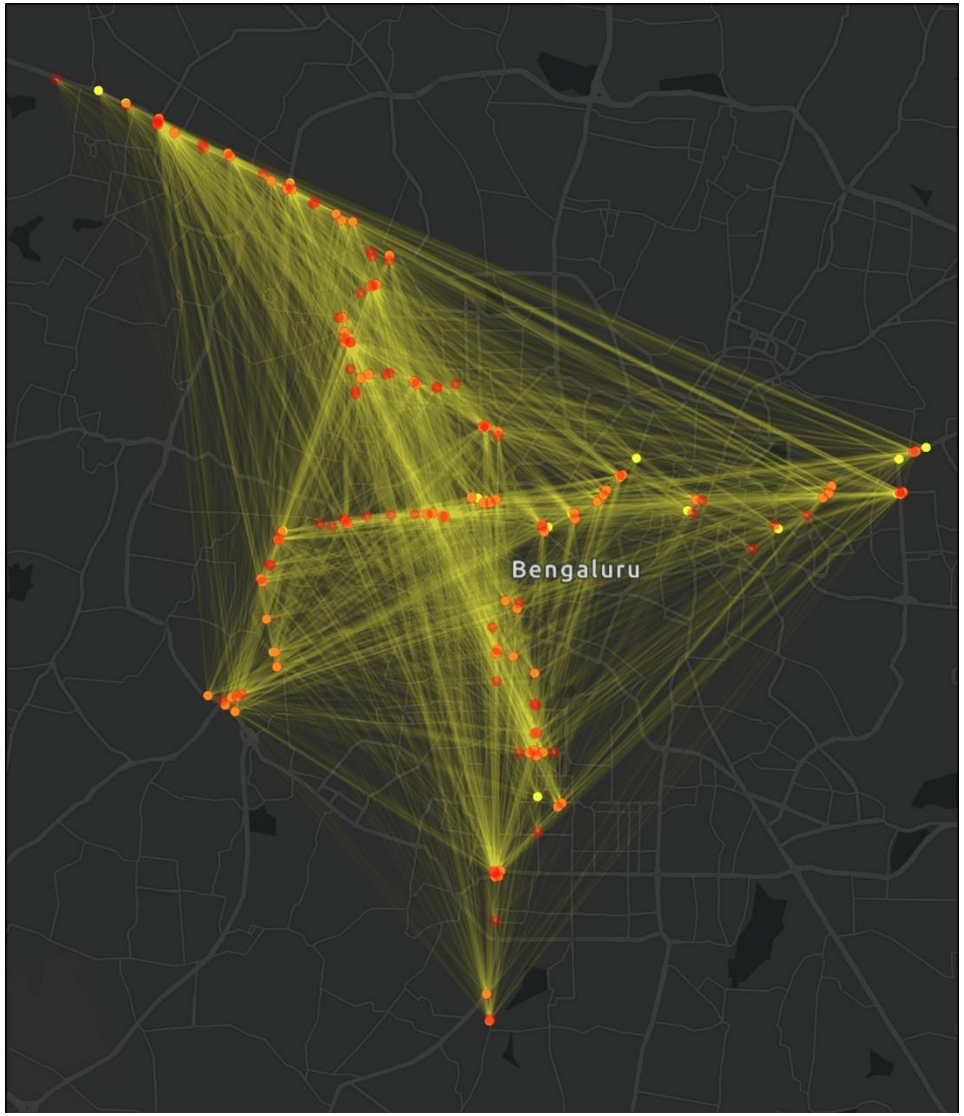




Framework for bus and metro network integration

- Key objective
  - ***Reduce routes with high service and demand overlap with metro for improved complementarity***
- Approach to identify routes for reduced service:

Approach	Analysis
Identify bus routes parallel to metro	734 out of 2,203 routes
Select routes with trips >=2 km along metro	502 routes
Priority for rationalisation: i) Routes with >=20% trips along metro	42 routes and 107 buses



Conclusions and key takeaways

- Multi-Modal Integration is crucial to attracting passengers to metro rail systems
- Each of the five pillars of integration are crucial- Physical, Information, Operations, Institutional and Ticketing integration
  - Physical integration
    - Metro agencies need to collaborate with local road owning agencies to ensure adequate access infrastructure
    - National-level guidelines for MMI need to incorporate adequate provisions
  - Operations integration
    - Buses are not competition to metro. Need to evolve an integrated network and service plan
  - Information integration
    - Metro agencies need to explore a National data centre and common integration platform with GTFS feeds
  - Ticketing integration
    - Need to enable open loop cards and account-based ticketing across bus and metro
  - Institutional integration
    - Metro needs to play the lead-role in institutional integration through the State urban development department
- Customer engagement is lacking across Indian public transport agencies. Metro agencies need to take up concerted efforts to improve this
- iMetro can explore facilitating engagements through MoHUA and Indian Roads Congress (IRC) to advance conversations with other agencies.

Additional slides

Blue Line - Phase 2A

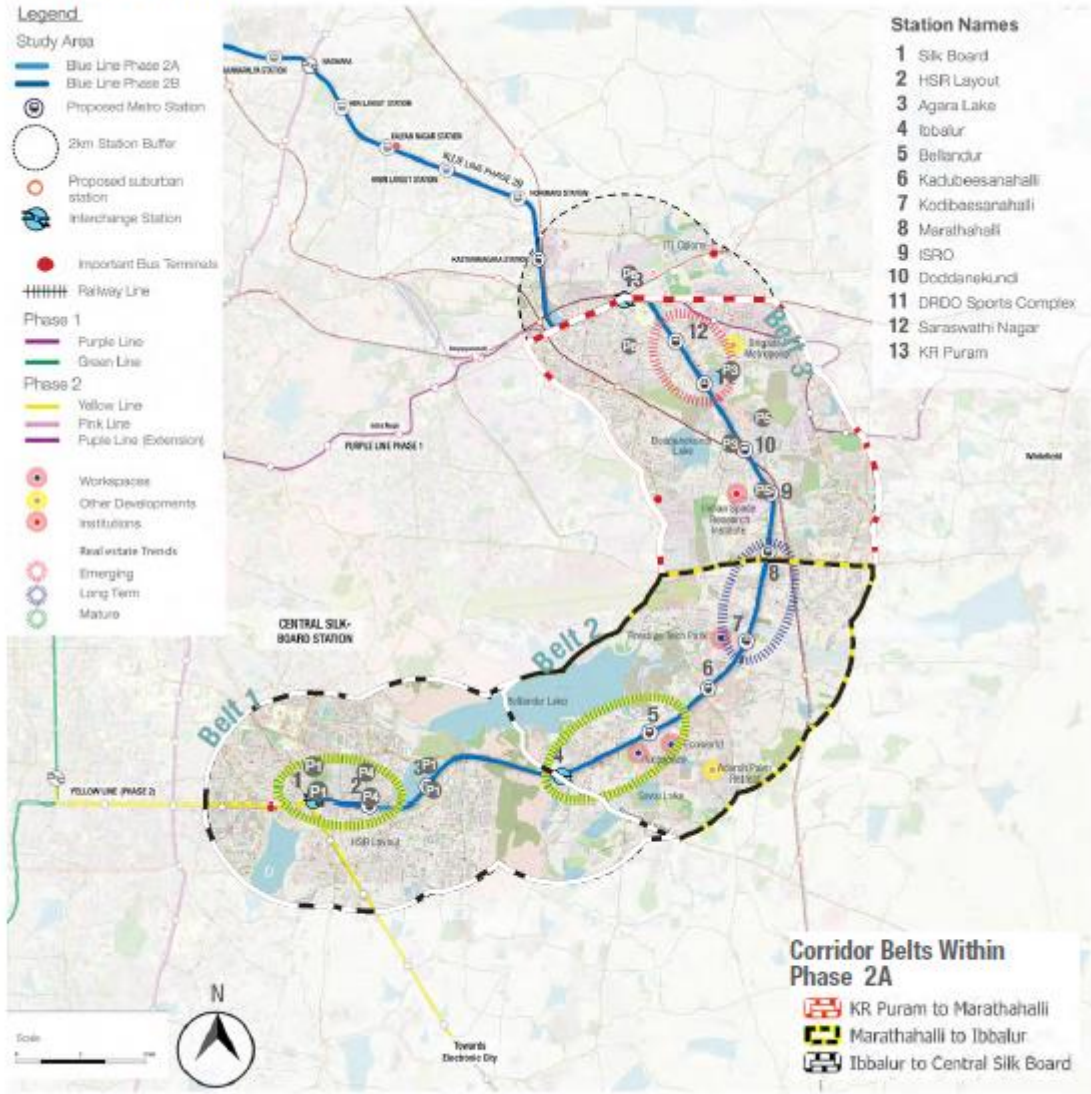


Exhibit 1.3: Key Features of the Phase 2A Metro Corridor

KEY FEATURES OF PHASE 2A METRO PROJECT

Length	Stations	Expected Year of Completion	Interchange Stations	Projected Daily Ridership 2031	Projected Daily Ridership 2041
18.5Kms	13 Nos	2025	3	4,49,990	5,82,912

KEY FACTS OF THE STUDY AREA

Traffic & Transit

Interchange Stations
- Central Silk board
- Ibbalur
- KR Puram

IR Stations in proximity
- KR Puram

KRIDE Station in proximity
- Bellandur road
- Marathahalli
- Kaggadasapura
- Baiyapanahalli

Bus Terminal
- Silkboard TTMC
- Vydehi TTMC
- KR Puram Bus Terminal

Bus Priority Lane

Pop up Cycle Lane

Major Intersections along ORR
- Whitefield Main Road
- Marathahalli Main Road
- Kadubeesanahalli Road
- Doddakanelli Road
- Bellandur Main Road
- Sarjapur Road

Open spaces

Lakes
- Agara Lake
- Bellandur Lake
- Ibbalur Lake
- Nekkundhi Lake
- B Narayanapura Lake
- Doddanekundi Lake

Major Open Spaces
- Ibbalur Park
- Agara Park

Development

Key Workplaces
- RMZ Ecoworld
- RMZ Ecospace
- Embassy Tech Village
- Cessna Business Park
- Global Technology Park
- Prestige Tech Park
- Bagmane Tech Park

Key Institutions
- ISRO Campus
- DRDO
- HAL
- New Horizon College
- Sakra World Hospital

Other developments
- HSR BDA Complex
- Adarsh Palm Retreat
- Green Glen Layout
- Purva Parkridge
- Brigade Metropolis

Blue Line - Phase 2B

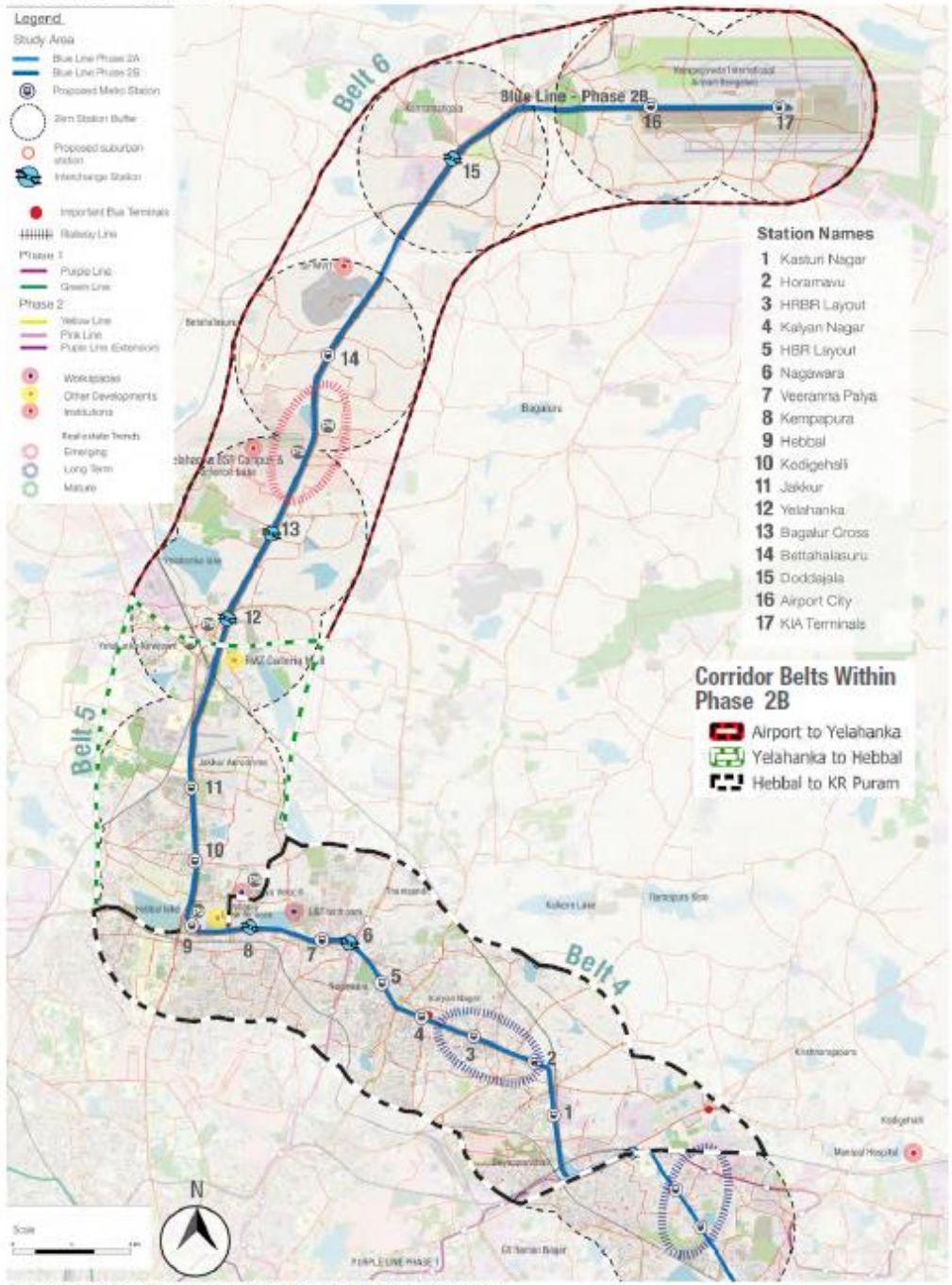


Exhibit 1.4: Key Features of the Phase 2B Metro Corridor

KEY FEATURES OF PHASE 2B METRO PROJECT

Length	Stations	Expected Year of Completion	Interchange Stations	Projected Daily Ridership 2031	Projected Daily Ridership 2041
36.4Kms	17 Nos	2025	5	8,35,623	11,14,240

KEY FACTS OF THE STUDY AREA

Traffic & Transit

Interchange Stations
- Nagawara Station
- Hebbal Station

IR Stations in Proximity
- Yelahanka
- Hebbal
- Baiyapanahalli

KRIDE Station in Proximity
- Kodigehalli
- Judicial Layout
- Yelahanka
- Doddajala
- Trumpet
- KIAL Terminals

Bus Terminals
- Hebbal
- Yelahanka
- Hennur

Major Intersections along ORR
- KIAL Road
- Vidyanagar Cross Road
- Bagalur Main Road
- Kogilu Main Road
- Yelahanka Main Road
- Jakkur Main Road
- Kempapura Main Road
- Nagawara Main Road
- Hennur Main Road
- Kammanahalli Main Road
- Horamavu Main Road
- Ramamurthy Nagar Main Road

Open spaces

Lakes
- Beninganahalli Lake
- Chalkere Lake
- Nagawara Lake
- Hebbala Lake
- Hunasemaranahalli Lake

Major Open Spaces
- Hennur Lake Biodiversity Park

Development

Key Workplaces
- Umiya Velociti
- Brigade magnum & Opus
- L&T Techpark

Key Institutions
- Manipal Hospital
- Aster CMI Hospital
- GKVK (UAS)
- Yelahanka BSF Campus & Airforce base
- Sir MVIT

Other developments
- Embassy Lake terraces
- Century Ethos
- L&T Raintree Boulevard
- RMZ Galleria Mall