MAINTENANCE STRATEGY FOR PERI-URBAN PEDESTRIAN INFRASTRUCTURE IN PIETERMARITZBURG CITY

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ABSTRACT

Socioeconomic factors, such as a high rate of unemployment and low income resulting in the inability to use public transport, coupled with the rising cost of living, have become core elements compelling pedestrians in peri-urban areas to opt for nonmotorized transport systems (NMTs). Peri-urban areas are nonurban locations directly adjacent to metropolitan areas that house a mixture of urban and rural populations, activities and infrastructure. Walking is one of the most sustainable modes of transport; it not only benefits the health and social interaction of users but also contributes positively to the environment by reducing the carbon footprint. However, the disregard of NMT infrastructure maintenance in most peri-urban areas in South Africa poses safety risks, forcing facility users to walk within roadways and possibly increasing the rate of pedestrian road accidents. A lack of maintenance further leads to defects such as uneven walkways, unsecured or broken manholes, malfunctioning traffic and streetlights, and missing road signs. Therefore, it is imperative to evaluate and develop maintenance plans to enhance the existing infrastructure and ensure sustainable, accessible and safer transport systems. A mixed-method research approach involving exhaustive site surveys of selected pedestrian walkways in peri-urban to urban areas and further investigation of existing maintenance strategies is proposed. The results will provide critical insights into measures to improve pedestrian walkway accessibility in peri-urban areas. Subsequently, a robust conceptual framework for maintenance strategies for NMT infrastructures in peri-urban areas is proposed.

Keywords: Non-motorized transport systems, Walking, Pedestrian infrastructure, Accessibility, Maintenance, Sustainability, Urban planning.

1. INTRODUCTION

Pedestrian safety is a critical concern in South Africa, particularly in rural areas where walking is the primary mode of transportation. Statistics indicate that pedestrian fatalities constitute approximately 35-40% of road deaths in South Africa (Albers *et al.*, 2010; Arendse *et al.*, 2012). According to the Road Traffic Management Corporation report (2021), KwaZulu-Natal (KZN) has experienced an increase in pedestrian fatalities, further proving that there are inadequate safe NMT facilities. Despite efforts to address this issue, there is a significant gap between the needs of pedestrians and the available pedestrian

infrastructure, such as safe walkways, pedestrian crossings, wheelchair-friendly ramps at crossings and bicycle lanes. Thus, there is a need for a comprehensive approach involving infrastructure improvement, pedestrian education and awareness, and the enforcement of road traffic laws. A holistic approach to determining the relationships among factors such as convenience, safety, accessibility, service cost, flexibility, and pedestrian walkway quality that influence pedestrian facility usage and the state of these facilities is needed.

The inadequacy of pedestrian facilities creates a gap in the connectivity of peri-urban and urban areas. Nonmotorized transport (NMT) systems can bridge the connectivity gap; however, NMT facilities in some areas are either non-existent or poorly maintained (Mokitimi & Vanderschuren, 2017). Peri-urban communities in some developing countries are immensely inundated by poor pedestrian facilities as a result of substandard construction and maintenance practices (Mutiawati *et al*. 2020). The provision of functional facilities for pedestrians in peri-urban areas should be prioritized because these facilities are crucial for ensuring the accessibility of everyday activities and facilitating daily commuting to and from work, school, public services, and religious and entertainment activities. The evident lack and poor standing of facilities visible in peri-urban areas is different from realities and experiences in urban areas, whose facilities are well maintained and functional.

Pedestrian facilities, particularly walkways, play a major role in connecting communities and facilitating safe and accessible mobility for individuals who either prefer walking or cycling as their main mode of transportation or who are captive to these modes. Rapid inflation and increased costs of living globally have resulted in more people choosing or being forced to walk as their regular mode of travel. The availability and quality of pedestrian walkways in South Africa’s peri-urban communities can significantly impact the liveability and sustainability of the city.

Various factors, such as convenience, safety, accessibility, service cost, flexibility, and pedestrian walkway quality, influence individuals' inclination to walk (Macioszek *et al*., 2023). However, in peri-urban communities, the leading factor influencing the need to walk is the cost factor, which is driven by the need to seek employment and commute to various places of employment. Therefore, there is an emerging need to provide and maintain adequate pedestrian facilities within peri-urban communities. A vast majority of pedestrians reside in peri-urban areas and rely on walking as their sole form of transport between home and work (Mokitimi & Vanderschuren, 2017). Hence, pedestrian facilities and walkways connecting peri-urban and urban areas are needed. It is imperative to fully invest in infrastructure that enables NMT usage. Such infrastructure could include the construction and proper upkeep of bike lanes, pedestrian walkways, and pedestrian crossings. These factors could improve the entire NMT system of a locality or city’s accessibility, mobility, and safety prospects, among other aspects. In addition to accessibility and improved mobility, safety is a major concern for NMTs, particularly in peri-urban communities. The development or improvement of existing facilities needs to include safety measures such as improving lighting, reducing speed limits, and providing safe pedestrian crossings.

Encouraging active transportation, such as walking and cycling, can help reduce traffic congestion, air pollution, and greenhouse gas emissions. Additionally, supporting low-income communities by providing affordable, safe, and accessible transportation options is essential. Collaboration with local municipalities, community organizations, and transport providers is crucial for the success of NMT initiatives. Stakeholders working together can

identify common goals, share resources, and develop effective strategies for promoting NMT (Vanderschuren *et al*., 2014).

This paper seeks to provide an in-depth examination of the current state of pedestrian walkways between peri-urban and urban areas and the impact of the lack of quality pedestrian facilities and maintenance plans in place. This study further proposes a workable strategy to ensure safe and functional pedestrian walkways and highlights useful insights for policymakers and stakeholders involved.

2. METHODOLOGY

The research objective was accomplished through the application of a mixed-method research approach, combining qualitative observations (e.g., condition and usability of the path) with quantitative measurements (e.g. width of walkways). This method encompassed an observational qualitative approach and the execution of a site survey (Slangspruit, Masons Mill, the Grange, Camps Drift area of Pietermaritzburg, KZN, South Africa) aimed at evaluating the present conditions and usability of pedestrian facilities. The selection of sites in this study was based on representative peri-urban areas in South Africa. The survey's primary goal was to enhance comprehension of user requirements and pinpoint deficiencies within the chosen route systems. The quantitative approach employed a measuring tape to assess the width and continuity of the pedestrian walkway and was compared with the recommended standards outlined by the South African Pedestrian and Bicycle Facility Guidelines, a directive issued by the Department of Transport (Department of Transport, 2015) (Table 1).

This comparison, along with the condition of the path, was graphically represented using ArcGIS mapping tools (Minhas & Poddar, 2017; Ahmed & Islam, 2017). Additionally, essential pedestrian amenities such as ramp access and lighting systems were scrutinized based on deficiencies (Minhas & Poddar, 2017). The comprehensive nature of this approach allowed for a thorough analysis of the existing conditions, ensuring a comprehensive understanding of the pedestrian environment. This methodological strategy facilitated the identification of areas requiring improvement and provided information for subsequent recommendations for optimizing pedestrian infrastructure. The utilization of measuring tools and a systematic examination of crucial facilities underscored the reliability and effectiveness of the mixed-method approach in achieving the research objectives.

Table 1: Minimum sidewalk and walkway width (Department of Transport, 2015)

Description	Minimum width (m)
Sidewalks/walkways with buffer strip	
Minimum width	1,5
Desirable width	1,8
Buffer strip width	0,6
Sidewalks/walkways without buffer strip	1,8
Sidewalks in Business Centres	2,5 – 3,5m

3. RESULTS AND DISCUSSION

3.1 Current Status Quo of Peri-Urban to Urban Pedestrian Facilities

This study focused on the peri-urban areas around Pietermaritzburg, where NMT facilities and maintenance facilities are desirable. Many of these areas lack functional facilities,

while some of those areas are disarrayed. Poor maintenance has resulted in some areas having a minimal walking area and numerous manholes on the paths without manhole covers.

3.1.1 Walkway Width and Surface Analysis

During the site survey, a walk-through was conducted on selected walkways connecting the peri-urban and urban areas. All aspects, such as the width of the walkway, its state, defects, and safety aspects, were noted. Most of the walkways were not of an acceptable width, partially due to damage and lack of maintenance, which resulted in overgrowth of vegetation blocking parts of the walkway. In some areas, the walkway was a mere 0.6 m in width, which does not allow two people to adequately pass each other without one having to move onto the roadway. The problem areas that posed safety and fall risks, such as open manholes, were noted, as were the areas that completely lacked any NMT facilities, as shown in Figure 1. Moreover, the study revealed that most essential utilities, including manhole covers and drainage grates (Figure 1B2), were conspicuously absent. This presents a tangible hazard (Figures 1B1 and 1B3), increasing the potential for accidents involving pedestrians.

Additionally, based on the universal design principle, walkways should accommodate the needs of different types of pedestrians, such as those using walking sticks, wheelchairs, or crutches (Vanderschuren *et al.*, 2015). The average width required by these pedestrians ranges from 700 mm to 900 mm, depending on the type of mobility aid. However, the site survey revealed that the walkway width was below this range in many areas, partly due to damage but also due to obstructions in the middle of the walkway.

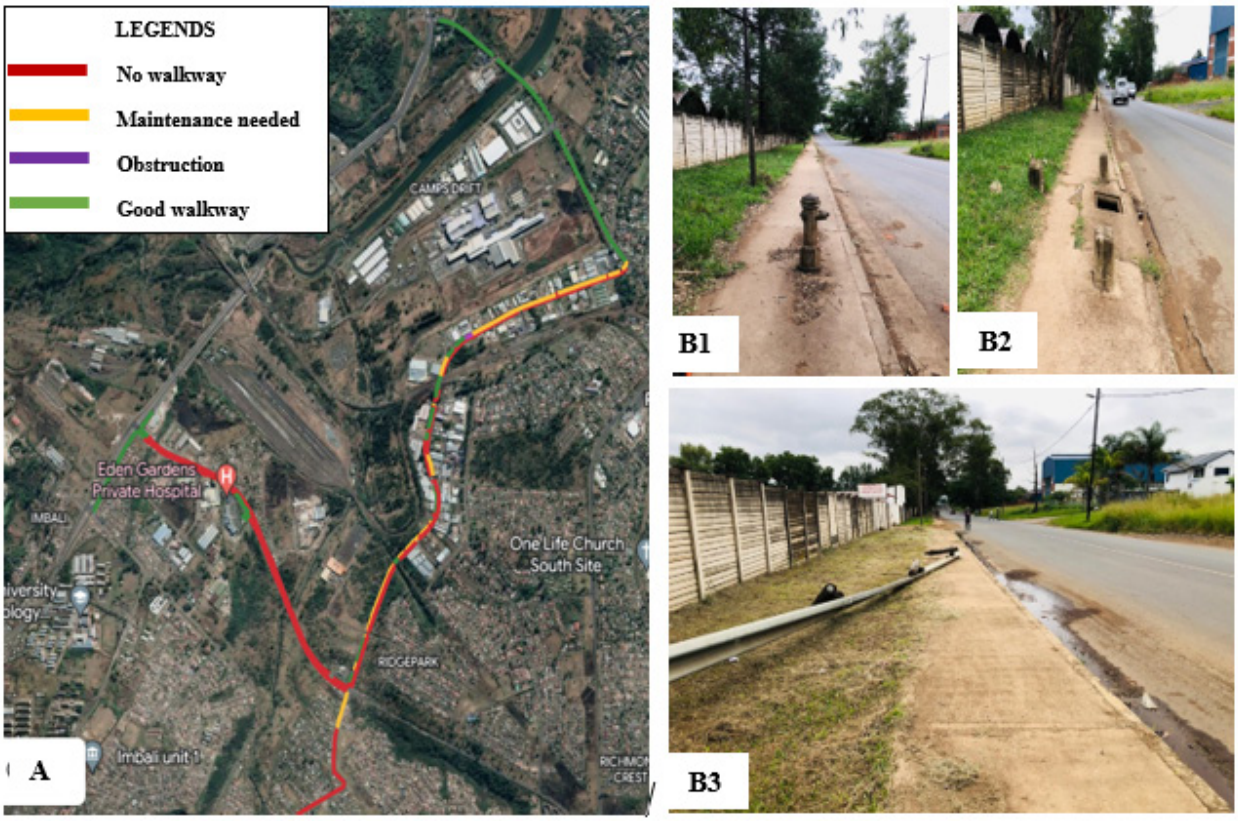

Figure 1: Current state of pedestrian facility A. Depicts the surveyed walkway, with sections highlighted in red, yellow, purple, and green indicating no walkway, inadequate width, obstruction, and adequate width, respectively; B. Details of the current problem on the walkway (Source: Authors Compilation)

The analysis revealed that the current conditions of pedestrian walkways along these routes are inadequate and require significant maintenance. Notably, these paths do not meet the minimum standards stipulated in the guidelines. This inadequacy increases the risk of accidents, putting pedestrians in perilous situations where traffic accidents or near misses become more likely. Reinforcing this concern is the analysis, which suggests that for approximately 50% of the route, pedestrians are forced to walk on road pavement, which also creates leverage for pedestrians to disregard traffic rules (Ogombe, 2016). This direct road use significantly increases the chances of interactions and potential collisions between vehicles and pedestrians, especially during rush hours.

3.1.2 Other Facilities – Manhole Cover, Lighting, and Missing Links

Furthermore, the site survey identified several safety and fall hazards, such as open manholes, along the walkway. The missing manhole covers may be due to theft of the cast iron covers or the breakage of the concrete covers to retrieve the steel rebars (Bele, 2022). These hazards were exacerbated by the lack of lighting, which made it difficult for pedestrians to see and avoid them (Albers *et al*., 2010). The site survey also showed that walkway conditions varied significantly between urban and peri-urban areas. Most manholes present danger to pedestrians because walkways lack sufficient lighting, vegetation overgrowth and reduced visibility, and manholes open and create fall hazards for users (Bele, 2022). These factors cause pedestrians to prefer walking on narrow streets where they avoid the obstacles and risks of using walkways but increase the likelihood of motor vehicle accidents.

The urban areas had wider walkways, adequate streetlights, and walkways on both sides of the road, while the peri-urban areas had narrower walkways, no lighting, and several gaps in the walkway. These findings indicate that the pedestrian walkways in the study area do not meet universal design standards and require significant improvement. During the site survey, it was noted that, closer to the urban areas, the width of the walkways was significantly wider, with adequate streetlights and walkways on both sides of the road, as opposed to being closer to the peri-urban areas where there was no lighting; additionally, the walkways were smaller and had several gaps between them.

Overall, the analysis underscores the intricate relationships among infrastructure deficiencies, pedestrian safety, and the potential for motor vehicle accidents. Visual representations, such as those shown in Figure 1, reinforce the urgency of targeted improvements, guiding policymakers toward creating universally accessible and safe pedestrian environments across diverse urban landscapes.

3.2 Conceptual Framework - Maintenance Strategies for Pedestrian Facilities in Peri Urban Areas

The maintenance strategies framework plan is a thorough plan that addresses the maintenance and improvement of pedestrian infrastructure in locations that connect rural and urban communities (Kaiser & Barstow, 2022). This framework meticulously outlines routine, specific, emergency, and periodic maintenance strategies (Mostafa, 2018) to combat challenges such as walkway width discrepancies, safety hazards, and inadequate lighting (Albers *et al*., 2010) (Figure 2). This conceptual framework seeks to assist urban planners, policymakers, and local authorities in developing focused interventions to guarantee the longevity, safety, and accessibility of peri-urban pedestrian walkways, thereby promoting the peaceful coexistence of urban and rural environments. This is accomplished by fusing theoretical underpinnings with real-world applications.

3.2.1 Routine Maintenance for Pedestrian Facilities

Routine maintenance plays a pivotal role in sustaining the functionality and safety of pedestrian walkways in peri-urban areas. This type of maintenance involves regular inspections and minor repairs to address immediate issues and prevent further deterioration (Mostafa, 2018; Robertson *et al*., 2018). For the identified deficiencies, such as damaged walkway sections, overgrown vegetation, and missing manhole covers, a routine maintenance strategy entails scheduled inspections and prompt rectification. Regular clearing of vegetation, repairing damaged walkway surfaces, and replacing missing manhole covers are essential components of routine maintenance to ensure a consistently safe and accessible pedestrian infrastructure.

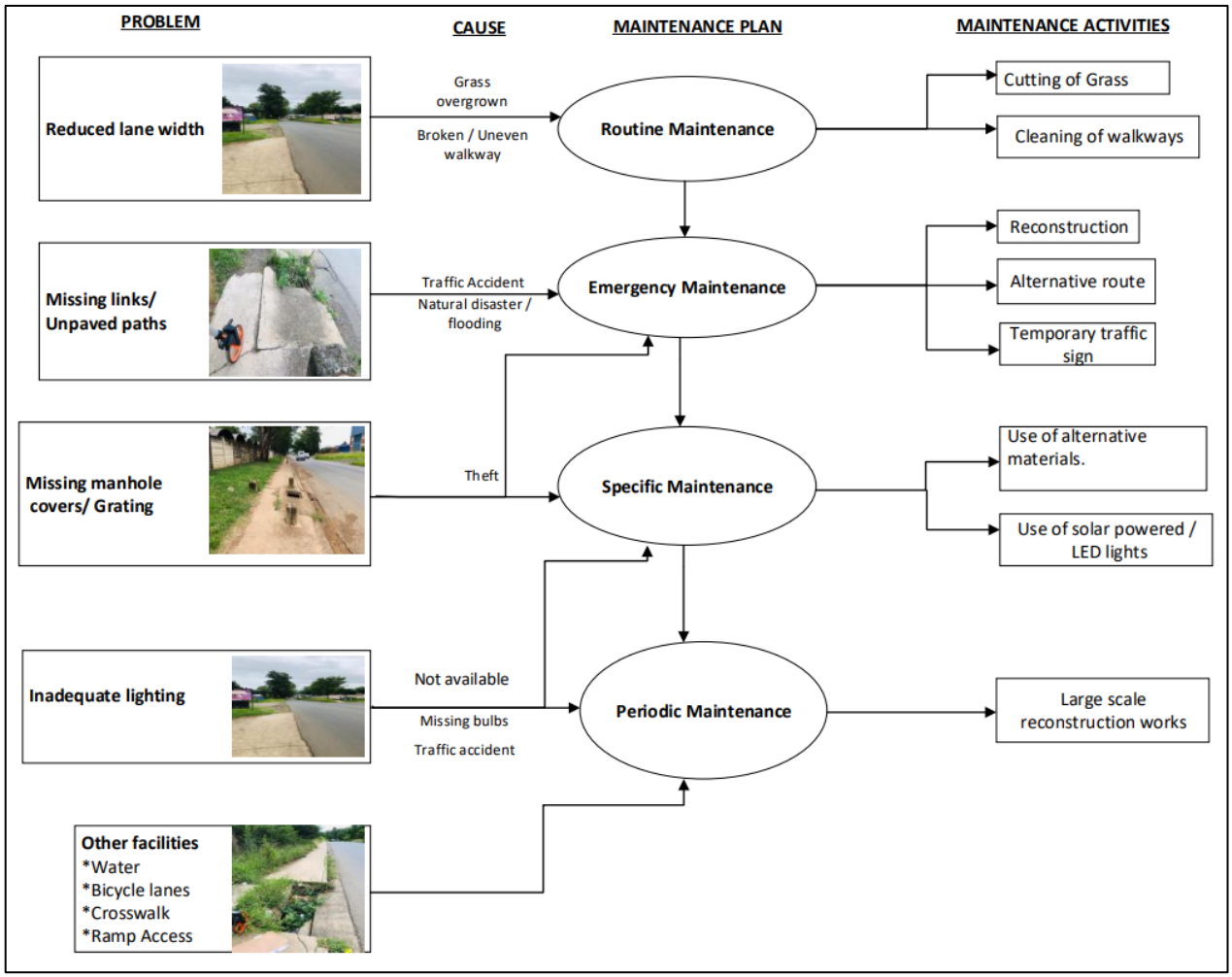

Figure 2: Conceptual Framework for the Maintenance of Pedestrian Facilities (Source: Authors' compilation)

3.2.2 Emergency Maintenance for Pedestrian Facilities

Emergency maintenance is crucial for addressing unforeseen issues that pose immediate threats to pedestrian safety. In the context of peri-urban walkways, this could involve swift responses to critical situations such as sudden collapses in walkway integrity, unexpected obstructions, or severe damage caused by natural disasters, especially in the case of wet regions in South Africa. Establishing an emergency response protocol, including a rapid assessment of the situation and immediate corrective actions, ensures the prompt restoration of safe pedestrian passages in emergencies (Mostafa, 2018). This type of maintenance is essential for mitigating risks and preventing accidents in high-impact situations.

3.2.3 Specific Maintenance for Pedestrian Facilities

Specific maintenance targets the identified shortcomings revealed during the site survey. This tailored approach involves addressing specific issues in a targeted manner. For instance, specific maintenance actions may include repairing damaged sections of walkways, installing adequate lighting to enhance visibility, and implementing measures to prevent theft or breakage of manhole covers. By focusing on the unique challenges identified in peri-urban areas, specific maintenance strategies aim to rectify deficiencies with precision, contributing to an overall improvement in the safety and usability of pedestrian facilities.

3.2.4 Periodic Maintenance for Pedestrian Facilities

Periodic maintenance involves comprehensive, scheduled interventions to address broader issues and prevent long-term degradation (Mostafa, 2018). It goes beyond routine inspections, encompassing in-depth assessments and strategic upgrades. For peri-urban pedestrian walkways, periodic maintenance could include resurfacing entire sections, upgrading lighting infrastructure, and implementing measures to enhance overall walkway resilience. This proactive strategy aims to extend the lifespan of the infrastructure, aligning it with long-term sustainability goals. By adopting periodic maintenance, authorities can address systemic challenges and implement strategic improvements that contribute to the longevity and efficiency of pedestrian facilities.

Overall, a multifaceted maintenance strategy is essential for addressing the identified deficiencies in peri-urban pedestrian walkways. Routine maintenance ensures ongoing upkeep, unique maintenance targets; emergency maintenance responds promptly to unforeseen threats; and periodic maintenance addresses broader issues for long-term sustainability. Implementing a comprehensive maintenance plan is critical for creating safer and more accessible environments for pedestrians in peri-urban areas, aligning with the overarching goal of enhancing urban infrastructure and ensuring the well-being of the community. However, South Africa does not have readily available funds to implement all NMT infrastructure requirements and improvements. The government will, therefore, have to prioritize identified projects. Funding should be provided first in areas where the need is the highest and where the largest number of people will benefit.

The NMT design guidelines (Vanderschuren *et al*., 2014) emphasize universal access by promoting equitable, flexible, simple, and intuitive facilities. Ensuring perceptible information, error tolerance, low physical effort, and appropriate size are crucial. Processes for the ideal situation involve government standards, funding prioritization, community route identification, stakeholder engagement, safety measures, effective maintenance teams, and the use of waste-resistant materials such as polymers or recycled waste plastic for manhole covers. These measures collectively contributed to the development of fully functional NMT facilities with broad accessibility and safety considerations.

4. CONCLUSION

In conclusion, this study examined the current conditions of pedestrian walkways in peri-urban areas around Pietermaritzburg. The key findings of the study include that 50% of the routes have inadequate walkway widths, hazards such as open manholes, and a lack of lighting on the route. This study aims to provide useful insights for policymakers and stakeholders to identify and address the areas that need immediate improvement. The study also established a baseline for future planning and development strategies to enhance pedestrian pathways within the city and to ensure that adequate maintenance

strategies are in place. The study used a mixed-method approach through a site survey to collect and analyse data on pedestrian walkways.

The data revealed pervasive inadequacies in the existing pedestrian infrastructure. The functionality and safety of current facilities are severely compromised by these shortcomings. The continued use of these deteriorated facilities has led to serious threats not only to pedestrians but also to other road users. The study showed that the current state of the facilities did not meet the minimum standards set by the Department of Transport's guidelines (Department of Transport, 2015). However, pedestrians still use these facilities due to the lack of alternatives and because of the dependence on their chosen mode of transport. Furthermore, the poor quality of the facilities did not necessarily cause a shift in transportation means but rather exposed the users to increased risks. These risks included choosing alternate routes to avoid hazardous infrastructures or walking on vehicle lanes, which heightened the potential for collisions with vehicular traffic. Some of the consequences of inaction include further deterioration of facilities and an increase in pedestrian fatalities, which can negatively impact the environment due to erosion.

To summarize, this study highlights the pivotal role of pedestrian walkways in connecting communities and ensuring safe and accessible transit and emphasizes the urgent need for sustained improvements and investments in pedestrian facility maintenance. This paper proposes proactive measures through the conceptual framework, such as periodic cleaning of pavements, clearing of roadside gutters and manholes, and consistent maintenance and repair of damaged pavements. Additionally, this study advocates for the implementation of the proposed maintenance framework by increasing funding for pedestrian infrastructure and encouraging the participation of stakeholders, such as community involvement in reporting and mitigating hazards. Overall, implementing these solutions can significantly improve the current challenges, enhance pedestrian safety, and improve the user experience.

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