Evaluation of Walkability Using GIS: A Case Study of Pune Metro Stations

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Abstract—Despite substantial investments in upgrading metro infrastructure, the overall effectiveness of a public transit system can be significantly undermined if pedestrian access to metro stations is overlooked. Integrating pedestrian access into transit planning is essential to fully realize the benefits of metro investments and to boost ridership and system performance. Hence, the present study assesses the existing conditions of pedestrian walkways using GIS for spatial analysis. A case study was done at three metro station in Pune those were PCMC metro station, Ramwadi metro station and Nal Stop metro station. With PCMC metro station being named the metro station with highest footfall by Maha Metro Rail Corporation. The study focuses on a 500-meter radius around three metro stations PCMC, Nal Stop and Ramwadi with a practical walking distance from key transit points. The data was collected by field survey. Utilizing Geographic Information Systems (GIS) for spatial analysis, the approach assessed critical walkability factors, including safety, connectivity, comfort, and infrastructure quality. The study underscores that Ramwadi Metro Station has the highest share of good-quality footpaths 35.71%, indicating stronger pedestrian infrastructure. In contrast, PCMC Metro Station shows the greatest need for improvement, with 70.83% of footpaths in poor or barely acceptable condition. Nal Stop Metro Station presents a more balanced condition. The results provided a data-driven decision support tool that can guide urban planners and authorities in creating more pedestrian-friendly environments, thereby optimizing the integration of metro services with surrounding urban areas.

Index Terms—Geographic Information Systems (GIS), Pedestrian Infrastructure, Walkability, Metro Station, transit-oriented developments (TOD)

I. INTRODUCTION

The concept of pedestrian infrastructure and walkability near metro stations in Pune has gained significant attention due to the ongoing urban challenges and the implementation of metro projects. The growing need for transit-oriented development (TOD) has highlighted the importance of creating walkable environments that improve accessibility and sustainability. The rapid urbanization of Pune has led to greater dependence on private vehicles, resulting in heightened traffic congestion and pollution. This underscores the need for well-designed pedestrian pathways to promote the use of public transportation, particularly metro systems.

In transit-oriented developments (TODs), walkability serves as a core component that strengthens connectivity and fosters increased public transport usage. Within a 500-meter radius of such transit facilities, it is essential to prioritize the quality of pedestrian pathways to effectively encourage a modal shift from private vehicles to public transportation. Well-designed pedestrian environments, characterized by safe, accessible, and attractive walkways, play a pivotal role in achieving this shift. Additionally, urban development strategies that integrate high-density housing, mixed land use, and efficient public transit systems create vibrant, walkable neighborhoods that maximize the accessibility and utility of public transport. Such an approach helps mitigate the adverse effects of car-centric cities, including traffic congestion, air and noise pollution, road accidents, excessive land consumption, and the substantial social costs associated with private vehicle dependency. Urban development plans for Pune under the Smart City Mission include prioritizing pedestrian-friendly

corridors and ensuring safe, accessible routes to metro stations. With proposed metro lines in Pune, the government aims to promote transit-oriented development by reducing urban sprawl and traffic congestion while enhancing mobility through walking and public transport. A case study is done at three metro station in Pune those were PCMC metro station, Ramwadi metro station and Nal Stop metro station. With PCMC metro station being named the metro station with highest footfall by Maha Metro Rail Corporation. The study focuses on a 500-meter radius around three metro stations PCMC, Nal Stop and Ramwadi with a practical walking distance from key transit points. The study assesses the existing conditions of pedestrian walkways using GIS for spatial analysis. This study can guide urban planners and authorities in creating more pedestrian-friendly environments, thereby optimizing the integration of metro services with surrounding urban areas.

II. METHODOLOGY

1. Study Area
2. Pedestrian network design and Data collection
3. Allocation of scores
4. Thematic map of the walkability
5. Results and Conclusions

III. STUDY AREA

The study examines a 500-meter radius around three metro stations which are PCMC, Nal Stop, and Ramwadi in Pune to assess walkability. It aims to evaluate the pedestrian infrastructure and accessibility within a practical walking distance from key transit

points. This 500-meter buffer zone represents a typical walking range for commuters, making it an ideal area to assess the ease of access and quality of pedestrian pathways in proximity to public transportation. The analysis considers factors such as sidewalk availability, road safety, pedestrian crossings, traffic density, lighting, and the presence of essential amenities, all of which contribute to the overall walkability of the area.

IV. PEDESTRIAN NETWORK AND DATA COLLECTION

The pedestrian network is mapped using GIS software, with each segment of the network assigned a unique ID number. Data was collected by field survey. Field survey was done around 500m radius of PCMC metro station, Nal stops metro station and Ramwadi metro station.

Identification Of Pedestrian Infrastructure and Walkability Parameters

Safety, security, continuity, comfort, and livability are fundamental principles to be considered in the planning and design of pedestrian infrastructure, ensuring a safe and enjoyable walking experience [4]. A score ranging from 1 to 5 is assigned to each arc using an Excel database, based on its significance in terms of pedestrian flow. An arc with a score close to 5 is regarded as excellent, while a score below 1 indicates very poor quality. Additionally, GIS software can be utilized to generate a map depicting the quality of the arcs in relation to pedestrian flow.

Table 1 Walkability Indicator

Factors	Indicators	Points	Description
Practicability	Pedestrian	0	High pedestrian flow, narrow pavements, and obstacles.
		1	Low pedestrian flow, sufficient sidewalk width, and absence of obstacles
	Surface degradation	0	Presence of potholes or depressions, and deteriorated sidewalks
		1	Absence of potholes or depressions, and the pavement in good condition.
Pleasantness	Street furniture	0	Lack of bins, benches, and other street furniture elements

		1	Presence of bins, benches, and other street furniture elements
	Shelter for rain and sun	0	Lack of shelter from sun or rain
		1	Availability of shelters from sun or rain
	Green spaces	0	Lack of flower beds or green spaces
		1	Availability of flower beds or landscaped green spaces
	shops	0	Lack of shops
		1	Availability of shop windows
	Context of buildings, mixed land use, and urban planning	0	Deteriorated urban landscape (including damage to urban furniture, lack of cleanliness, presence of graffiti and inappropriate posters on buildings and buildings with degraded facades)
		1	Well-maintained urban landscape (with fully functional urban furniture, proper cleanliness, and the presence of well-preserved buildings)
Safety	Streetlights	0	Inadequate lighting or absence of streetlights
		1	Adequate and efficient street lighting in accordance with standards
	Traffic volume and vehicle speed	0	High speed (> 50 km/h) or high traffic volumes (> 1000 vph)
		1	In other instances,
		2	Low speed (< 30 km/h) and free flow (< 300 vph)
	Pedestrian protection barriers from vehicles	0	Lack of protective barriers
		1	Presence of protective barriers to shield pedestrians from vehicles
	Traffic control signal at intersections	0	Lack of traffic control signals at the intersection
		1	Presence of traffic control signals at the intersection, but with conflicts between different traffic component
		2	Traffic control signals that resolve conflict points between vehicles and pedestrians

V. RESULTS

GIS Based Thematic map of the walkability
- Dark green = very good (value between 0-1)
- Neon green = good (value between 1-2)
- Light green = barely acceptable (value between 2-3)
- Yellow = poor (value between 3-4)
- Dark red = very poor (value between 4-5)

Figure 1. PCMC Metro Station Walkability

Based on the Data and GIS analysis, it was observed that pedestrian footpaths near the PCMC metro station are predominantly in substandard condition. Specifically, 12.5% of thefootpaths are in a very poor state, while 25% are classified as poor. Additionally, about 33.33% of the footpaths are in barely acceptable condition, indicating limited usability and comfort for pedestrians. Only 8.33% of the footpaths are in good condition and considered favorable for walking. Meanwhile, 20.83% of the footpaths are in very good condition but still require routine maintenance to sustain their quality.

Figure 2. Ramwadi Metro Station Walkability

Based on the data and GIS analysis, it was found that near Ramwadi metro station, 21.42% and 14.28% of the pedestrian footpaths are in very poor and poor condition, respectively. Additionally, around 21.42% of the footpaths are in barely acceptable condition. Approximately 35.71% of the footpaths are in good condition and suitable for walking, while 7.17% are in very good condition and require regular maintenance

to preserve their quality. This data highlights that a significant portion of the footpath infrastructure requires improvement, with only about 43% currently in good or very good condition.

Figure 3. Nal Stop Metro Station Walkability

From the data and GIS analysis it is observed that only 5%, 10% of pedestrian footpath near Nal stop metro station is in very poor and poor condition respectively. Whereas around 40% of footpath is in barely acceptable condition. It is obtained that 20% of footpath is in good condition and favourable to walk. About 25% of footpath is in very good state and needs to be maintained.

A significant portion of the footpaths 40% are in barely acceptable condition, indicating room for improvement in pedestrian infrastructure. Only 15% of the footpaths fall under poor or very poor condition, which is relatively low compared to other metro station areas. With 45% of the footpaths in good or very good condition, the overall pedestrian environment near Nal Stop shows promise, but targeted upgrades are still necessary.

All in all, Ramwadi Metro Station stands out with the highest proportion of good-quality footpaths 35.71%, suggesting better overall pedestrian infrastructure. PCMC Metro Station has the largest share of poor and barely acceptable footpaths 70.83%, indicating a pressing need for upgrades. Nal Stop Metro Station presents a more balanced condition, with a relatively low percentage of footpaths in poor or very poor condition 15% and a notable 25% in very good condition. Across all stations, barely acceptable footpaths make up a significant portion, especially at Nal Stop 40% and PCMC 33.33%, pointing to general maintenance and quality challenges.

VI. CONCLUSIONS

The study has shown that across all stations barely acceptable footpaths make up a significant portion which indicates that these footpaths need maintenance so as the they can contribute to good quality footpath thereby enhancing the connectivity with the metro stations. PCMC metro station footpath needs more connectivity to metro station as only few areas are well connected to the metro station. Nal Stop metro station needs more maintenance as there is more degraded quality of footpath. Ramwadi metro station also need to repair their degraded footpath and provide street furniture like benches, bins, shelters.The study gives us the insight into existing pedestrian infrastructure.

The limitation of the study is that it is not valid for all metro station across Pune City. The following study can be carried out for all metro stations thereby serving as a valuable resource for urban planners and authorities in developing more pedestrian friendly environments.

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