

Study on Supporting Facilities for the Attraction of the Aek Kanopan Outer Ring Road Urban Development

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Abstract

This study aims to analyze the supporting facilities that contribute to the attractiveness and functionality of the Aek Kanopan Outer Ring Road as part of urban area development. The research employs a qualitative method using field studies, direct observations, and interviews with relevant stakeholders and local communities. The findings reveal that supporting facilities such as sidewalks, bicycle lanes, street lighting, drainage systems, green spaces, rest areas, and MSME facilities are mostly unavailable or not functioning optimally. This condition affects the comfort, safety, and overall appeal of the area. The main constraints in developing these facilities include technical, social, and institutional factors. Effective and sustainable development of supporting facilities through integrated planning, community participation, inter-agency coordination, and environmentally friendly principles has proven to enhance the area's attractiveness, road function, and local economic potential. This study provides strategic recommendations for local governments and urban planners to improve the quality of public spaces and urban transportation corridors in Aek Kanopan.

Keywords: Supporting Facilities, Area Attractiveness, Outer Ring Road, Urban Development, Sustainability

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Introduction

The development of transportation infrastructure represents one of the most essential aspects of driving economic growth and ensuring equitable regional development. Roads, as the main medium for the movement of people and goods, play a strategic role in supporting the social, economic, and cultural activities of communities [1]. In this context, the existence of an urban outer ring road serves as a solution to alleviate traffic congestion in city centers, enhance inter-regional connectivity, and accelerate the distribution of goods and services [2];[3].

The Aek Kanopan area, as the capital of Labuhanbatu Utara Regency, has experienced rapid economic and social growth in recent years. The increase in population, the expansion of commercial areas, and the growing volume of vehicles have all contributed to worsening traffic congestion in the city center. This condition necessitates the development of alternative transportation infrastructure capable of distributing traffic flow away from the city center one of which is the Aek Kanopan Outer Ring Road [4].

However, the effectiveness of an outer ring road is determined not only by the quality of its main road but also by the availability and feasibility of supporting facilities along its corridor. Facilities such as street lighting, traffic signs, bus stops, rest areas, drainage systems, sidewalks, and access to public amenities play a significant role in enhancing the attractiveness, comfort, and safety of road users [3];[5]. The absence or inadequacy of these facilities often leads to suboptimal utilization of the ring road, potentially creating accident-prone areas and reducing the overall appeal of the route [4].

Beyond its transportation function, supporting facilities also have economic and social impacts. A well-equipped outer ring road can serve as a new economic corridor, attract investment, and stimulate commercial activity in its surrounding areas (1,2). Conversely, poorly managed facilities can hinder regional growth, making the area less appealing to both residents and business actors [5].

Table 1. Supporting Facilities for Enhancing the Attractiveness of the Aek Kanopan Outer Ring Road

No.	Type of Supporting Facility	Description / Technical Specifications	Function and Benefits
1	Continuous Sidewalks and Pedestrian Paths	Sidewalk width according to minimum standards (1.5–2 meters), non-slip surface, accessible ramps for persons with disabilities, and continuous connections between zones.	Improves pedestrian comfort, supports nonmotorized mobility, and creates a pedestrianfriendly urban image.
2	Dedicated Bicycle Lanes	One-way or two-way lanes with clear markings and physical separation from motorized lanes.	Encourages eco-friendly transportation, enhances cyclist safety, and reduces air pollution.
3	Rest Areas and MicroPlazas	Small open spaces with benches, shade trees, park lighting, and trash bins.	Provides rest points and social interaction areas, enhancing the aesthetic and social quality of the corridor.
4	Thematic Street Lighting and Informative Signage	Energy-efficient lamps with thematic design and clear directional or location signage.	Improves nighttime safety, strengthens the visual identity of the corridor,

and assists users in orientation.

5	Drainage Systems and Linear Green Spaces (Street Trees, Bioswales)	Surface water drainage integrated with roadside vegetation.	Reduces flooding, improves air quality, and enhances the visual and thermal comfort of the street.
6	Traffic Signs, Crosswalks, and Intersection Design	Reflective traffic signs, crosswalks at key points, and safe intersection geometry design.	Enhances pedestrian and driver safety and ensures smoother traffic flow.
7	Regulated MSME / Street Vendor Facilities	Semi-permanent stalls with uniform design located at strategic points without obstructing sidewalks.	Boosts local economy, provides business space for small enterprises, and maintains area orderliness.

The development of the Aek Kanopan outer ring road is not merely intended as a transportation corridor to reduce congestion in the city center; it also holds strong potential to enhance the attractiveness of the area when supported by well-planned infrastructure [6]. Given Aek Kanopan's natural tourism potential and growing local trade activities, the outer ring road could serve as a new economic artery connecting key nodes of activity, facilitating goods distribution, and improving access for both tourists and residents [7].

Visually and functionally, a ring road designed with high-quality streetscape elements such as continuous pedestrian pathways, green buffers, bicycle tracks, and well-designed rest areas can form an "attractive corridor" that invites people to pass through and engage with the area [8]. Facade arrangements, artistic lighting, thematic signage, and small lookout points can strengthen the corridor's identity as an integral part of Aek Kanopan's urban character, rather than merely a transport artery [9].

From a functional perspective, strong pedestrian networks along the main road serve to connect different zones, promote non-motorized mobility, extend users' dwell time in public spaces, and support microeconomic activities such as kiosks, coffee carts, and MSMEs [10]. Integrating facilities such as adequate drainage, universally accessible sidewalks, safe lighting, waste bins, and small green areas will improve comfort and safety, thereby encouraging greater utilization of the ring road as both an alternative route and a public space [11];[12].

Research Urgency

The urgency of this research lies in the strategic role of the Aek Kanopan Outer Ring Road as infrastructure that not only alleviates traffic congestion but also serves as a key driver of new urban growth within Labuhanbatu Utara Regency [13]. With increasing economic activity and population mobility, the need for safe, comfortable, and visually appealing road infrastructure has become increasingly critical [14].

In the context of regional development, outer ring roads without adequate supporting facilities often lead to various problems such as low utilization rates, spatial disorder, and a lack of added value for surrounding communities [9]. Hence, this study is essential to identify and analyze which supporting facilities can strengthen the corridor's function and attractiveness, contributing to improved urban environmental quality and local economic activity (15).

Beyond the transportation aspect, this study also addresses spatial planning and sustainable urban development concerns. Outer ring roads designed with public amenities such

as pedestrian paths, bicycle lanes, green spaces, MSME zones, and effective drainage systems can foster more inclusive, pedestrian-friendly, and climate-adaptive urban environments [8]. This aligns with the Sustainable Development Goals (SDGs), particularly Goals 9 and 11, which emphasize resilient infrastructure and sustainable cities [16].

Furthermore, the findings of this research are expected to provide practical recommendations for local governments in policymaking related to urban transportation infrastructure development particularly in prioritizing investments in effective and community-oriented supporting facilities (8). Thus, this study carries strategic value not only in academic discourse but also in practical regional development, as it contributes to improving citizens' quality of life and enhancing Aek Kanopan's competitiveness as a new growth center in Labuhanbatu Utara [17].

Based on these considerations, it is necessary to conduct a study on the supporting facilities that enhance the attractiveness of the Aek Kanopan Outer Ring Road. This study aims to assess the extent to which the existing facilities support the optimal functioning of the ring road, identify challenges in their development, and provide strategic recommendations for improving the corridor's quality and appeal (18). The results are expected to serve as a basis for local governments in planning sustainable, safe, and community-oriented transportation infrastructure (11).

Problem Identification

Based on the background and urgency described above, several key issues have been identified as the basis for conducting this study:

1. The Aek Kanopan Outer Ring Road has not yet functioned optimally as an alternative route to reduce traffic congestion in the city center due to the limited availability of supporting facilities that ensure user comfort and safety.
2. The lack of pedestrian and bicycle facilities accommodating non-motorized mobility reduces accessibility and the corridor's attractiveness as a public space friendly to the community.
3. The absence of adequate lighting, informative signage, and organized intersections results in low levels of safety and security for road users, particularly at night.
4. Poor drainage conditions around the ring road lead to potential flooding or pavement damage, decreasing user comfort.
5. The lack of integrated green spaces and rest areas (micro-plazas) within the corridor design reduces the aesthetic and visual quality of the area.
6. The absence or poor management of community economic facilities (MSME/street vendors) along the corridor limits the potential for local economic growth and social activity.
7. The lack of design standards or guidelines for supporting facilities adapted to Aek Kanopan's characteristics results in fragmented development and poor spatial integration.

Research Questions

Based on the background, urgency, and problem identification previously discussed, the research questions in this study can be formulated as follows:

1. What is the current condition of the supporting facilities along the Aek Kanopan Urban Outer Ring Road in terms of comfort, safety, and the overall attractiveness of the area?
2. Which supporting facilities are not yet available or have not functioned optimally in supporting the development of the Aek Kanopan Urban Outer Ring Road?
3. How does the availability of supporting facilities influence the enhancement of the attractiveness and functional performance of the area along the Aek Kanopan Urban Outer Ring Road?
4. What are the inhibiting factors in the development of supporting facilities along the Aek Kanopan Outer Ring Road, viewed from technical, social, and institutional aspects?

5. What strategies can be implemented to develop effective and sustainable supporting facilities that enhance the attractiveness and functionality of the Aek Kanopan Urban Outer Ring Road as part of the broader urban development framework?

Literature Review

2.1. The Concept of Walkability and Pedestrian Behavior

Walkability is defined as the degree of ease, comfort, and safety offered by an environment for walking. Built-environment factors such as the continuity and width of sidewalks, surface quality, accessibility for people with disabilities, pedestrian crossing safety, connectivity between activity nodes, and thermal or visual comfort all influence people's tendency to choose walking for daily mobility or recreation. The walkability index serves as a quantitative tool to assess these conditions and has been shown to positively correlate with walking frequency and public health outcomes.

In this study, walkability indicators will be used to evaluate the quality of sidewalks, pedestrian continuity, accessibility for persons with disabilities, and the connectivity of pedestrian paths to key activity points (such as markets, bus stops, and public facilities) along the Aek Kanopan Outer Ring Road.

2.2. Bicycle Lanes (Active Mobility) and Safety Design

Contemporary literature emphasizes that the success of bicycle lanes in promoting active mobility depends on physical separation (protected or separated bike lanes). Physically separated lanes enhance the perception of safety, reduce conflicts between cyclists and motorized vehicles, and can lower the risk of serious accidents on urban routes. However, their effectiveness depends on detailed design aspects such as lane width, buffers, intersection treatments, and network continuity [19].

The evaluation of bicycle lanes along the Aek Kanopan corridor must therefore consider the type of separation (painted vs. physically protected), lane continuity, and intersection management to ensure user safety. Accident or near-miss data, along with user perception, will serve as key evaluation metrics.

2.3. Streetscape, Micro-Plazas, and Corridor Identity Formation

Streetscape elements (street furniture, shade trees, paving, benches, and lighting design) and micro-plazas function as *quality-of-place* components that increase dwell time, social interaction, and street-side economic activity. Modern public space theory suggests that urban corridors designed not only as transit routes but also as spaces for visual and recreational experience enhance the overall attractiveness of an area. Well-designed streetscapes also play an important role in shaping the visual identity of a corridor.

This study will assess the existence and quality of streetscape elements across corridor segments, linking the availability of facilities (benches, micro-plazas, and shading) to public space utilization intensity and local economic potential.

2.4. Green Infrastructure and Drainage Management (Bioswales, Street Trees)

Green Infrastructure (GI) in urban corridors including bioswales, rain gardens, and street trees serves multiple functions: reducing surface runoff (stormwater management), improving the microclimate (cooling effect), and enhancing corridor aesthetics. The “green streets” approach integrates drainage systems with open spaces, thereby reducing flooding while improving pedestrian comfort. Systematic reviews have shown that GI effectively reduces pressure on conventional drainage infrastructure when properly designed and maintained.

The analysis includes mapping flood-prone points, assessing the presence and condition of existing GI, and exploring the potential integration of bioswales and street trees along the Aek Kanopan corridor with specific attention to long-term maintenance aspects.

2.5. Informal Economy: MSMEs and Street Vendors (PKL) in Street Spatial Planning

Street vendors play a vital role in local economic dynamics and street life. Post-2019 literature emphasizes the need for inclusive spatial management models through zoning, uniform kiosk design, and participatory mechanisms to maintain local economic sustainability without compromising orderliness and walkability. Successful governance models involve collaboration among stakeholders, including vendors, local governments, and communities.

This study will map the distribution of street vendors along the corridor, evaluate their impact on sidewalks and walkability, and propose spatial management options suited to the local context of Aek Kanopan.

2.6. Street Lighting, CPTED, and Perception of Safety

The CPTED (Crime Prevention Through Environmental Design) principle recognizes lighting as a key intervention to reduce crime and enhance safety in public spaces at night. Experimental and field studies have demonstrated that improving lighting quality can decrease crime rates and enhance residents' sense of safety provided it is supported by sound environmental design and regular maintenance.

Measured indicators include illumination levels (lux), lighting uniformity, maintenance conditions, and user perceptions of nighttime safety along the corridor. Recommendations will incorporate CPTED principles and energy efficiency considerations.

2.7. Policy Integration, Public Participation, and Implementation Approach

The success of an attractive urban corridor development requires cross-sectoral integration (transportation, spatial planning, environment, and local economy) and a participatory approach. Recent literature recommends the use of pilot projects, *before-and-after* monitoring of usage indicators, and design iteration based on stakeholder feedback as effective implementation strategies.

This study will propose a governance framework encompassing design guidelines, maintenance schemes, and mechanisms for engaging local communities and businesses as part of the implementation strategy for Aek Kanopan.

2.8. Conceptual Framework

The availability and quality of supporting facilities (sidewalks, bicycle lanes, streetscape and micro-plazas, green infrastructure/drainage, lighting, and vendor management) influence corridor attractiveness (user perception, intensity of use, dwell time, and economic activity). Local policies, drainage conditions, and community participation act as moderating factors determining the effectiveness of interventions.

3. Research Methodology

3.1. Type and Approach of Research

This study employs a descriptive qualitative approach aimed at gaining a deep understanding of the condition, function, and role of supporting facilities in enhancing the attractiveness of the Aek Kanopan Urban Outer Ring Road. According [20], qualitative research is an approach used to explore and understand meanings derived from social or human problems. This approach emphasizes a deep comprehension of the context and phenomena observed in the field.

Furthermore, [21] explains that qualitative research seeks to understand participants' behavior, perceptions, motivations, and actions through holistic and naturalistic inquiry, with the researcher serving as the main instrument.

Accordingly, this study focuses on exploring existing conditions, community perceptions, and stakeholder views regarding supporting facilities that influence the attractiveness of the area surrounding the Aek Kanopan Outer Ring Road.

3.2. Research Location and Period

The research was conducted along the Aek Kanopan Urban Outer Ring Road, located in Labuhanbatu Utara Regency, North Sumatra. This location was selected purposively as it serves as a key interregional connector with high urban development potential but lacks adequate supporting facilities.

The research was carried out from August to November 2025, covering stages of field observation, interviews, documentation, and data analysis.

3.3. Data Sources and Types

Data Types

1. Primary Data: obtained through direct field observation and in-depth interviews with key informants, including officials from the Department of Public Works and Spatial Planning (PUPR), Bappeda, local community members, and MSME actors.
2. Secondary Data: collected through literature reviews, spatial planning documents, technical reports, and previous relevant research.

Data Sources

According to Miles, Huberman, and Saldaña (2020), data sources in qualitative research include people, places, and documents that provide essential information related to the phenomenon studied. The main data sources for this study include:

1. Local government agencies (Bappeda, Department of Transportation, and PUPR Office)
2. Local road users and MSME actors
3. Spatial planning documents (RTRW, RDTR) and infrastructure development reports

3.4. Data Collection Techniques

Data collection was carried out using the following methods:

1. Field Observation
Observation was conducted to identify the existing condition of supporting facilities such as sidewalks, bicycle lanes, lighting, drainage, and streetscape elements. According to [19], field observation in qualitative research helps researchers understand the physical, social, and cultural context of the study area.
2. In-depth Interviews
Interviews were conducted with key informants possessing knowledge and direct involvement in area development. [22] explain that qualitative interviews aim to obtain narrative data and deep insights into the informants' lived experiences.
3. Documentation
Documentation involved collecting photographs, maps, technical reports, and planning documents related to the supporting facilities of the outer ring road. Bowen (2019) emphasizes that documents are crucial in qualitative research as they help confirm and strengthen field findings.

3.5. Data Analysis Technique

Data analysis was carried out interactively and continuously, beginning during data collection and continuing through to conclusion drawing. The analytical model used follows [23] consisting of three main stages:

1. Data Reduction: selecting, focusing, and simplifying field data to identify main themes related to supporting facilities and corridor attractiveness.
2. Data Display: presenting findings in the form of tables, concept maps, and descriptive narratives showing relationships among supporting facility aspects.
3. Conclusion Drawing/Verification: developing preliminary conclusions and verifying them through data triangulation and key informant confirmation.

3.6. Data Validity

To ensure data validity, this study applies triangulation techniques, which involve comparing and confirming findings from multiple sources and methods. [24] identify four types of triangulation: source, method, researcher, and theory triangulation.

In this study, triangulation was conducted by:

1. Comparing observation and interview results with official documents.
2. Engaging multiple key informants from different institutions.
3. Confirming findings with relevant theories and prior studies.

3.7. Research Stages

The stages of this research include:

1. Preparation Stage: literature review, site determination, and instrument design.
2. Data Collection Stage: field observation, interviews, and documentation.
3. Data Analysis Stage: data reduction, display, and verification of findings.
4. Reporting Stage: preparation of findings and recommendations for developing supporting facilities for the Aek Kanopan Outer Ring Road.

Results

4.1 Existing Condition of Supporting Facilities along the Outer Ring Road of Aek Kanopan Urban Area

Comfort Aspect

Based on field observations and interviews with local residents, the existing supporting facilities along the Outer Ring Road of Aek Kanopan remain inadequate in terms of user comfort. Generally, the road width is sufficient to accommodate the flow of four-wheeled and two-wheeled vehicles; however, pedestrian facilities such as sidewalks and pedestrian lanes are not yet fully available. Several segments are still characterized by earthen or grassy shoulders, making them uncomfortable to traverse, particularly during the rainy season. Furthermore, there are no separate bicycle lanes, forcing cyclists to share space with motorized vehicles reducing both comfort and safety for non-motorized users.

From a visual-environment perspective, spatial organization along the corridor has not been optimized, as vacant lots, unmanaged vegetation, and the absence of green open spaces or landscape elements diminish the visual comfort of road users. Supporting amenities such as benches, small rest areas (micro-plazas), and shade trees are also lacking, leaving users without comfortable resting points. This condition indicates that the area has not yet functioned as an urban public space capable of supporting community social activities.

Safety Aspect

In terms of safety, it was found that public street lighting (PJU) remains limited in several sections. During nighttime, several areas, particularly at curves and intersections, are poorly illuminated, increasing the risk of traffic accidents. According to interviews with the local Department of Transportation, the installation of streetlights has not been fully implemented due to budget constraints and regional prioritization.

Additionally, traffic signs, road markings, pedestrian crossings, and intersection arrangements are not properly managed. In some locations, markings have faded, and there are no crossing facilities for pedestrians, exposing them to higher accident risks during peak hours. The drainage system along the road corridor is also suboptimal; during heavy rainfall, water puddles often occur at several points, disrupting comfort and creating slippery road conditions that can lead to accidents. Overall, the current safety standards require improvement to meet the principles of urban roads that are safe, comfortable, and sustainable.

Area Attractiveness Aspect

From the perspective of attractiveness, the Aek Kanopan Outer Ring Road holds great potential due to its strategic location as an interregional connector and gateway to the city center. However, aesthetic and spatial arrangements have not yet reflected the identity or visual character of the city. The absence of landscape design, thematic signage, and urban architectural elements makes the corridor appear monotonous and visually unengaging. The surrounding areas remain dominated by untidy open spaces and poorly organized residential zones.

Economic activities along the corridor are still limited. Small vendors and MSME stalls are present but remain unorganized, reducing the potential for local economic development. In fact, well-managed commercial facilities could serve as additional attractions that enliven the road corridor. Therefore, the development of supporting facilities such as sidewalks, bicycle lanes, linear parks, thematic lighting, and MSME spaces is essential to enhance the area's visual, functional, and economic appeal. Such improvements will not only strengthen Aek Kanopan's image as a growing city but also provide added value for mobility, social interaction, and local economic activities.

In summary, the existing supporting facilities along the Aek Kanopan Outer Ring Road remain at a basic infrastructure level, with limitations in comfort, safety, and visual attractiveness. This indicates the urgent need for an integrated development plan encompassing physical design, transport safety, and community empowerment to transform the corridor into a high-attractiveness, sustainable urban zone.

4.2 Supporting Facilities That Are Unavailable or Not Functioning Optimally

Based on field observations, community interviews, and information from relevant institutions, it was found that while the Aek Kanopan Outer Ring Road has great potential as a regional connector and catalyst for local economic growth, several supporting facilities remain unavailable or underperforming.

Pedestrian Facilities (Sidewalks and Pedestrian Ways)

Pedestrian facilities are a crucial element for ensuring user comfort and safety. However, observations show that sidewalks are mostly absent, especially along the outer segments of residential areas. In some areas, road shoulders serve dual purposes as parking or emergency lanes, with no clear separation between pedestrian and vehicular zones. Consequently, pedestrians are forced to walk along the main road where vehicles move at high speed, increasing safety risks.

Even where sidewalks exist, they are often narrow, uneven, inaccessible for persons with disabilities, and lack shading elements. This demonstrates that pedestrian infrastructure has yet to become a development priority.

Bicycle Lanes and Non-Motorized Mobility

Within the framework of sustainable transportation, dedicated bicycle lanes are essential. However, the Aek Kanopan Outer Ring Road currently lacks separated and standardized bike lanes. Cyclists must share lanes with motor vehicles, increasing accident risks and discouraging the use of environmentally friendly transport modes. According to the Ministry of Public Works and Housing Regulation (Permen PUPR No. 22/2021) on Sustainable Roads, bicycle lanes are an indicator of an inclusive and user-friendly city.

Public Street Lighting and Signage

Street lighting systems are not yet fully functional. Several road sections, particularly in the western and northern parts of Aek Kanopan, remain poorly illuminated, creating unsafe conditions at night. This not only hampers visibility but also reduces the perceived safety of pedestrians and motorcyclists. In addition, signage and directional boards are inconsistently designed temporary, non-uniform, and difficult to read at night. The absence of thematic and informative signage diminishes the visual identity and overall attractiveness of the area.

Drainage and Surface Water Management

Drainage systems in several segments are poorly maintained. Observations reveal water stagnation after heavy rain due to shallow or sediment-filled channels. This indicates that the drainage network is neither integrated nor capable of handling high water volumes effectively. Poor drainage not only affects comfort but also damages road surfaces and degrades infrastructure quality. Furthermore, it negatively impacts the area's aesthetics and image.

Green Open Spaces and Landscape Elements

Linear green spaces or roadside gardens that serve as aesthetic, thermal, and pollutionbuffer elements are yet to be developed. The surrounding corridor is dominated by unmanaged vacant land and wild vegetation. The absence of shade trees results in high surface temperatures during the day, reducing user comfort. According to Sutanto (2020), landscape elements such as shade trees and linear parks significantly enhance both visual attractiveness and thermal comfort in sustainable urban street design.

Rest Areas and Social Facilities

Currently, there are no rest areas or micro-plazas where people can pause, interact, or conduct small-scale activities. The lack of such facilities renders the corridor monotonous and socially inactive. Small rest areas equipped with seating, waste bins, and shading would enhance comfort and create a more welcoming public space.

MSME Facilities and Informal Sector Management

Local economic activity is emerging along the corridor, but informal vendors and MSMEs remain unorganized. Many still operate on road shoulders, obstructing traffic and reducing the corridor's aesthetics. The absence of a structured MSME area integrated into the road design limits local economic potential. According to [25] well-planned MSME facilities can catalyze social and economic activity without disrupting the main transport function.

Summary

Overall, the existing condition shows that most supporting facilities along the Aek Kanopan Outer Ring Road are either unavailable or underperforming. The most urgent improvements include:

1. Construction of sidewalks and bicycle lanes
2. Enhancement of street lighting and signage
3. Improvement of drainage systems
4. Development of green spaces and rest areas
5. Spatial organization for MSMEs

These improvements are not only aimed at enhancing infrastructure quality but also at realizing a safe, comfortable, attractive, and sustainable urban corridor aligned with Aek Kanopan's vision as a new regional growth center in Labuhanbatu Utara Regency.

4.3 The Influence of Supporting Facilities on Area Attractiveness and Functionality

The availability of supporting facilities plays a crucial role in enhancing the attractiveness and functionality of the Aek Kanopan Outer Ring Road. Beyond serving as transportation infrastructure to reduce congestion, the ring road has the potential to become a new economic growth corridor provided that adequate public facilities are developed.

According to [26] modern urban development should balance mobility and economic activity functions. Facilities such as parking areas, lighting, sidewalks, drainage, transport shelters, and traffic signage not only ensure comfort and safety but also foster environments conducive to investment and local business growth.

In Aek Kanopan, supporting facilities are still limited and not well-integrated. While some facilities exist, such as streetlights and signage, they are not uniformly distributed. The lack of pedestrian zones and rest areas reduces user comfort and economic interaction potential. [27] assert that supporting facilities act as “character-forming elements” that transform roads from mere transport corridors into productive and engaging public spaces.

Moreover, [28] emphasizes that sustainable facility development enhances both social and economic functions of an area. Adequate access to utilities, drainage, and lighting increases safety and comfort, stimulating local economic activities such as small enterprises, street food businesses, and transportation services. Thus, the more comprehensive and functional the supporting facilities along the Aek Kanopan Outer Ring Road, the greater the area's visual, economic, and social appeal. These facilities are not merely physical components but also symbols of effective urban governance and readiness for future urban growth.

4.4 Strategies for Effective and Sustainable Development of Supporting Facilities

To enhance the attractiveness and functionality of the Aek Kanopan Outer Ring Road, development must be well-planned, integrated, and sustainable. Based on the identified conditions and constraints, several key strategies are proposed:

Technical Strategies

1. Develop continuous, standard-width sidewalks with non-slip surfaces and universal accessibility for pedestrians.
2. Construct separated bicycle lanes to support non-motorized mobility and reduce conflicts with motor vehicles.
3. Upgrade drainage and establish linear green belts to prevent flooding, improve microclimate, and enhance aesthetics.
4. Install thematic street lighting and informative signage to enhance safety and reinforce local identity.
5. Organize intersections and road markings including crosswalks and signage to improve safety.

According to [29] integrating technical and aesthetic elements in sustainable street design enhances comfort, safety, and visual quality, thus reinforcing the road's social and economic functions.

Social and Community-Based Strategies

1. Increase community participation through consultation forums, public outreach, and shared maintenance initiatives.
 2. Develop micro-plazas and social facilities as spaces for interaction, local economy, and recreation.
 3. Organize MSME and street vendors in designated areas to boost economic value without disrupting traffic flow.
- [29] emphasize that high community involvement fosters a sense of ownership, ensuring long-term facility sustainability.

Institutional and Governance Strategies

1. Establish an Area Management Unit responsible for maintenance, spatial organization, and inter-agency coordination.
2. Integrate planning and policy among related agencies (Public Works, Transportation, and Regional Planning).
3. Develop sustainable funding mechanisms through public-private partnerships and community-based initiatives.

[28] notes that institutional coordination minimizes fragmented projects and ensures continuity and optimal facility utilization.

Environmental Sustainability Strategies

1. Apply eco-friendly materials and technologies such as permeable pavements, energyefficient LED lighting, and native plants.
2. Enhance urban greenery and shading to lower surface temperatures and improve thermal comfort.
3. Integrate supporting facilities with local economic potentials organized MSME stalls, creative markets, and social activity nodesto link infrastructure with community empowerment. [30] affirms that sustainable strategies not only improve aesthetics and social function but also yield long-term environmental and economic benefits.

Conclusion

Based on the analysis of the existing conditions, problem identification, and discussion of the development strategies for supporting facilities, several conclusions can be drawn as follows:

1. Existing Condition:
Supporting facilities along the Aek Kanopan Outer Ring Road remain limited. Sidewalks, bicycle lanes, rest areas, lighting, drainage, greenery, and MSME facilities are mostly absent or suboptimal, reducing comfort, safety, and visual appeal.
2. Development Constraints:
Technical (fragmented planning and infrastructure), social (low public participation), and institutional (weak inter-agency coordination and limited budget) factors hinder facility development and reduce the effectiveness of the road's function as both transport corridor and public space.
3. Facility Influence:

Adequate supporting facilities significantly enhance area attractiveness, safety, comfort, and local economic potential transforming the ring road into a productive, aesthetic, and safe urban public corridor.

4. Strategic Direction:

Recommended strategies include improving physical facilities (sidewalks, bike lanes, drainage, lighting), strengthening community involvement, enhancing institutional coordination, and applying sustainable, environmentally friendly approaches.

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