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Assessing Performance at Multimodal Interchange:

A Case Study of New Delhi Railway Station

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Introduction

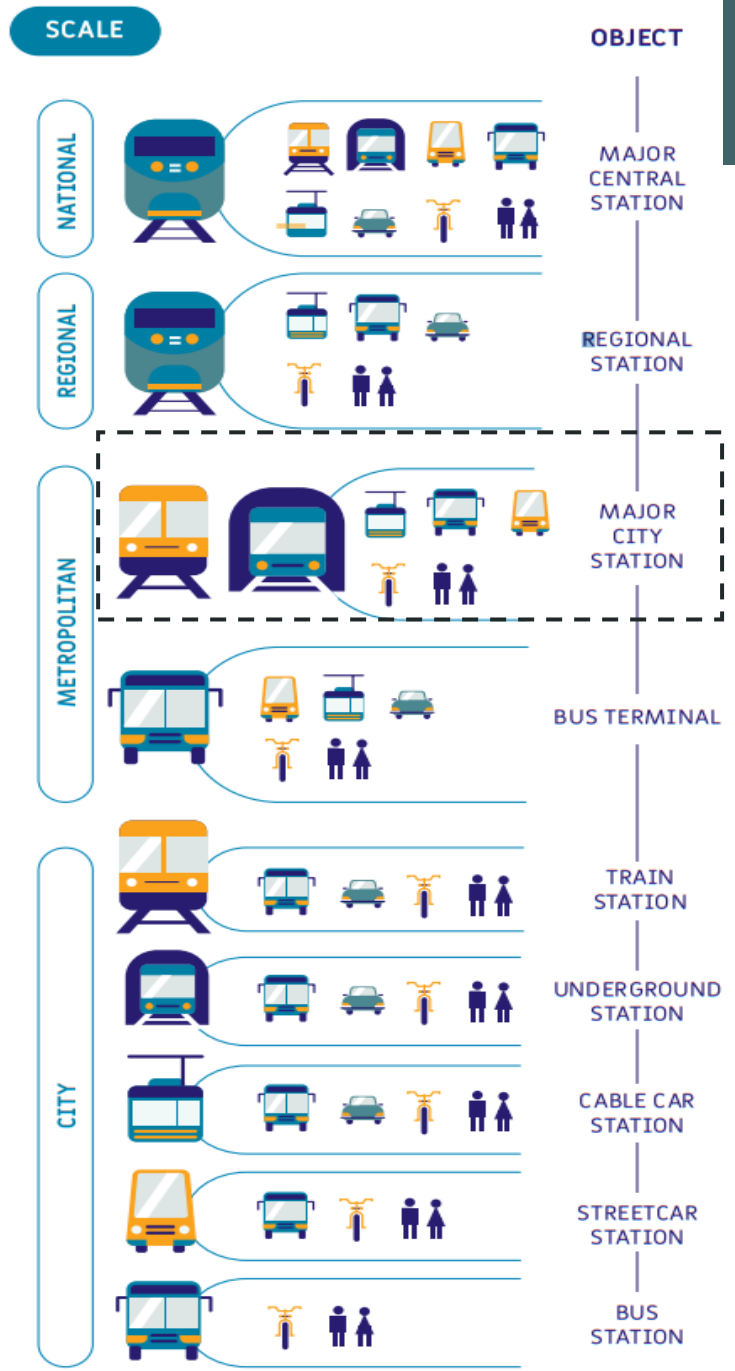
Multimodal Interchange

Integrate various modes of transportation, providing passengers (or Freight) with a seamless and efficient way to transfer between them.

1. Network Integration
2. Fare Integration
3. Information Integration
4. Physical Integration
5. Scheduled Integration

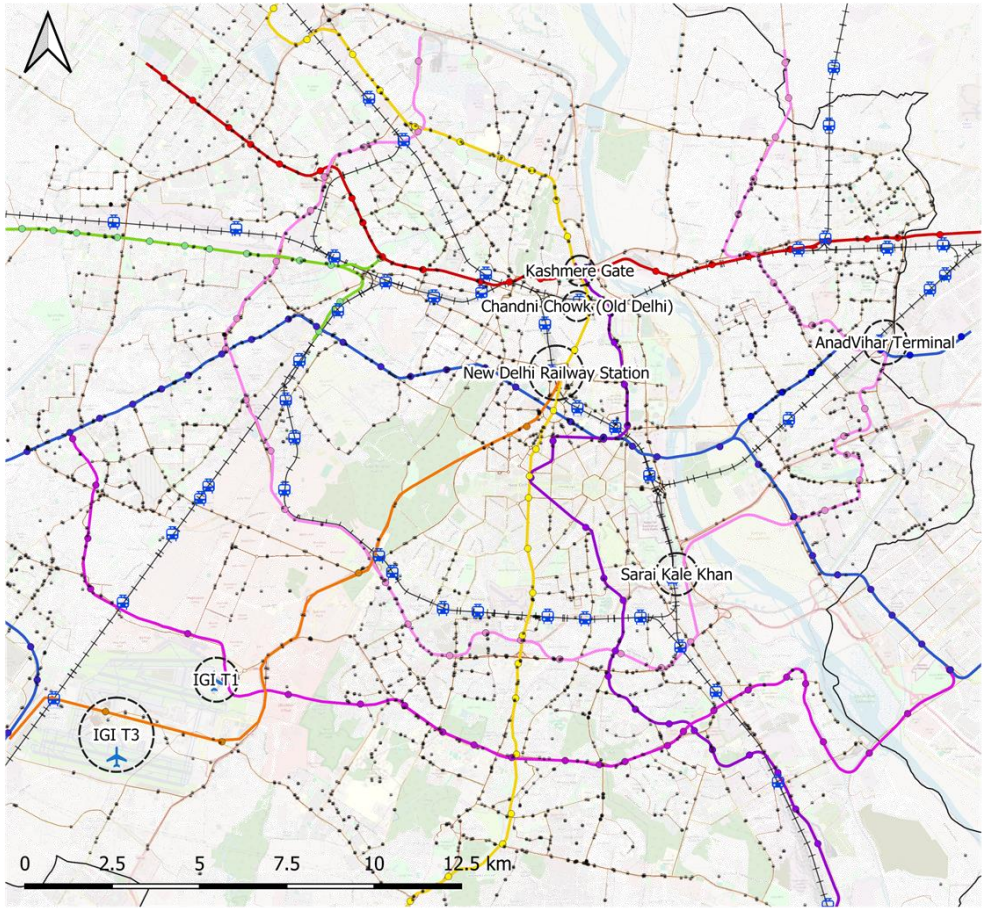
Why MMI?

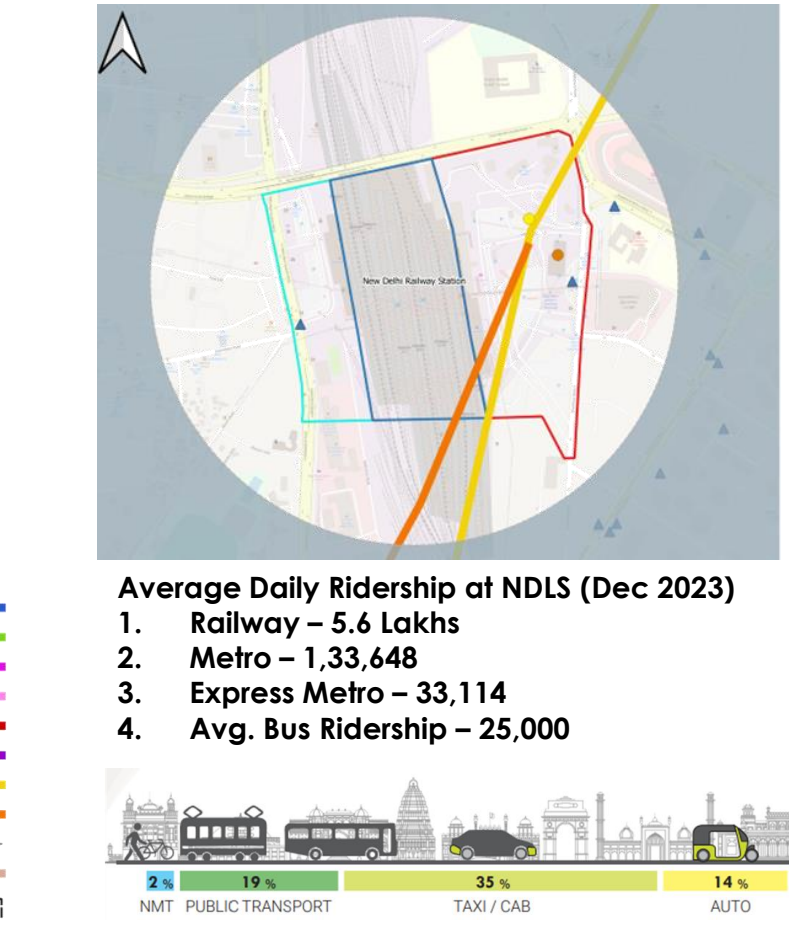
- **Urbanization Growth:** India's urban population is projected to reach 600 million by 2030, a 40% increase from 2018. (Source: World Bank, 2020)
- **Delhi's Density:** Delhi's population density is over 11,000 people per sq. km, significantly higher than the national average. (Source: World Population Review, 2024)
- **Shift towards Private Vehicles:** This imbalance fuels a preference for private vehicles, worsening congestion, pollution, and traffic incidents.

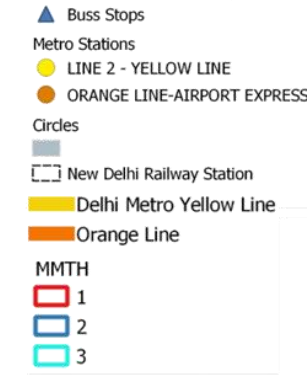


Site Selection – New Delhi Railway Station

- NDLS has a daily footfall of 500,000 passengers.
- It serves as a hub for trains, metros, buses, taxis, and auto-rickshaws.
- Critical connectivity to the Delhi Metro, buses, and the Airport Express Line.







Average Daily Ridership at NDLS (Dec 2023)

1. **Railway – 5.6 Lakhs**
2. **Metro – 1,33,648**
3. **Express Metro – 33,114**
4. **Avg. Bus Ridership – 25,000**

Site Selection - New Delhi Railway Station

Name		New Delhi Railway Station	Kashmere Gate	Chandni Chowk (Old Delhi)	Anand Vihar Terminal	Sarai Kale Khan	IGI T3	IGI T1
Avg. Daily Footfall		5,00,000	2,40,000	2,50,000	80,000	65,000- 97,000	5,95,000	
Metro Ridership		166762	2,40,480	136696	73,315	33218	33114	27688
Mode availability	Bus	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Railway	Yes	No	Yes	Yes	Yes	No	No
	Airway	Yes *	No	No	No	No	Yes	Yes
	Metro	Yes	3	Yes	Yes	Yes	Yes	Yes
	Local Train	Yes	No	Yes	Yes	Yes	No	No
	IPT	Yes	Yes	Yes	Yes	Yes	No	No
	Taxi	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Express Metro	Yes	No	No	No	No	No	No
	ISBT	No	Yes	No	Yes	Yes	No	No

* - Directly Connected via Express metro

Key Performance Indicators (KPI's) - Literature

Accessibility & Connectivity

Physical Accessibility
- Ramp access
- Elevators (capacity, accessible controls)
- Accessible restrooms
- Tactile paving
- Designated accessible parking

Navigational Accessibility
- Intuitive wayfinding design
- Digital wayfinding tools (accessible interfaces)
- Maps and information (multiple formats)

Connectivity to Surroundings
- Safe pedestrian paths (sidewalks, crossings)
- Designated drop-off/pick-up zones
- Bicycle parking facilities

Passenger Amenities

Basic Amenities
- Clean and plentiful restrooms
- Comfortable seating (varied options)
- Drinking fountains/refilling stations
- Variety of food & beverage options
- Retail outlets (travel essentials, convenience)

Additional Amenities
- Luggage storage
- Family restrooms/nursing areas
- Public Wi-Fi
- ATMs, currency exchange
- Charging stations

Efficiency & Reliability

Operational Efficiency
- Schedule adherence
- Frequency of service
- Smooth transfers
- Real-time information (accuracy, availability)

Ticketing Systems
- Ease of use (kiosks, counters, online)
- Multiple purchase options
- Clear instructions

Contingency Plans
- Procedures for disruptions
- Effective user communication

User Experience

Informational Clarity
- Signage (design, placement, language)
- Announcements (clarity, audibility)
- Information booths/help desks
- Ticketing machine interfaces

Comfort and Ambiance
- Cleanliness and maintenance
- Temperature control
- Noise management
- Lighting (adequate, safety)

Responsiveness and Support
- Staff visibility and presence
- Proactive assistance
- Issue resolution efficiency
- User-friendly feedback mechanisms

Research Design

Research Need

The research need is to improve the functionality of NDLS, making it more accessible and user-friendly and encouraging higher public transport ridership through the interchange.

Aim

To improve user experience at multimodal transit Interchange.

Objectives

1. To identify various factors influencing user experience at the multimodal interchange
2. To Assess the existing user experience at Multimodal Interchange
3. Create a comprehensive performance index for multimodal interchanges.
4. To develop recommendations for enhancing performance at multimodal interchanges.

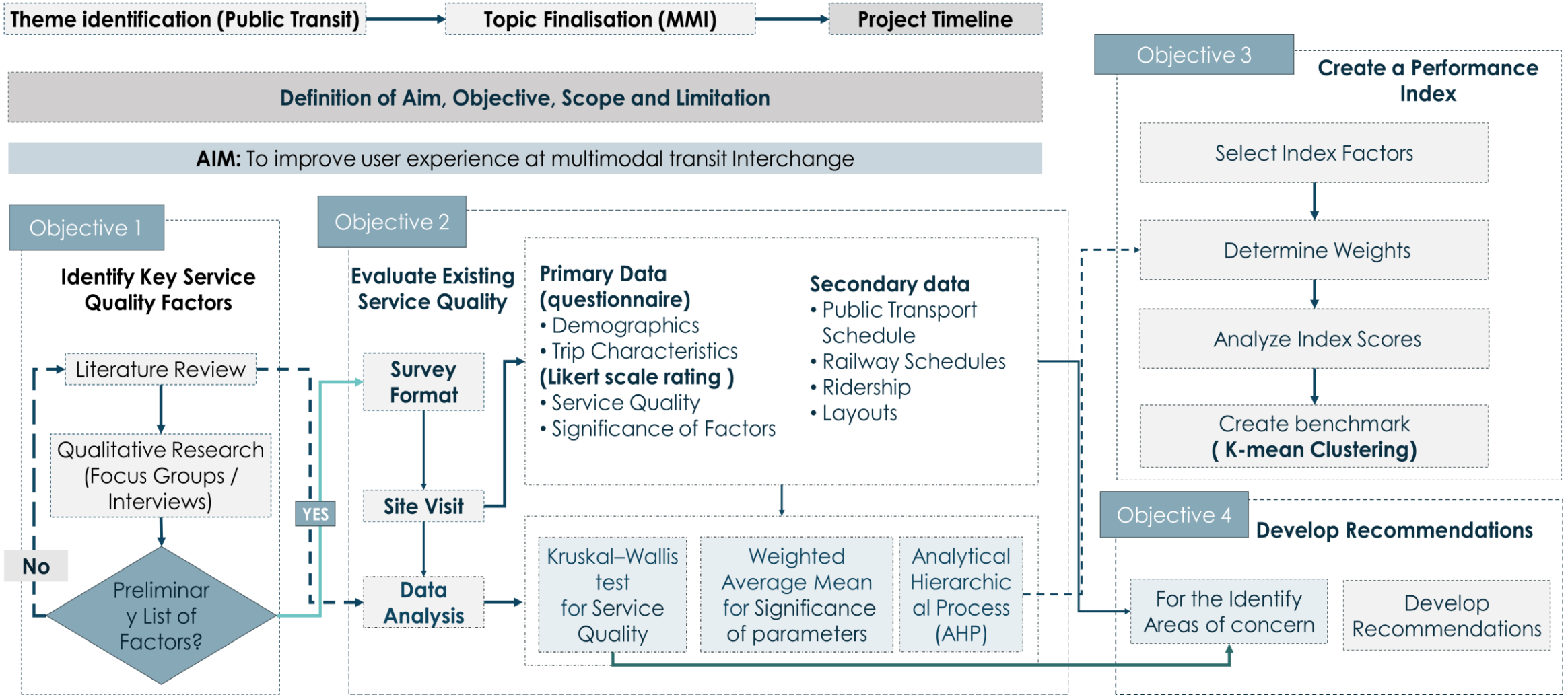
Scope and Limitations

- The study is focused on passenger multimodal interchange and not freight, logistics.
- The study is restricted to an Urban and Regional Multimodal Interchange.

Limitation

- During the site visit many trains were cancelled, so the assessment of a few parameters was affected.
- Due to limited resources due to time constraints
- The study doesn't incorporate fare and finance-related aspects.

Methodology



Parameter Evaluated

Performance Indicators

Accessibility & Connectivity

- Ease of Direction/ Wayfinding
- Transfer time (TT) & Travel distance (TD)
- Quality of walkway(QS)
- Information Systems
- Universal Accessibility

Passenger Amenities

- Restrooms
- F&B Options
- Retail Outlets &
- Luggage Storage Options
- Waiting Areas

Efficiency & Reliability

- Schedule & Frequency Integration
- Availability of Signage
- Transfer Efficiency
- Efficiency Ticketing
- Real time information

User Experience

- Security
- Staff Assistance
- Feedback Mechanism
- Inclusive Maps/layouts Availability

Passenger Characteristics

Travel characteristics

- Luggage's
- No. of Person Accompanying
- Transfer Time
- Travel Frequency & Purpose
- Travel distance & Direction

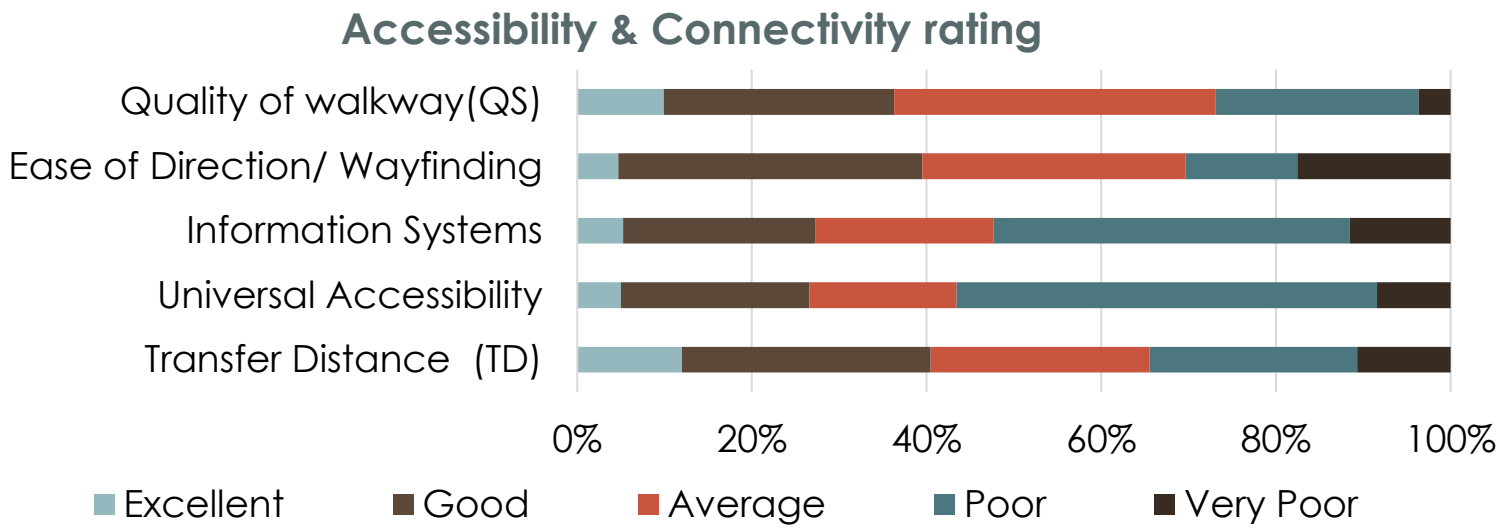
Socio-Demographic

- Age
- Gender
- Annual Income
- Qualification

Accessibility & Connectivity

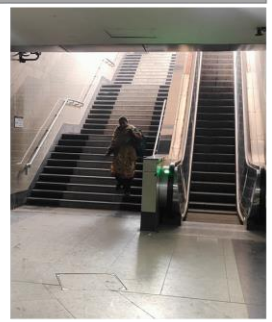
Challenges:
- Lack of facilities for disabled passengers.
- Complex wayfinding and inadequate signage.
- Poor pedestrian walkways and unclear transfer routes.
- Long walking distances between transport modes.

Recommendations:
- Improve ramps, elevators, accessibility, for disabled and passengers with luggage, and tactile paving for visually impaired users.
- Implement clearer signage with multilingual options and Braille.
- Introduce interactive digital maps and wayfinding apps to guide passengers.
- Shorten transfer routes and improve corridor design to reduce walking time.



Hinderance in signage

Staircase & Escalator Utilization



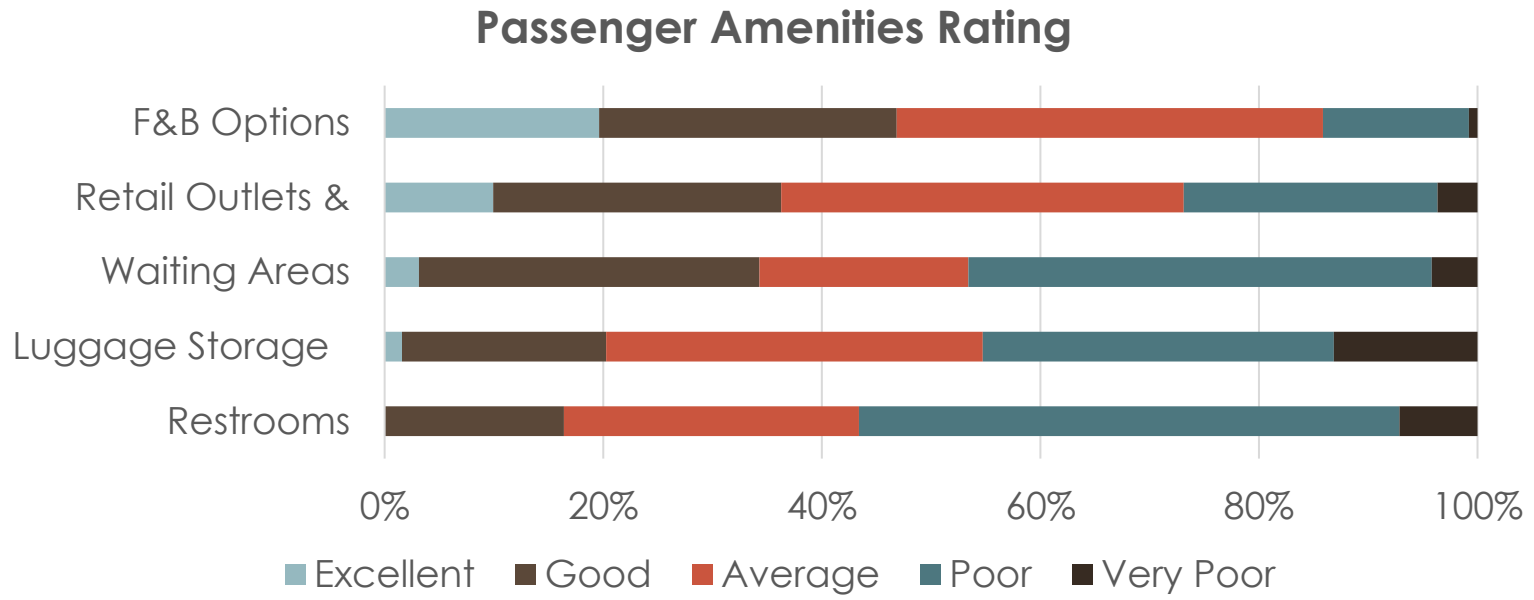
Footpath & Road utilization

Accessibility to PT access and Ramp Placement

Passenger Amenities

Challenges
- Poor restroom conditions.
- Limited seating in waiting areas.
- Inadequate luggage storage and lack of charging points.

Recommendations
- Upgrade restrooms with improved cleanliness and maintenance protocols and feedback mechanism
- Increase seating capacity and provide comfort zones for passengers.
- Increase luggage storage space, add charging stations, and improve overall waiting area facilities.



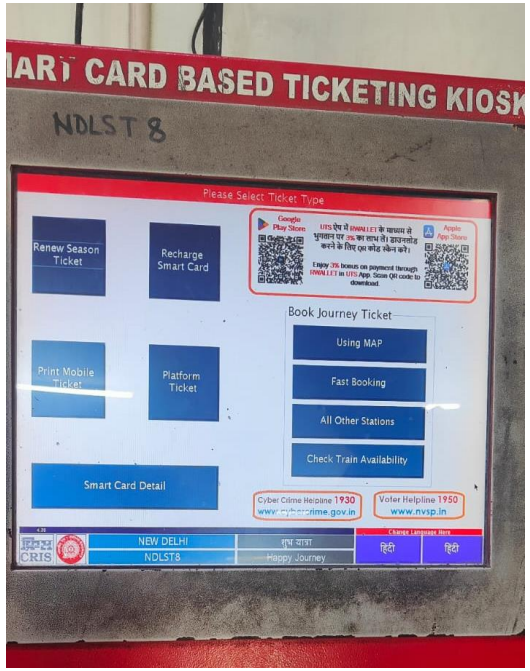
Efficiency & Reliability

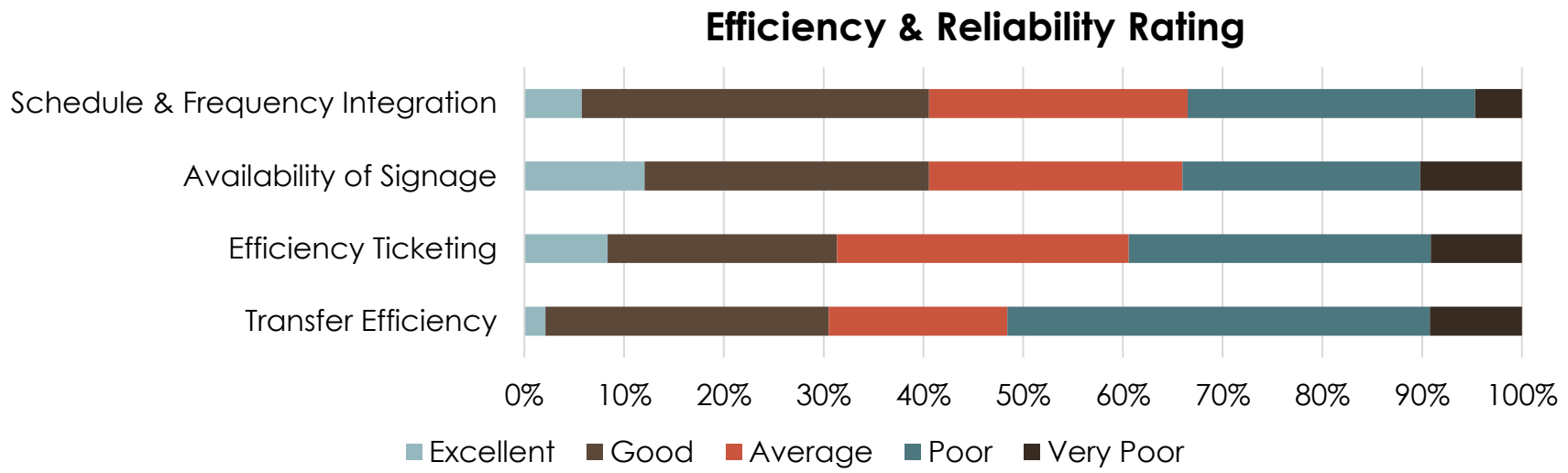
Challenges:

- Long transfer times between transport modes.
- An inefficient ticketing system is causing delays, and redundant kiosks at RS.
- Misaligned schedules between different transport modes.
- Transfer bottlenecks with crowded transfer areas.

Recommendations:

- Optimize transfer routes, reduce walking distances, and improve signage for faster connections.
- Upgrade ticketing systems with contactless and online booking options to reduce wait times.
- Synchronize timetables between trains, buses, and metros to minimize wait times.
- Redesign transfer areas to increase space and provide clear directional information.





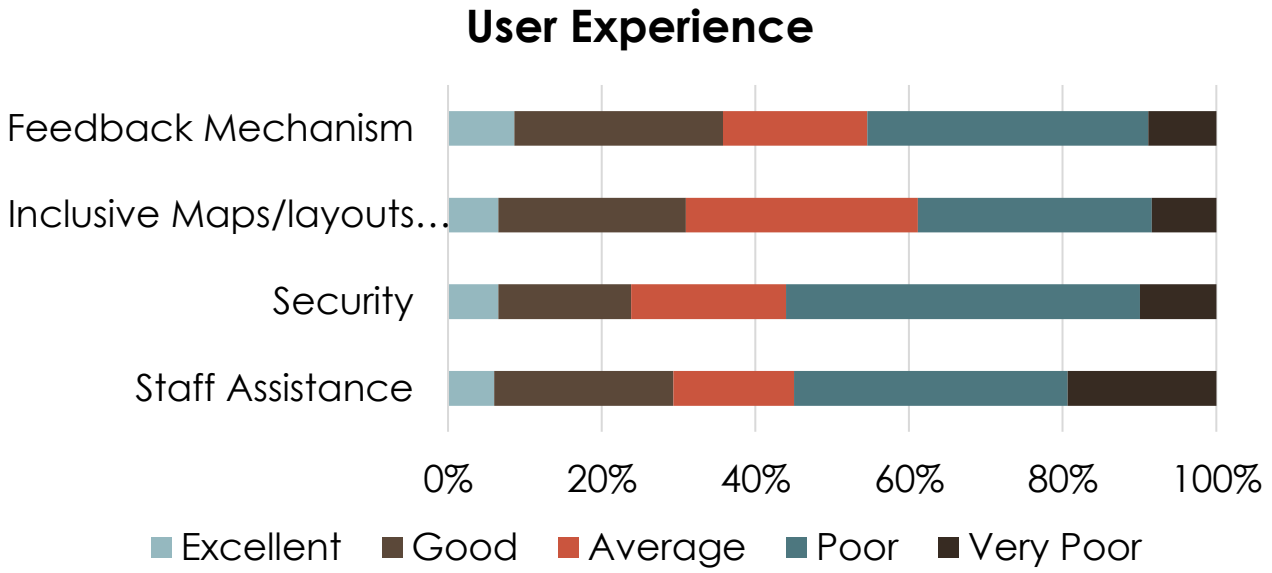
User Experience

Challenges

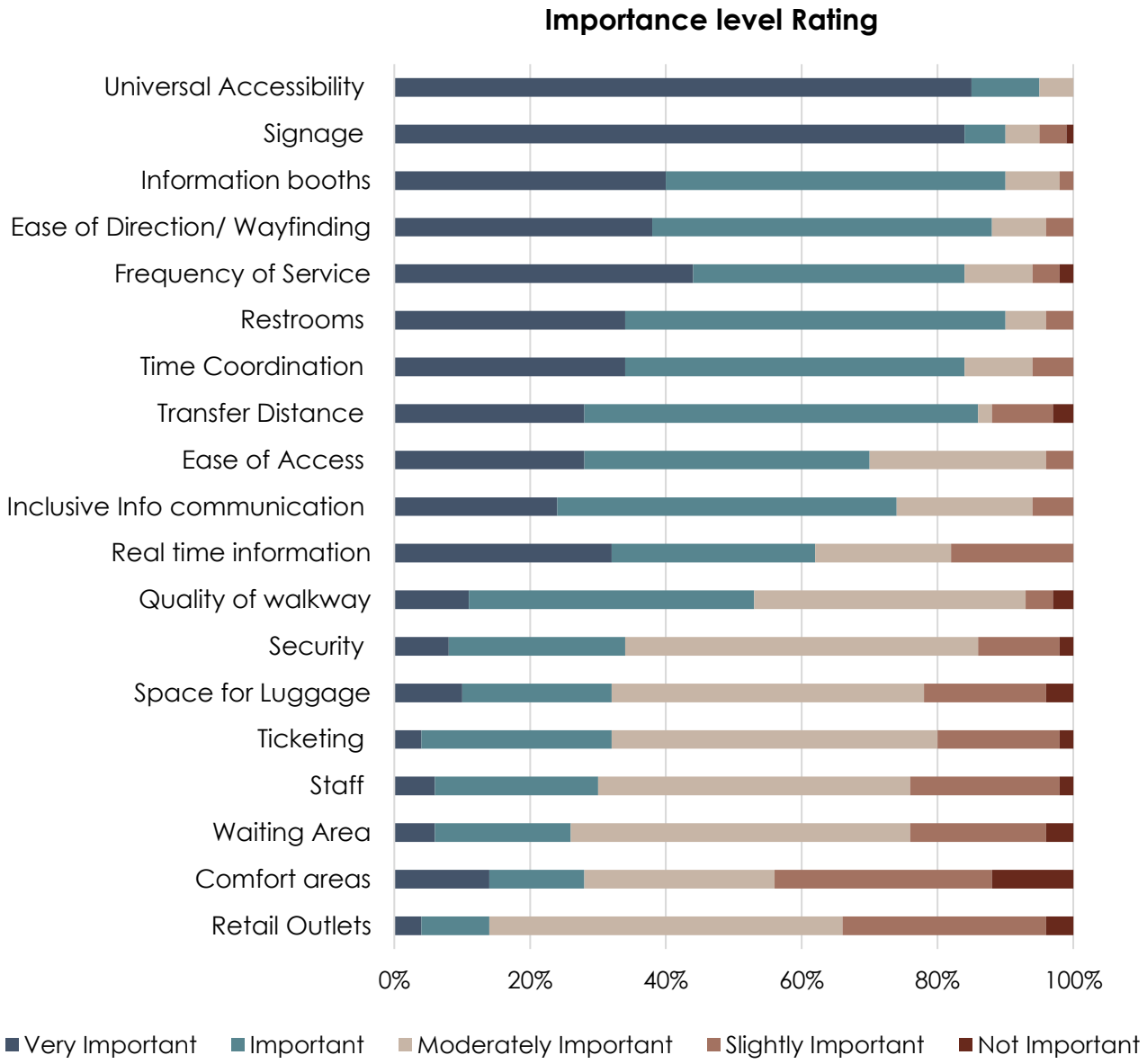
- Security concerns due to inconsistent patrols.
- Lack of adequately trained staff for passenger assistance.
- Confusing layout for first-time or non-local passengers.
- Lack of real-time travel information and guidance.

Recommendations

- Increase security presence, especially during peak hours and at critical locations.
- Provide enhanced customer service training for staff.
- Enhance wayfinding with color-coded pathways and interactive kiosks for directions.
- Implement real-time journey planning apps and digital wayfinding using augmented reality (AR).

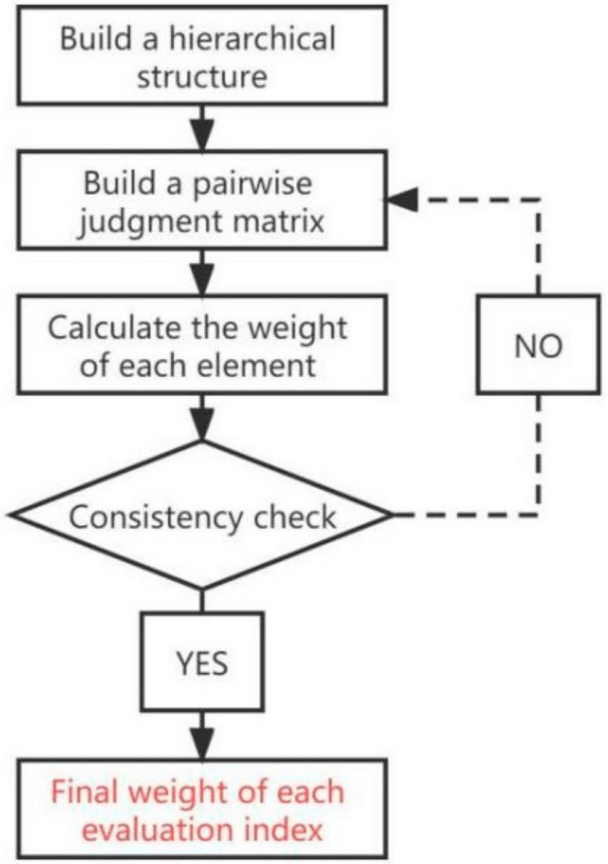


Passenger Priorities Rating



Parameter	Weightage	Sub parameter	Weightage
Accessibility & Connectivity	0.33	Ease of Direction/ Wayfinding (EOD)	0.18
		Information booths	0.17
		Universal Accessibility (UA)	0.23
		Quality of walkway(QS)	0.19
		Transfer time (TT) & TD	0.23
Passenger Amenities	0.22	Restrooms (R)	0.24
		Retail (RO)	0.17
		Waiting (WA)	0.18
		Space for Luggage	0.20
		Comfort areas	0.22
Efficiency & Reliability	0.25	Coordination (CT)	0.22
		Ease of Access (EA)	0.20
		Signage (S)	0.20
		Ticketing Booth (TB)	0.17
		Real time information (RTI)	0.21
User Experience	0.23	Security (SS)	0.23
		Staff (AS)	0.21
		Frequency (FS)	0.29
		Inclusive Info Communication (IIC)	0.27

Analytical Hierarchy Process



AHP Matrix				
Parameters	Accessibility & Connectivity	Passenger Amenities	Efficiency & Reliability	User Experience
Accessibility & Connectivity	1	5	3	4
Passenger Amenities	0.2	1	0.33	0.5
Efficiency & Reliability	0.33	3	1	2
User Experience	0.25	2	0.5	1

By using K-mean Clustering Benchmarking is done from 50 samples of the survey data

Benchmarking for MMII	
A	3.04-5
B	2.41-3.03
C	1.99-2.4
D	1.36-1.98
E	0-1.35

2.85 is the Rating for NDLS as per the remaining survey data – **LOS D**

Recommendations

Category	Issue	Recommendations
Accessibility & Connectivity (A&C)	- Lack of facilities for disabled passengers.	- Improve ramps, elevators, accessibility, for disabled and passengers with luggage, and tactile paving for visually impaired users.
	- Complex wayfinding and inadequate signage.	- Implement clearer signage with multilingual options and Braille.
	- Poor pedestrian walkways and unclear transfer routes.	- Introduce interactive digital maps and wayfinding apps to guide passengers.
	- Long walking distances between transport modes.	- Shorten transfer routes and improve corridor design to reduce walking time.
Passenger Amenities (P&A)	- Poor restroom conditions.	- Upgrade restrooms with improved cleanliness and maintenance protocols.
	- Limited seating in waiting areas.	- Increase seating capacity and provide comfort zones for passengers.
	- Subpar food and beverage services.	- Expand food and beverage options with quality standards for vendors.
	- Inadequate luggage storage and lack of charging points.	- Increase luggage storage space, add charging stations, and improve overall waiting area facilities.
Efficiency & Reliability (E&R)	- Long transfer times between transport modes.	- Optimize transfer routes, reduce walking distances, and improve signage for faster connections.
	- Inefficient ticketing system causing delays.	- Upgrade ticketing systems with contactless and online booking options to reduce wait times.
	- Misaligned schedules between different transport modes.	- Synchronize timetables between trains, buses, and metros to minimize wait times.
	- Transfer bottlenecks with crowded transfer areas.	- Redesign transfer areas to increase space and provide clear directional information.
User Experience (U&E)	- Security concerns due to inconsistent patrols.	- Increase security presence, especially during peak hours and at critical locations.
	- Lack of adequately trained staff for passenger assistance.	- Provide enhanced customer service training for staff.
	- Confusing layout for first-time or non-local passengers.	- Enhance wayfinding with color-coded pathways and interactive kiosks for directions.
	- Lack of real-time travel information and guidance.	- Implement real-time journey planning apps and digital wayfinding using augmented reality (AR).

Recommendations- Innovative interventions

Smart Restrooms	**Real-time Occupancy Sensors:** Improve cleaning efficiency and user awareness of availability.
Personalized Wayfinding	**Accessibility-focused Apps:** Customized routes for those with mobility needs.
	Wearable Integration: Haptic feedback (vibrations) for navigation assistance.
Gamification	**Rewards for Feedback:** Motivate participation with badges or points.
	Interactive Waiting Areas: Reduce perceived wait times, especially for children.
Temporary Amenities	**Pop-up Solutions:** Mobile restrooms, seating, etc., during peak times or renovations.
Coordination & Connectivity	**Late-Night Partnerships:** Ride-hailing or shuttles to fill public transport gaps.
	Smart Journey Planning: App factoring in preferences, real-time data, and accessibility.
Transfer Design	**AR Wayfinding:** Live camera view with overlaid directions for seamless guidance.
	Interactive Kiosks: Visuals and walking times to help plan transfers efficiently.
Security	**Wearable SOS Devices:** Discreet panic alerts with location tracking.
	Crowdsourced Safety Mapping: App for users to report safe/unsafe zones.
Staffing	**Virtual Help Desks:** Remote assistance via QR codes or signage.
	Skill Exchange: Cross-training for flexible deployment in busy areas.
Feedback Mechanisms	**Social Media Analysis:** Mine geotagged posts for sentiment trends.
Accessibility	**Beacon-Based Navigation:** Spoken directions, aiding visually impaired users.
	VR Empathy Training: Simulations for staff to understand diverse needs.

Thank You

Look Forward to your Questions