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Enhancing Wayfinding in Chennai Metro: Insights from Passenger Feedback

K. Vaidyanathan*, G. Yogapriya

Chettinad School of Architecture, Chettinad Academy of Research and Education, Kelambakkam – 603103, Tamil Nadu, India

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Abstract Metro systems are now essential for urban mobility due to the rapid urbanization of the world, but many users still find it difficult to navigate these complex environments. Clear and inclusive wayfinding is not only critical for improving passenger ease of commuting. It is also for certifying security, effectiveness, and reasonable access to public transport. In Chennai, like in other cities where the transit usage has increased rapidly in recent years, user-centered navigation design remains unknown. In order to categorise design limitations and recommend user-centered improvements, this study examines passenger feedback to investigate the wayfinding experience in Chennai Metro stations. The research builds on international frameworks such as Metrolinx (Canada), APTA (USA), and MTC (USA), while positioning results within the local socio-cultural context. Using a mixed-methods approach, the study evaluates overall navigation satisfaction through integrating quantitative survey data with qualitative responses from 88 respondents. The investigation apprehended demographic variations across age, gender, and travel frequency. The open-ended responses delivered understandings into signage clarity, digital tools, and accessibility. The results show serious deficiencies in real-time navigation assistance, digital integration, multilingual signage, and accessibility for people with disabilities. Starting from the mobile apps, interactive kiosks, restroom signage, and multilingual guidance, the need varies by age and gender. These results point to demographic-exact needs that should inform design revisions. The study highlights the need for inclusive design principles by comparing Chennai Metro's current practices to international standards like Metrolinx (Canada), APTA (USA), and MTC (USA). The use of universally recognizable symbols, enhanced station mapping, tactile and Braille signage, and participatory design—which involves passengers in the evaluation of signage—are among the recommendations. By providing scalable methods for improving wayfinding in expanding metropolitan networks, the study adds to the broader conversation on transit accessibility and user experience.

Keywords Wayfinding, Metro Stations, User Experience, Signage Design, Accessibility

1. Introduction

Urbanisation has paved the way for different infrastructural development in urban areas. One of such technological advancements is the metro station that enabled safe and comfortable commuting for the people within the cities. When cities are in a phase of urbanisation, the demand for effective transportation solutions tends to rise [1]. The metro station, being complex with its technical aspects, faces a challenge in accommodating the increasing population. It needs to foster smooth and effective navigation for passengers, too. Various aspects of metro stations have been identified to make them easier for usage in day-to-day activities, inclusive for all people in the ongoing study everywhere. A clear and intuitive wayfinding is crucial for reducing stress, improving efficiency, and it also enhances the overall user experience in metro stations.

Wayfinding helps to navigate unfamiliar places. Usage

of signs, floor markings, digital displays, and design of stations needs to help the travellers without the feeling of being lost to move from entrance to exit [2]. Wayfinding, defined by Peponis et al. [3] is the ability to get to a point in a brief period free from stress and worry. Navigation activities for metro station passengers include entering, leaving, and transferring. Passengers at metro stations in multi-modal transport hubs must get to their destinations swiftly. Essential are the right exits for departure lines and the right platforms for entry and transfer lines. Wayfinding signs are installed most often to reduce negative impacts. Well-placed guidance signs can help first-time travellers or those unfamiliar with the surroundings rapidly get accurate wayfinding information and get to their destinations [4].

Most assessments focus on passenger behavioural needs [5]. But, considering the significant transitory passenger flow in metro stations inside multimodal transport hubs, it is vital to lower the pressure of transient passenger flow and prevent safety concerns. From the standpoint of a more efficient passenger flow organisation, the shortest route sought by passengers might not necessarily correspond with the best route favoured by the operational crew. Thus, it is essential to assess the wayfinding system of metro stations in multi-modal transport hubs from both the viewpoints of passengers and operating staff.

User comments will provide useful ideas for improving designs, which will help make public transit systems better overall. This study aims to find better ways to help people navigate spaces easily and comfortably by putting users' needs first.

2. Literature Review

In the 19th century, London's rapid growth and urbanisation led to severe traffic congestion, prompting a need for more efficient transportation systems. The idea for the metro emerged, with Charles Pearson advocating for the creation of the Metropolitan Railway in 1863, which was the world’s first underground railway system [6]. From that point onwards, the countries that are in urbanisation phases have started to develop their metros in a range of different technological aspects. As metro systems developed into major transportation networks with diverse public users, the need to enhance the user experience became increasingly essential. The design strategies have been developed based on understanding how people navigate complex environments. By comparing the early theories of cognitive psychology with the modern advancements of spatial analysis and virtual reality, the designers tried to capture a better user experience. This literature review traces the development of wayfinding theory and its application in metro systems, focusing on the key milestones from the early years to the present.

Early to mid-20th-century research on wayfinding concentrated on how humans move between settings, particularly in cities. Kevin Lynch's - The Image of the City [7], in which he examined how people mentally map their environment, is among the major works in this field. Important components for establishing a distinct sense of direction, he said, are landmarks, pathways, and districts. These concepts turned into the cornerstone for creating simple, follow-through guidance systems in intricate locations like metro stations. Simultaneously, Gestalt psychology was also crucial in helping us to comprehend spatial information. Ideas developed by researchers such as Wertheimer [8] shaped the design of environments in a way that seems natural and logical for individuals. Early to mid-20th century, wayfinding started to be studied with an eye towards cognitive psychology and spatial navigation. Expanding Kevin Lynch's ideas [7] Siegel and White [9] showed in the 1970s and 1980s how interactions with the environment and personal events build mental maps. Effective wayfinding systems, according to Arthur & Passini [2] require more than simply signage; they also need cognitive psychology and environmental design to lower confusion and simplify travel.

The choice-clue wayfinding model compares task complexity in built environments by focusing on two key elements: choices and clues. Raubal and Egenhofer [10] investigated how more effective metro layouts might be designed using spatial analytic methods. Research by Jin W et al. [11] showed how well-placed, clear signage might lower cognitive load, thereby lessening the burden on navigating for passengers. The emphasis changed during this period to user-centred design since it helps one to grasp how various passenger groups interact with wayfinding systems. Early in the 2000s, wayfinding design started to incorporate technology more deliberately. Virtual reality (VR) started to be a major instrument for testing and improving navigation systems by the 2010s. By means of VR, Hu, and Xu [4] evaluated the efficacy of guidance signage in metro stations, thereby enabling more realistic simulations prior to real-world application of improvements.

The focus turned in the 2020s towards enhancing navigation system accessibility and cultural sensitivity. There are also a few studies underlining the need to consider cultural variances to guarantee signage is globally comprehended. Focusing on inclusivity and accessibility for all users, including those with disabilities and low technological knowledge, was identified as a key factor for navigation. Then the tools like space syntax software, which was discussed, were also incorporated into wayfinding design to maximise station layouts for different user groups [12]. Table 1 summarizes the significant eras in wayfinding theory, highlighting major thinkers and their contributions over time. It depicts the history from the pre-Passini era to the present, stressing shifts in focus and innovative ideas.

Table 1. History of development in wayfinding

Era	Key Thinkers	Key Contributions
Pre-Passini Era 1960s–1970s	Lynch [7]; Downs & Stea [13]; Kaplan [14]; Siegel & White [9];	"wayfinding" to describe maps, signs, etc.
		Identified paths, landmarks, regions, edges, and nodes as key navigation elements.
Passini Era 1970s–1990s	Passini [15,16]; Arthur & Passini [2]; Weisman [8];	Focused on how people dynamically solve navigation problems.
		Redefined wayfinding as a problem-solving process beyond just orientation.
Post-Passini Era Mid-1990s–Present	Pro-Passinis: Carpman & Grant [17]; Huelat [18];	Pro-Passinis emphasized environmental psychology.
	Pro-Cognitivists: Golledge [19]; Hölscher et al. [12];	Pro-Cognitivists emphasized cognitive psychology.
		Refined and applied existing theories in various contexts.

Source: Ndlovu Rooke [20]

2.1. Research Questions

1. What problems do passengers face while finding their way in Chennai Metro stations?
2. How do age, gender, and how often people travel affect their wayfinding experience?
3. What do users suggest for improving signs, maps, and navigation tools in metro stations?

2.2. Research Objectives

- To study how users feel about the current signs, floor markings, and navigation tools in Chennai Metro.
- To find out the main problems users face, like confusing exits or unclear maps.
- To give simple, user-friendly ideas for improving signs and maps in metro stations.
- To develop Chennai's metro wayfinding system based on passengers' comments and experiences to improve user happiness and accessibility for varied user groups.

2.3. Case Study

Chennai, a coastal metropolis in South India, displays a multifaceted and dynamic urban structure influenced by historical settlements, colonial grids, and organic growth patterns. The city's expansion is organized around significant transport corridors and hubs, notably the Guindy-Alandur intersection, which plays a vital role in multi-modal connectivity. With an urban agglomeration population exceeding 10.9 million as per the 2011 Census—and expected to rise, Chennai's spatial configuration includes dense residential areas, industrial belts, institutional zones, and green infrastructure.

The historical Madras Metropolitan Plan 14 (Figure 1) illustrates the early vision of Chennai as a node-based urban network connected by radial corridors, providing insights into its planned versus organic development trajectory. Figure 2 outlines an integrated transit network combining metro rail, suburban rail, and bus rapid transit systems to enhance urban connectivity across Chennai's expanding metropolitan region. These dynamic spatial transitions place additional stress on wayfinding in public transport settings. As such, Chennai’s irregular urban fabric and functional complexity necessitate a more refined and user-centered navigation system within its transit infrastructure to support a growing and diverse population.

Figure 3 provides information on various public transit systems of Chennai and Figure 4 gives an idea of metro ridership details of 2022-2024. Chennai's metro system started in 2015, and has a significant operational length, which is around the middle range compared to other Indian cities. In terms of annual ridership in 2023, Chennai's metro stands out with a high number, indicating a strong usage of the metro system by commuters. While not at the top like Delhi, it still shows a considerable share of ridership, reflecting its importance in urban transportation.

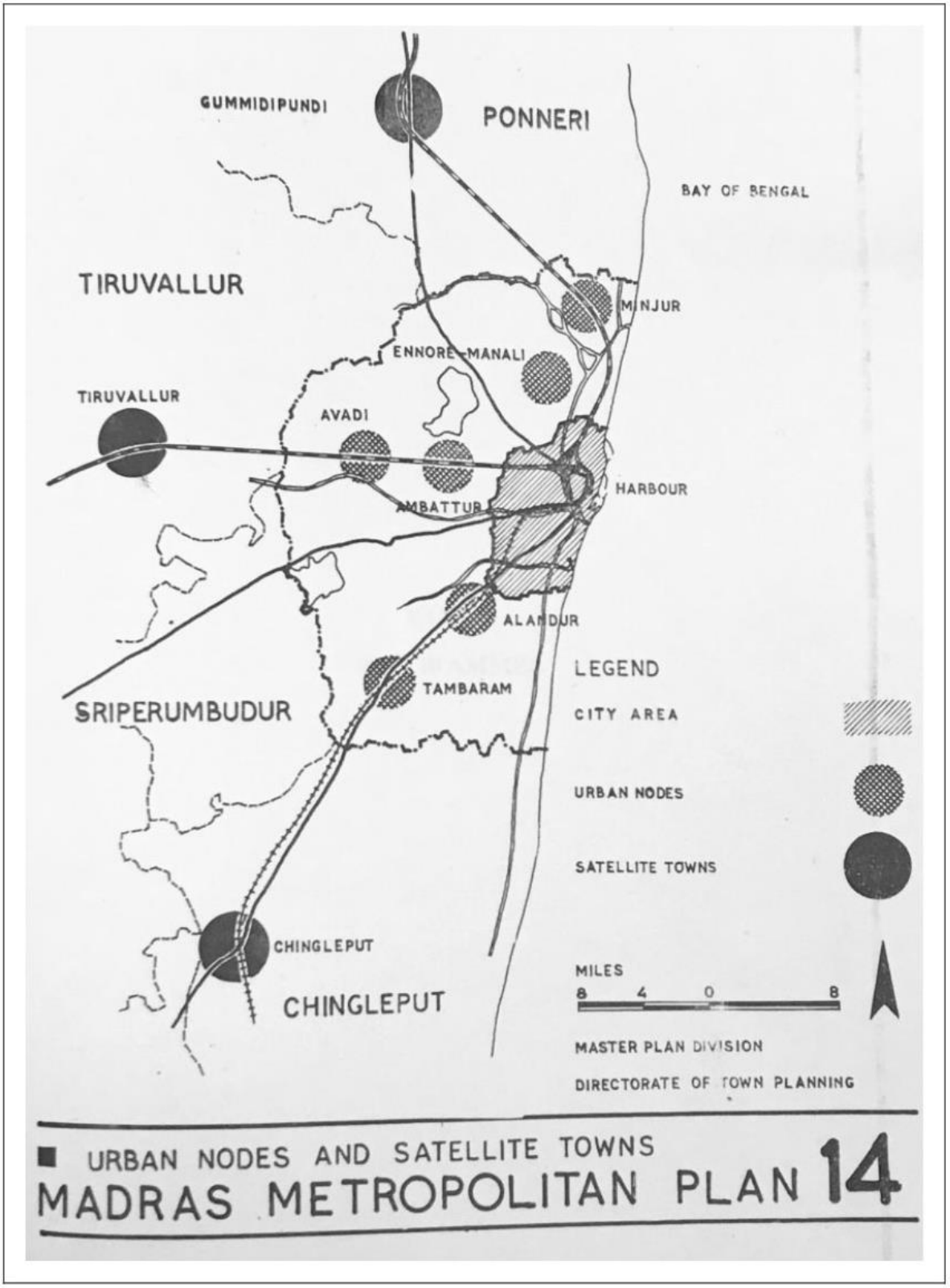

Figure 1. Madras Metropolitan Plan 14: Urban Nodes and Satellite Towns of 1971 [21,22]

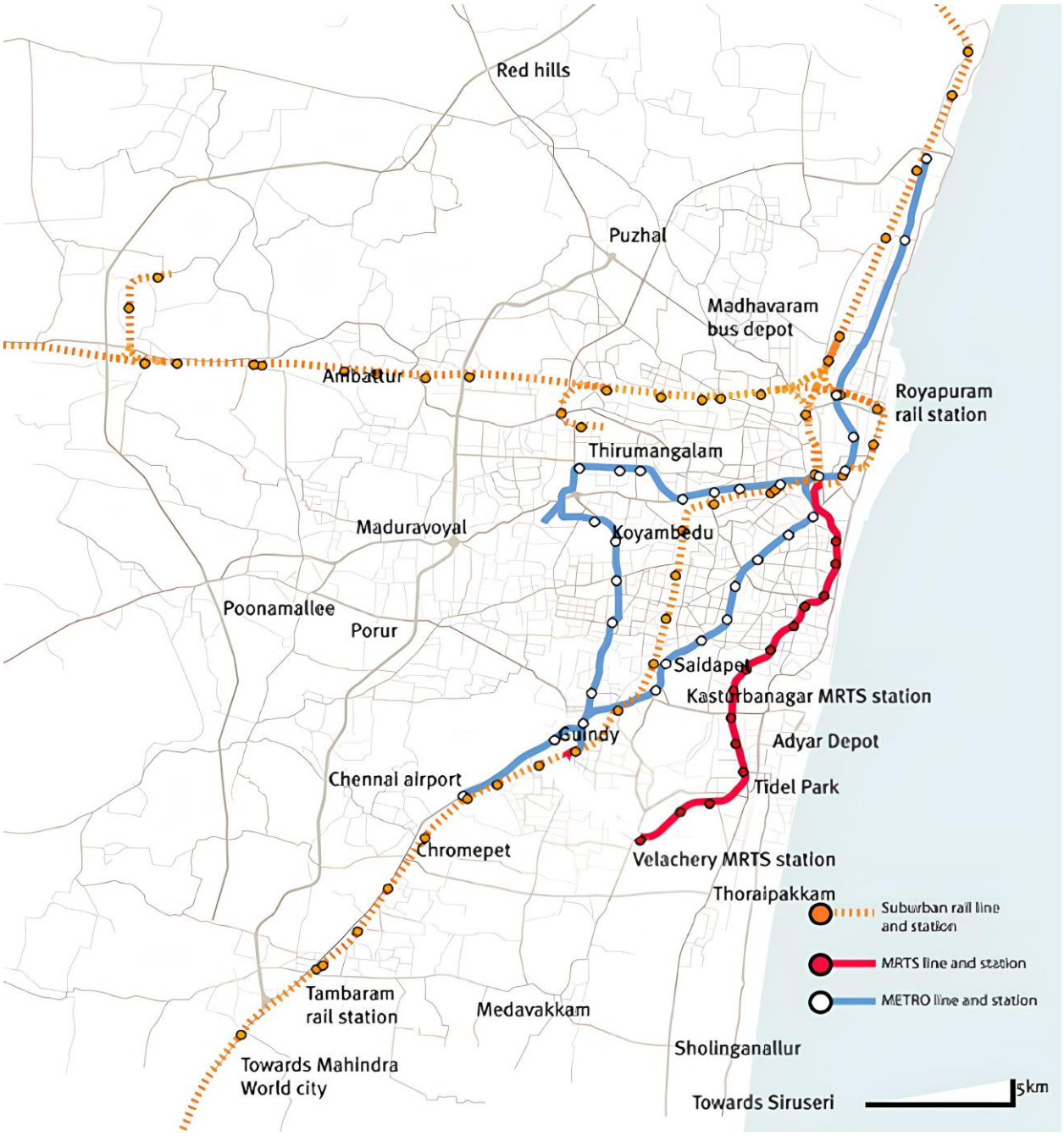

Figure 2. Public transit system in Chennai [23]

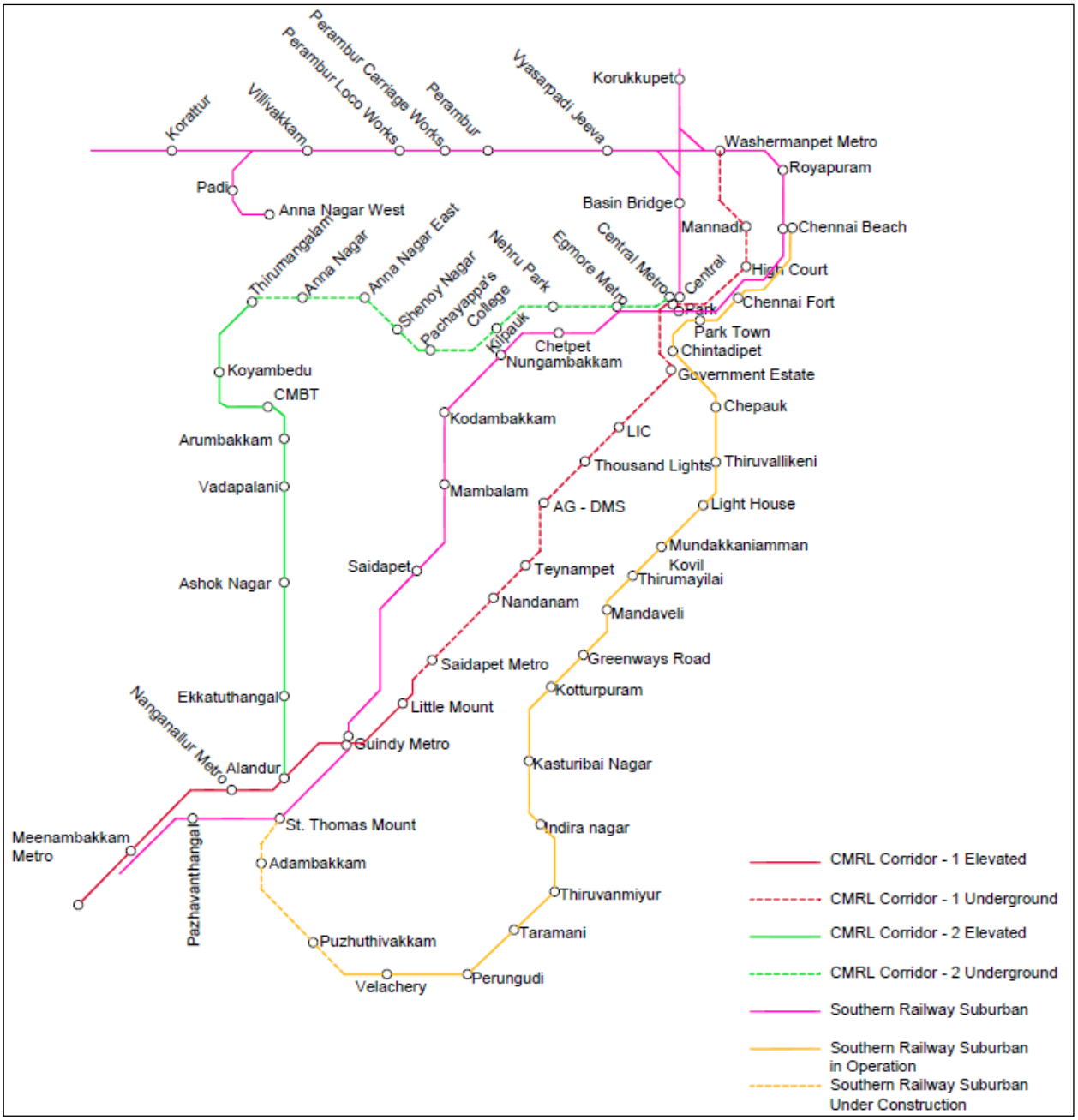

Figure 3. Metro corridors of Chennai [24]

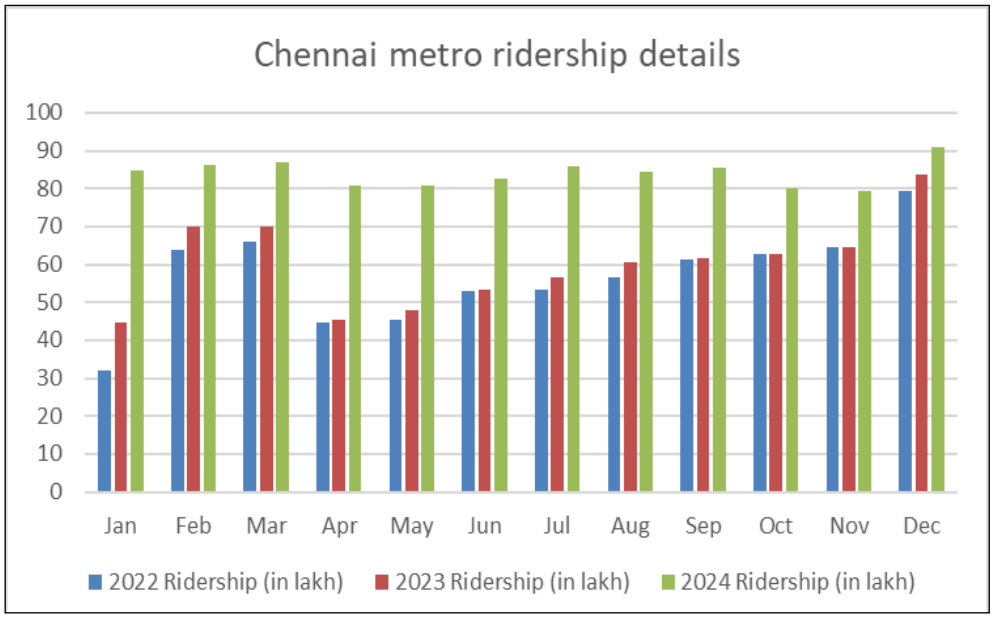

Figure 4. Chennai metro rider details from 2022-24 [25]

3. Methodology

Using a mixed-methods approach, integrating quantitative and qualitative research techniques, this study helps to figure out the user experience and wayfinding challenges at Chennai's metro stations. The study is set up to gather textual data (e.g., passenger recommendations, complaints) and numerical data (e.g., satisfaction ratings, frequency of concerns). There are 100 participants selected by a random sampling method. Among them, only 88 respondents' data are clear and defined. Likert scale scores evaluating signage clarity, convenience of use, and general satisfaction with the metro station environment were given on a survey, incorporating closed-ended questions.

Based on actual user experiences, this mixed-methods approach provides a whole picture of how travellers engage with the wayfinding systems and points up areas needing design change. Open-ended inquiries were used to get passenger recommendations for enhancements as well as thorough accounts of any difficulties they face while traversing the metro stations. Quantitative data was analyzed using frequency distributions and cross-tabulation to identify trends in user behavior. Qualitative responses were analyzed thematically to identify recurring suggestions for improvement.

3.1. Limitations

The sample size is kept as 100 participants with valid responses as 88. This is relatively small as it followed the approach of previous wayfinding studies that prioritize in-depth insights over broad representation, especially in location-specific research [18]. Since wayfinding is still a new concept for Chennai Metro users, a focused sample allowed for more meaningful and reflective findings.

Research by Hu & Xu [4] and Passini [16] has shown that small samples can effectively capture user experiences and highlight design challenges in complex transit systems. Although the results may not be universally applicable, they provide a strong foundation for future studies with larger and more diverse participant groups.

4. Results and Data Analysis

4.1. Demographic Breakdown of Survey Participants

The survey respondents were predominantly in the 18-30 age group, with a higher number of male participants.

Age vs Gender Distribution is represented in Figure 5. With a declining male and female participation as age rises, the general tendency indicates that younger men are more involved with the metro system than women.

4.2. Metro Usage and Survey Participation

Most respondents reported a willingness to participate in surveys about their metro station experience, indicating a high level of engagement among metro users. Figure 6 explains that the majority over 70 are interested in participating in this survey to improve wayfinding systems.

4.3. Wayfinding Features

Figure 7 highlights the different wayfinding features available at Chennai metro station. Most people think directional signs are clear. The existence of neutral and negative comments (15 Disagree, 18 Neutral) suggests that certain users might struggle or be confused with signage, and it needs to be improved.

As ticket counters are at the entrance and it is also guided by staff to reach out, it received more positive feedback, and the system is well optimised too. There is a disagreement with the multilingual signage, as it needs more enhancement for non-native speakers.

Station maps express mixed reviews. It establishes the need for accurate and clear maps at decision-making points. Digital wayfinding also received unfavourable comments. The result emphasises a vital area of development, especially regarding system dependability, user-friendliness, or accessibility.

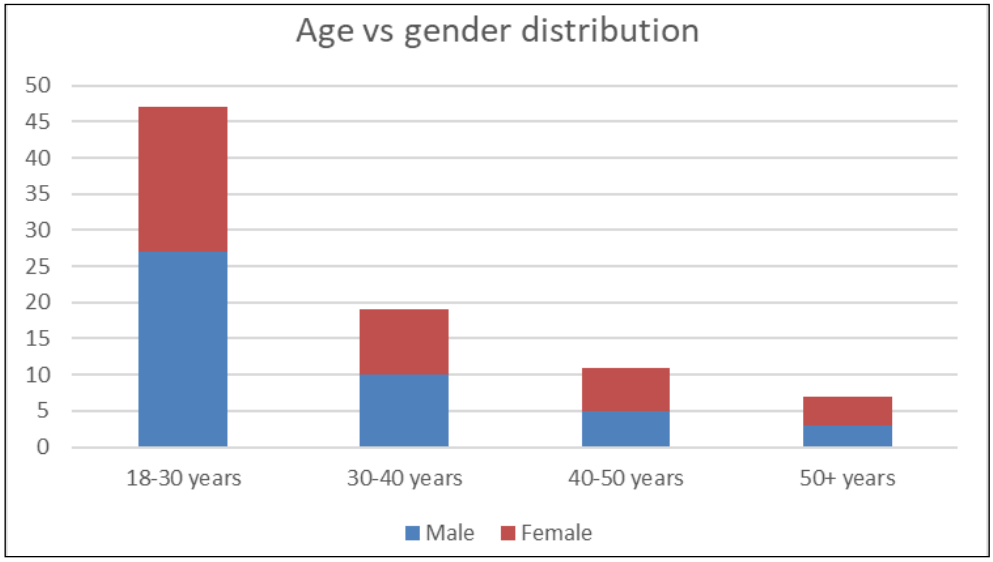

Figure 5. Gender and age distribution

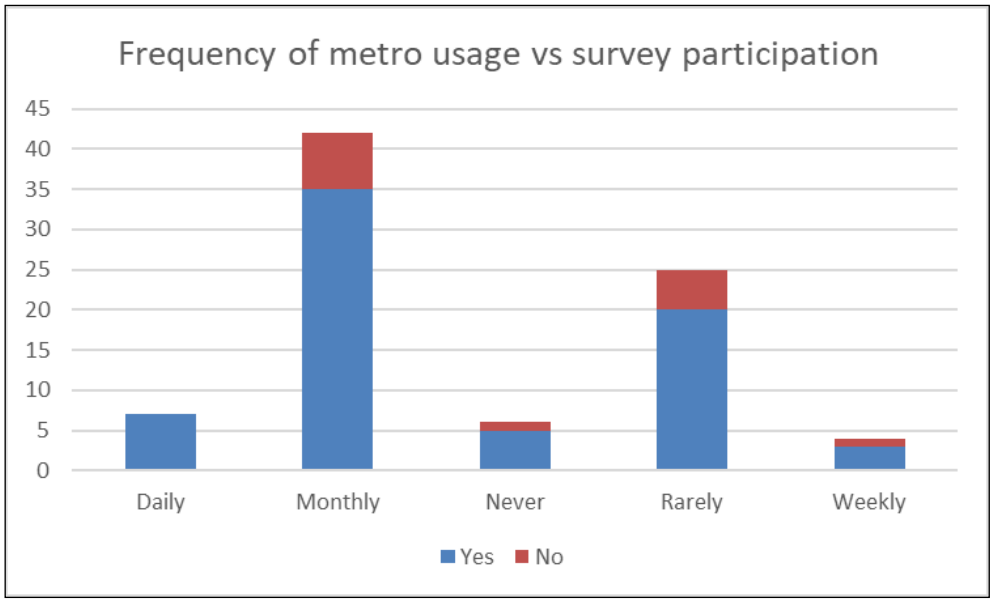

Figure 6. Metro user frequency vs participation level

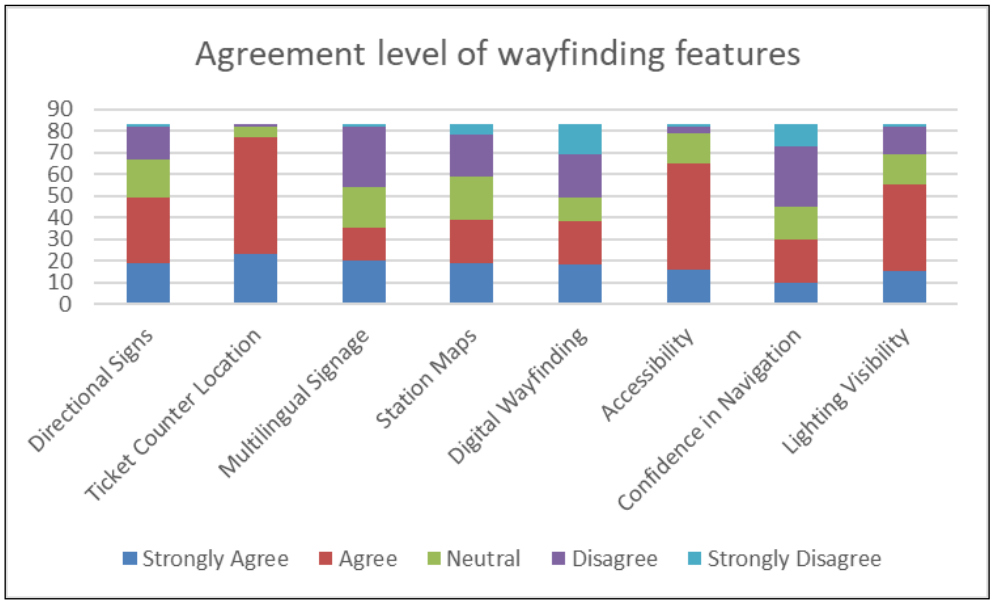

Figure 7. Agreement level of wayfinding features

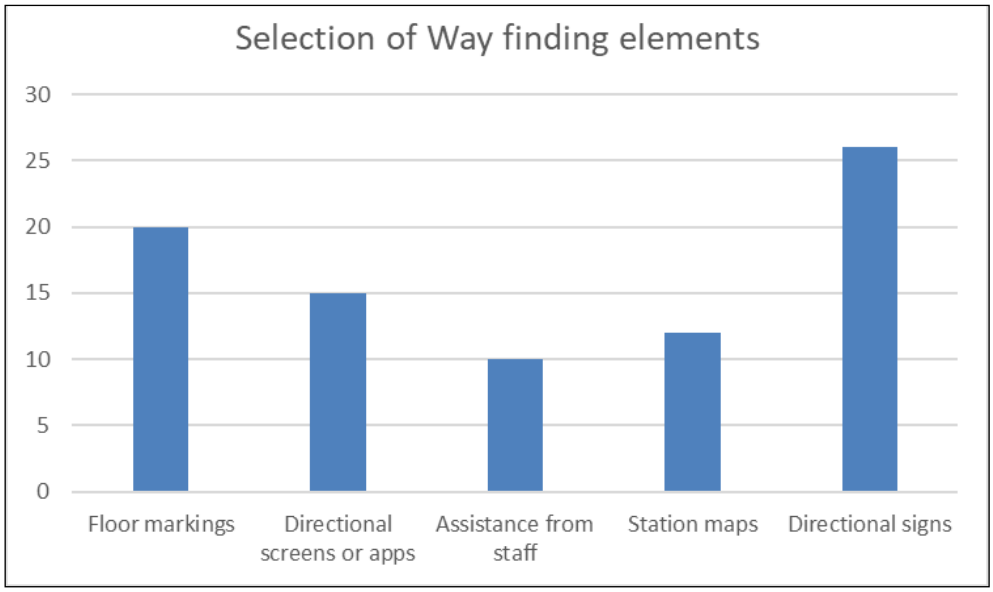

Figure 8. Selection of Way finding elements

The study reveals that while many aspects of the wayfinding system are successful, others—especially digital tools, station maps, and multilingual signage—need more focus to guarantee a smooth user experience and confidence in navigators. Figure 8 explains wayfinding in metro stations, and the most often cited characteristics are floor markings, which were mentioned 18 times, and directional signs, which were mentioned 15 times. While directional screens and apps were mentioned seven times, station maps were mentioned ten times. Staff help was also highlighted as a useful aspect, with six mentions.

4.4. Suggestions for Improvement

The most common suggestions included the need for more signage, improved lighting, clearer pictograms/icons, and better integration of digital tools. Notably, multilingual signage and Braille/tactile signs were recommended to enhance accessibility (Figure 9).

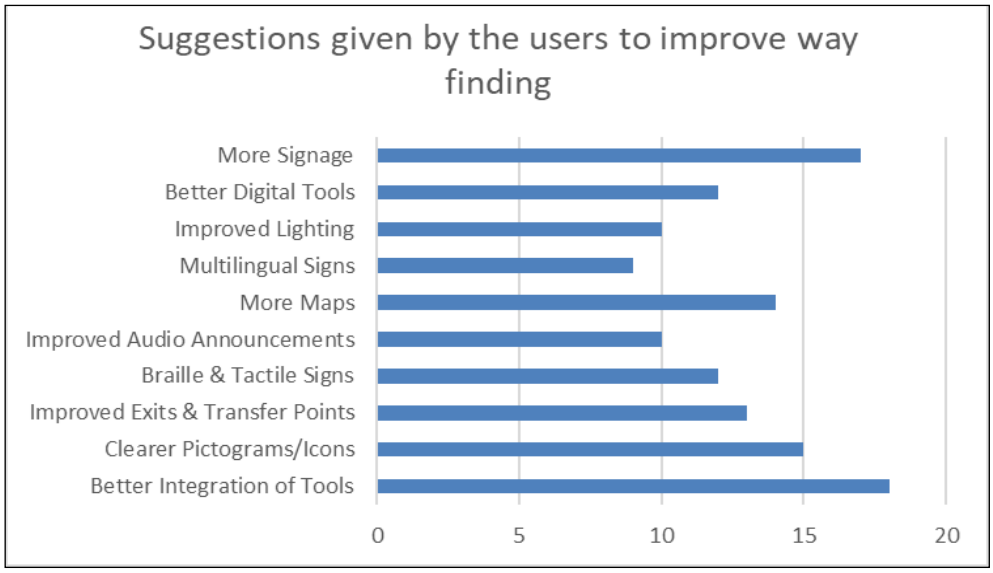

Figure 9. Survey participants' suggestions to improve wayfinding

4.5. Sentiment Analysis of Open-Ended Feedback

Open-ended responses provided rich, qualitative insights into how users experience metro station navigation. This section breaks down user sentiments, emotional tone, and demographic context.

4.5.1. Key Themes in User Feedback

- Signage Clarity: Many respondents emphasized the importance of using universal language signboards to support non-native speakers. There were also suggestions to position signage at eye level and make toilet signs simpler. Clear station mapping at entry and exit points was recommended, especially for new users. The issue of too many confusing exits was frequently mentioned, highlighting the need for a more streamlined and intuitive layout.
- Digital Solutions: Several users suggested the inclusion of more digital signboards, like those found in malls and airports, to make real-time navigation easier and more efficient.
- Accessibility and Human Assistance: Some respondents noted the importance of inclusive signage that caters to individuals with physical challenges. Although there wasn't a widespread request for more staff presence, some comments implied that digital tools should support, not replace, human help when needed.

4.5.2. Sentiment Polarity Analysis

Polarity scores range from -1 (strongly negative) to +1 (strongly positive), reflecting the emotional orientation of user comments.

- Positive Sentiments: Comments such as "Make sure of metros timing and platforms" (0.5) and "It would be better if we get interactive wayfinding displays" (0.5) express optimism and a clear desire for system improvements.
- Mildly Positive Feedback: Comments like "Too many exits are confusing" (0.1) and "More digital screens might be helpful" (0.25) show mild satisfaction or constructive suggestions, often neutral in tone.
- Negative Sentiments: Strong dissatisfaction appears in comments such as "Improve the signage for restrooms in metro" (-0.5), indicating frustration with current wayfinding systems.
- Neutral Feedback: Comments with 0.0 polarity (e.g., "Add signages", "Lighting should not overpower the digital screens") are fact-based, without emotional or judgmental language.

4.5.3. Subjectivity Analysis

Subjectivity values range from 0 (completely objective) to 1 (highly subjective). This indicates whether feedback reflects opinion or factual observation.

- Highly Subjective Comments: Statements like "Make sure of metros timing and platforms" (0.89) reveal strong personal feelings or preferences.
- Moderately Subjective Comments: Feedback such as "It should be user-friendly, too many ups and downs" (0.63) blends personal experience with practical suggestions.
- Low Subjectivity / Objective Feedback: Comments like "Lighting should not overpower the digital screens" (0.0) are fact-based, aiming to improve specific aspects of design without emotional language.

As shown in Table 2, polarity scores varied across comments, with most falling in the mildly positive to neutral range, reflecting a generally constructive tone from respondents.

Table 2. Sentiment and Subjectivity Analysis of their metro experience

Comment	Polarity	Subjectivity	Gender & Age
Make sure of metros timing and platforms	0.5	0.89	Female 18-30
More universal language sign boards, clear platform locator for destination	0.2	0.29	Male 18-30
In brief time find which platform train arrives, in which level train need arrive	0	0.3	Male 50-60
Not able to easily navigate between platforms to exits	0.15	0.72	Female 18-30
It should be user-friendly, too many ups and downs	0.13	0.63	Female 50-60
Highlight physical challenge signages too	0	0.14	Female 30-40
Bright lights in the signage are more than enough	0.43	0.66	Male 18-30
Change of size of few signages	-0.2	0.1	Female 18-30
Decrease the height of the sign boards	0.25	0.3	Female 18-30
More digital screens might be helpful	0.25	0.25	Female 18-30
Add signages	0	0	Female 18-30
The signages provided could be presented in a more infographic way	0.39	0.52	Female 18-30
Frequent trains in peak hours	0.1	0.3	Female 30-40
Too many exits are confusing	0.1	0.45	Female 18-30
Improve the signage for restrooms in metro	-0.5	1	Female 18-30
Lighting should not overpower the digital screens	0	0	Female 18-30
More human help	0.25	0.3	Female 18-30
To provide better and more detailed mapping for entrances and exits	0.39	0.44	Male 18-30
It would be better if we got interactive wayfinding displays	0.5	0.5	Male 18-30

4.5.4. Demographic Insights

- Age Group Trends: Most of the responses came from the 18–30 age group, suggesting that younger users are more engaged and share their metro experiences. Feedback was also received from users aged 30–40 and 50–60, contributing to a multi-generational perspective on wayfinding issues.
- Gender Distribution: Responses were received from both male and female participants. Notably, female respondents (especially 18–30) provided the highest number of feedback entries, suggesting an active interest in metro usability and design.

4.5.5. Design Implications from Demographic Sentiment

Figure 10 and Table 3 reveal some striking differences in how various groups experience the Chennai Metro. Women in the 50–60 age range tend to express more personal and subjective feedback, often pointing to frustration with complex station layouts—highlighting the need for simpler, more intuitive navigation. Younger women (18–30) gave the most feedback overall, often mentioning confusing exits and the lack of clear, multilingual signs. On the other hand, men in the 18–30 group were generally more positive and practical, showing a preference for tech-based solutions like digital kiosks and mobile apps. Meanwhile, those in the 30–40 age group offered straightforward, fact-based suggestions, mostly focusing on accessibility features like tactile maps. These patterns make it clear: to truly improve wayfinding, the system must respond to the unique needs and expectations of each user group.

4.5.6. Summary of Key Observations

Sentiments are largely positive or constructive, with clear suggestions for improving wayfinding and user experience. Repeated themes include the need for multilingual signage, clear restroom directions, reduced navigational confusion, and digital tools. Feedback shows a mix of emotionally driven comments and factual, solution-oriented suggestions, as reflected in varying subjectivity scores. The analysis captures a diverse demographic, dominated by young users, whose feedback can guide user-centered design improvements.

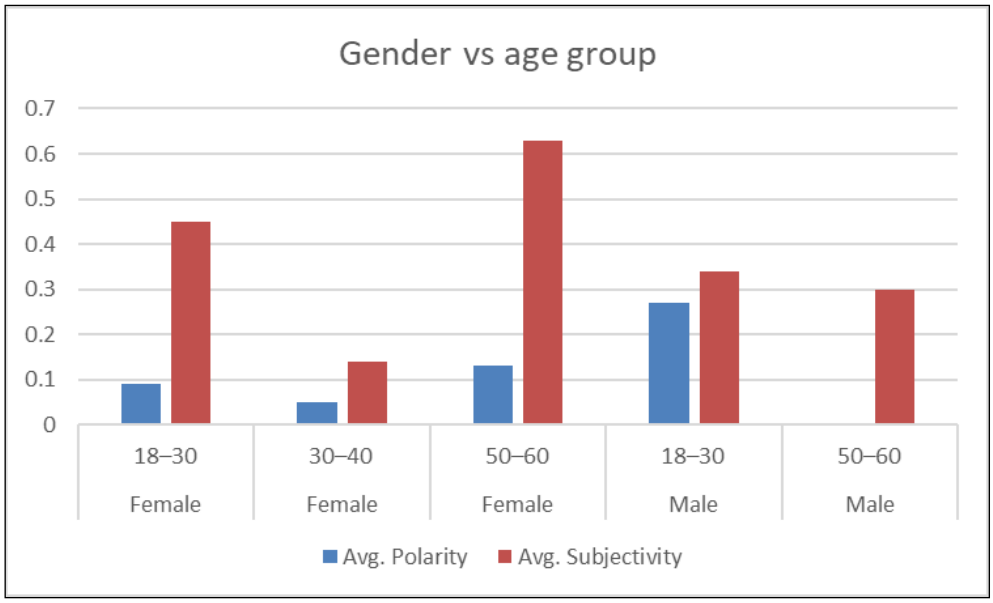

Figure 10. Survey participants' suggestions to improve wayfinding

Table 3. Sentiment and Subjectivity Analysis of their metro experience

User Group	Key Traits	Suggested Focus
Females (18–30)	High feedback volume, mixed sentiment, moderately subjective	Prioritize clarity in exits, multilingual signs, restroom signage
Males (18–30)	Positive sentiment, objective tone	Improve tech-based features like digital kiosks and apps
Females (50–60)	Lower comment volume, subjective tone	Simplify station navigation (fewer stairs/ups and downs)
Males 30–40	Fact-based feedback, low subjectivity	Focus on universal accessibility, tactile maps

5. Discussion and Recommendations

The analysis of Chennai Metro's wayfinding system reveals gaps when compared to global best practices. Like metro systems in London and Singapore, improvements in signage clarity, the introduction of interactive kiosks, and the integration of real-time navigation apps could enhance the overall user experience. The principles of cognitive psychology suggest that the metro system's wayfinding design should minimize cognitive load by using clear, easily processed information.

Respondents' preference for intuitive and simple tools aligns with the theory that cognitive maps—mental representations of the environment—should be as straightforward as possible [7]. Suggestions for Braille and Multilingual signage highlight the need for greater accessibility in the metro stations. The integration of tools that cater to passengers with disabilities, such as larger text signage and tactile paths, will create a more inclusive environment for all users. As a recommendation, we can have criteria like enhanced signage and visibility. Like placing additional signage at critical junctions, such as platform exits and transfer points, to always ensure clear direction. Implement multilingual and universally recognizable symbols to cater to international passengers and non-native speakers. Ensure all signage is well-lit, particularly at exits, elevators, and escalators. The other one could leverage technology. To develop and implement a mobile app that provides real-time navigation, train schedules, and information about metro routes. Introduce digital kiosks at stations to offer information on train schedules, platform changes, and wayfinding. Optimize station layouts using space syntax software to determine the most efficient pathways for passengers. Ensure that exits are well-marked and easy to identify from all areas of the station.

To align Chennai Metro's wayfinding with international best practices, this study reviewed relevant global standards, including Metrolinx's Wayfinding Design Standard (Canada) [26], APTA's Universal Design Guidelines (USA) [27], and MTC's Regional Transit Hub Signage Standards (California, USA) [28]. These frameworks emphasize user-first principles such as intuitive signage, consistent terminology, and multimodal integration. Key universal design elements—like perceptible information, multilingual and pictogram-based communication, and low physical effort—are fundamental to improving accessibility for all user groups. While this study relies primarily on passenger feedback, future phases will aim to integrate spatial tools and benchmarking audits.

In the interim, Chennai Metro can consider adopting scalable practices from these standards, such as progressive information disclosure, improved digital integration, and barrier-free navigation cues to enhance user comprehension and reduce cognitive load.

6. Conclusions

This study highlights significant user experience challenges in the Chennai Metro's wayfinding system, underscoring the importance of clear, intuitive design for efficient navigation. Passenger feedback reveals that while basic directional signage is effective, more advanced solutions such as multilingual and tactile signs, alongside digital wayfinding tools, are necessary to meet the needs of diverse user groups. The recommendation to improve station layouts and integrate real-time navigation apps aligns with best practices observed in other global metro systems, suggesting that such upgrades could notably enhance passenger satisfaction and reduce confusion.

Importantly, this research also emphasizes the need for improvements in accessibility, especially for passengers with disabilities. The incorporation of features like Braille signage and tactile pathways will create a more inclusive and navigable environment. Further studies should focus on the implementation of these proposed solutions and evaluate their impact on long-term user behaviour and station efficiency.

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