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Assessing the Potential of Transit-Oriented Development (TOD) in Advancing Sustainable Transportation in Medan City

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ABSTRACT

The increasing use of private vehicles in Medan City has caused traffic congestion problems. One effort to address urban transportation issues and support a sustainable transportation system is the implementation of the Transit-Oriented Development (TOD) concept, which has been adopted in several metropolitan areas in Indonesia. The TOD concept can be implemented by adhering to the principles of Transit-Oriented Development, as outlined in the applicable minimum standards. This article presents the results of field research and analysis to assess the feasibility of an area in meeting TOD standards in Medan City. This research uses a qualitative descriptive method with a mixed methods approach, and data collection through literature studies, observation, and documentation. The analysis was carried out using the IFE and EFE matrices to identify internal and external factors, and a SWOT analysis to describe the potential and problems of the area based on TOD criteria. The focus of the research is the central trade and service area in Medan Petisah District, with a radius of 500 meters from the Medan Fair Plaza node as the area delineation. Observed variables include transportation systems, land use, and spatial planning policies. The results show that the Medan Fair Plaza area and its surroundings have the potential to become a TOD area, as the area meets the minimum TOD standards.

Keywords: implementation, TOD principles, transportation, analysis, SWOT, IFE, EFE, matrix

1. Introduction

Traffic congestion remains a persistent issue in major Indonesian cities, including Medan. Previous efforts to alleviate congestion in Medan have primarily involved road widening and extension to accommodate increasing transportation demand. However, these measures typically offer only short-term relief, as the number of motorized vehicles and inefficiencies in movement systems continue to increase due to insufficient transportation accessibility. As a result, traffic congestion may generate significant long-term social, environmental, and economic consequences. An effective transportation system requires adequate accessibility among residential areas, industrial zones, business centers, transportation modes, parking facilities, terminals, and traffic signage to support public mobility.

Medan City, one of the largest cities in Indonesia and the most densely populated in North Sumatra, had a population of 2,486,283 in 2024, representing an increase of 51,031 people (2.09%) from 2020. This population growth has significantly influenced land use patterns and community mobility. Medan Petisah District, with a population of 72,599 and a density of 16,241 people per km² [1], serves as a major urban growth center and hosts key governmental facilities, including the Mayor's Office, the City and Provincial Regional House of Representatives, the District Court, the Public Prosecutor's Office, and the Military District Command 02/10 BS. In addition, the commercial sector in this district has developed rapidly, particularly in hospitality and retail activities, with major facilities such as Pasar Petisah and Plaza Medan Fair.

The rapid growth of commercial activities and high residential density has contributed to various urban problems, including traffic congestion and urban sprawl, which in turn increase travel distances

and travel time for daily activities [2]. Addressing these issues requires strong support from local government policies. One of the strategies adopted is the concept of transit-oriented development (TOD), as stipulated in Regional Regulation No. 1 of 2022 concerning the Spatial Plan of Medan City for the period 2022–2042 [3].

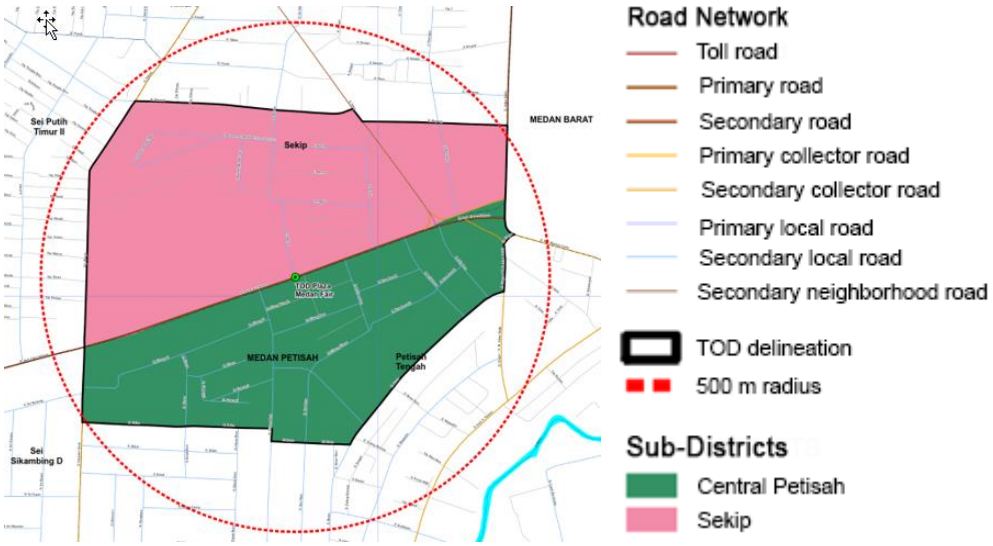

Figure 1. Transit-Oriented Development Area

Transit-Oriented Development (TOD)

Transit-oriented development is a sustainable urban planning strategy that optimizes land use and prioritizes pedestrian comfort in areas surrounding public transportation nodes [4]. According to Chisholm, TOD is understood as a planning concept that integrates land use with urban activities based on transportation systems, where transit points such as bus terminals, bus stops, and railway stations function not only as passenger pick-up and drop-off locations but also as connectors between commercial areas, public facilities, and other urban activities [5].

Dittmar and Ohland [6] describe TOD as an efficient regional planning concept that emphasizes mixed land use, easy access to transit nodes, facility connectivity, mobility, and pedestrian-friendly environments, to control urban sprawl and reduce dependence on private vehicles. In addition to reducing motorized vehicle use and lowering pollution, TOD also fosters social interaction and contributes to the creation of environmentally friendly urban areas [7]. The implementation of TOD typically covers a walkable radius of approximately 5 to 10 minutes, or about 400 to 800 meters, from transit points [5].

In its early development, the TOD concept focused on enhancing mobility and accessibility to accommodate daily activity patterns, primarily through walking and public transportation. Over time, activity centers were systematically integrated with transit nodes to encourage a modal shift toward public transit and to reduce reliance on private automobiles [8][9].

According to the Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency No. 16 of 2017, a TOD area is defined as a mixed-use zone that is carefully planned and has safe and convenient access to transportation hubs [10]. Transit points or secondary TOD areas are generally located near trade and service centers or commercial districts and are easily accessible by urban transportation networks [11]. TOD is characterized by four main attributes: high land-use density, environmentally friendly pedestrian pathways, the proximity of public facilities to stations or terminals, and stations that function as nodes connecting various community activities [12][13].

Principles and Standards of TOD

According to the Institute for Transportation and Development Policy, there are eight core principles in the development of transit-oriented areas. These principles include: Walking, which emphasizes the creation of safe, comfortable, and healthy pedestrian environments; Cycling, which prioritizes the provision of non-motorized transport infrastructure; Connect, which focuses on developing dense and

well-integrated pedestrian networks; Transit, which promotes high-quality infrastructure development around public transportation hubs; Mix, which encourages mixed land-use development; Densify, which optimizes land use and development intensity around transit facilities; Closeness, which emphasizes spatial design with short travel distances; and Switching, which supports the provision of public facilities that enable seamless integration among various transportation modes [4].

TOD standards serve as evaluation tools for assessing urban development plans and outcomes in line with TOD principles [14]. These principles are further translated into 14 objectives and 25 quantitative metrics, with a total score of 100 points. TOD areas typically span a radius of 400 to 800 meters around transit nodes, aiming to integrate mass transit systems, reduce reliance on private vehicles, and encourage walking and public transportation use [15].

The criteria for TOD area development include location within high-capacity rail-based mass transit networks, service by at least two modes of transportation, alignment with designated activity center development directions, and a mixed-use based spatial structure. Mixed-use areas integrate office spaces, residential areas, commercial business zones, and green open spaces to ensure functional connectivity. TOD also emphasizes the provision of public facilities that support pedestrian accessibility and comfort [15]. The implementation of TOD principles represents a sustainable urban planning strategy that can enhance quality of life, improve transportation cost efficiency, reduce environmental pollution, and serve as an alternative solution to traffic congestion [16]. Therefore, the completeness and connectivity of the study area must be evaluated in accordance with the applicable TOD standard categories.

Based on this background, this study aims to analyze the feasibility of applying TOD principles in the study area according to minimum TOD standards, in order to support the realization of sustainable transportation in Medan City.

2. Method

Research Design

This study adopts a descriptive qualitative design combined with a mixed-methods approach. Qualitative inquiry is conducted in a natural setting to interpret contextual phenomena, with the researcher serving as the primary instrument of analysis [17]. The descriptive qualitative approach is employed to examine the physical, social, economic, and institutional characteristics of the study area, as well as stakeholder perceptions of transit-oriented development (TOD). Quantitative elements are integrated to strengthen analytical rigor during data classification and evaluation.

Data Collection Procedure

Data are collected through literature review, field observation, and documentation. The literature review focuses on spatial planning policies and regulatory frameworks, particularly the Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency No. 16 of 2017 on TOD Area Development Guidelines, as well as relevant empirical studies. Field observations and documentation are conducted to assess on-site conditions with reference to established TOD principles and criteria. All collected data are systematically categorized into analytical components to support SWOT analysis and the construction of Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrices.

Data Analysis Techniques

SWOT analysis is employed as a strategic analytical framework to systematically identify and evaluate factors influencing TOD implementation [18]. In this study, SWOT analysis is used to assess internal and external factors affecting the application of TOD principles in advancing sustainable transportation. The analysis begins with the Internal Factor Evaluation (IFE) matrix, which identifies strengths and weaknesses within the study area. This is followed by the External Factor Evaluation (EFE) matrix, which examines external opportunities and threats that may influence TOD development [19][20]. The combined results provide a structured basis for evaluating the feasibility of TOD implementation in the study area.

3. Results and Discussion

3.1 Results

TOD principles are examined in areas characterized by mixed-use development as well as high-density and centralized urban zones. Based on land-use composition, the study area comprises a variety of land-use types, with commercial and service activities constituting the largest and most dominant land use, including retail and other commercial facilities. In contrast, green open spaces and public parks represent the smallest proportion of land use. Details of land-use distribution within the Medan Fair TOD area are presented in Table 1.

Table 1. Land Use Distribution at the Plaza Medan Fair and Its Surroundings

Land Use	Area (ha)	Percentage (%)
Roads	10.23	22%
Defense facilities	0.13	0%
Hospital buildings	0.26	1%
Tourism buildings	1.22	3%
School buildings	0.51	1%
Commercial and service buildings	25.47	55%
Warehouse buildings	0.24	1%
Office buildings	0.87	2%
Residential buildings	2.34	5%
Transportation facilities	0.27	1%
Vacant / unutilized land	4.59	10%
Road median	0.09	0%
Public parks	0.24	1%
Total	**46.45**	**100%**

Source: Field survey results

Table 1 presents the land-use composition of the 46.45-hectare study area, indicating that the area is predominantly characterized by commercial functions, with commercial and service buildings occupying 25.47 hectares, or 55% of the total land area. This dominance reflects the area's role as a major commercial activity center, consistent with the strategic function of the Medan Fair Plaza area and its surroundings within the spatial structure of Medan City. Land uses other than commercial activities include roads (22%), residential areas (5%), and other supporting facilities, each accounting for approximately 1–3% of the total area. The presence of vacant land covering 10% of the study area indicates potential for future development and functional intensification.

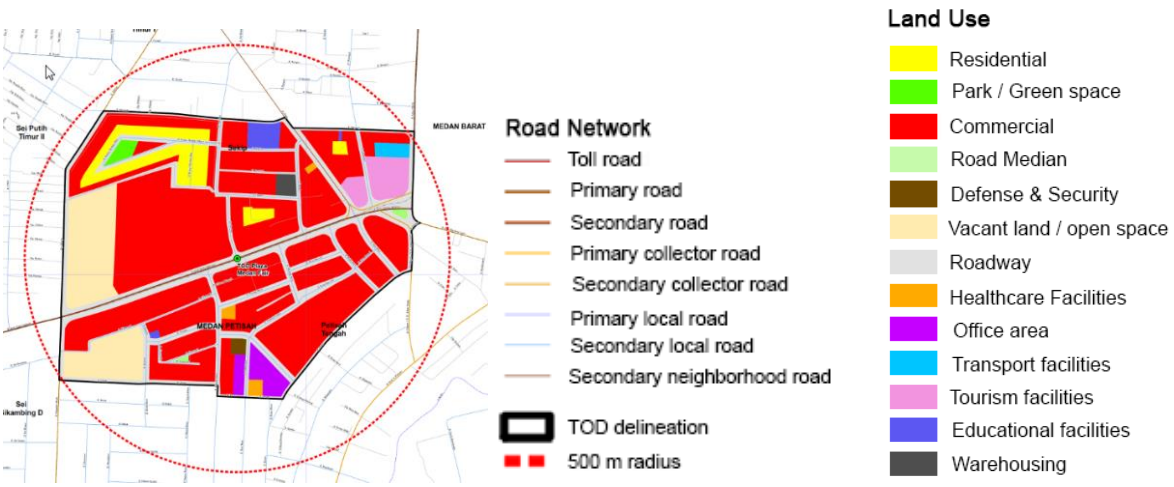

Figure 2. Land Use Distribution in the Study Area

Figure 2 illustrates the spatial distribution of land use within the study area, confirming a strong orientation toward commercial activities (areas shaded in red). At the same time, the figure highlights the presence of vacant land, which represents opportunities for spatial restructuring, the provision of public

facilities, and the integration of transportation and residential functions in a more optimal manner to support the implementation of transit-oriented development (TOD).

TOD represents an urban spatial development pattern that integrates land use with transportation systems to promote urban efficiency. This concept offers an alternative approach to addressing metropolitan growth challenges that are typically characterized by automobile-oriented development patterns. Based on the collected data, the transportation system in the study area is served by multiple modes of mass transportation, including both short-distance (intra-city) and long-distance services (Medan–Kuala Namo–Binjai). This condition is consistent with the Regulation of the Minister of Agrarian Affairs and Spatial Planning/National Land Agency No. 16 of 2017 on Guidelines for Transit-Oriented Development, which stipulates that a potential TOD location must meet at least one key criterion, namely being served by a minimum of one short-distance public transport mode and one long-distance transport mode [15]. This criterion indicates the potential feasibility of TOD implementation in the study area.

Figure 3. Mass Transportation Modes Serving the Study Area

In addition to meeting the requirement for mass transportation services, another key TOD principle considered in this study is the importance of establishing integrated transit nodes that are well connected to supporting facilities for non-motorized transport and pedestrians. Based on field observations and analysis, the road segments within the planning delineation comprise arterial, collector, local, and neighborhood roads. According to functional standards and survey results, the road widths in the study area generally comply with the minimum road standards stipulated in Government Regulation No. 34 of 2016 [21].

Survey findings indicate that supporting facilities for non-motorized transportation, such as cycling infrastructure and pedestrian walkways, are currently not yet available in the study area. However, considering the existing road widths and spatial conditions, there is potential to develop an integrated TOD area that connects mass public transportation networks with non-motorized transport systems for cyclists and pedestrians.

Figure 4. Road Conditions in the Study Area

The Regulation of the Minister of Transportation of the Republic of Indonesia No. 27 of 2015 on Minimum Service Standards for Road-Based Mass Transportation stipulates that bus stops constitute one of the minimum required service components. Supporting facilities for bus stops include pedestrian access to the stop location in the form of sidewalks, marked pedestrian crossings and/or traffic signs, pedestrian overpasses, or underpasses [22]. Based on the survey results, the availability and service conditions of bus stops within the TOD area are presented in Table 2:

Table 2. Evaluation of Minimum Service Standards for Integrated Bus Stops

Facility	Availability	Description
Lighting	Available	Public street lighting (PJU) functions properly along the main corridors and surrounding areas, providing safety and comfort for pedestrians and vehicle users during nighttime.
Complaint Information	Not available	Stickers containing telephone numbers and/or SMS complaint contacts placed in visible locations are not provided.
Cleanliness	Partly available	Trash bins are available at several points; however, their number is limited and unevenly distributed. Public areas appear relatively clean, although litter is still found in certain spots.
Traffic and Road Transport Equipment	Available	Traffic signs and road markings function as supporting facilities for the operation of road-based mass transportation.
Vehicle Storage and Maintenance Facilities	Not available	Facilities intended for vehicle storage, maintenance, and repair are not provided.
Passenger Boarding and Alighting Facilities	Available	Public bus stop facilities are available to support passenger boarding and alighting.
Bus Stop Entrance and Exit Access	Available in poor condition	Access points for entering and exiting the bus stop exist; however, their physical condition is deteriorated, potentially affecting user convenience and traffic flow.
Service information	Not available	Visual information boards displaying arrival and departure schedules, routes, and directions are not provided.
Schedule Information	Not available	Visual information at strategic locations within the bus stop regarding estimated bus waiting times is not available.

Source: Field survey results

Table 2 shows that the existing transportation support facilities in the study area consist solely of general public bus stops. Although these bus stops are physically in relatively good condition, their operational performance is poor, primarily because the mass transportation modes serving the area are not supported by dedicated lanes. As a result, passenger boarding and alighting activities are not well organized, leading to ineffective stopping and pickup systems.

In addition, several sidewalks are in poor condition, as they are frequently occupied by on-street parking and informal street vendors. This situation reduces pedestrian accessibility and comfort, particularly for transit users accessing the bus stops, and undermines the principles of walkability within the TOD area. The activity system represents the manifestation of space and its contents, particularly human presence and daily activities such as working, schooling, and shopping, which take place within specific land uses, including residential, office, and commercial areas. Each land-use type generates distinct activity patterns characterized by fluctuations in movement intensity as individuals fulfill their daily needs. The magnitude of movement is strongly influenced by the type and intensity of activities occurring within a given area.

Currently, the activities observed in the study area include office-related activities, residential activities, educational and health services, trade and services, as well as other commercial activities. These diverse activity patterns contribute to varying levels of movement and interaction within the area, reinforcing its role as an urban activity center.

Figure 4. Commercial, hospitality, and educational activities within the study area

The diverse activities present in the study area generate various movement patterns as part of daily needs fulfillment. The intensity of movement is closely related to the type and scale of activities taking place. The movement of people and/or goods requires appropriate transportation modes (services) as well as supporting infrastructure through which these modes operate. Based on field observations, the high concentration of activities in the area gives rise to multiple types of trips, including movements from residential areas to workplaces, commercial centers, office districts, and educational facilities.

The interaction and overlap of these trip purposes contribute to increased traffic volumes during peak hours. Given the existing travel demand characteristics and current road conditions, reliance on road-based transport alone is no longer sufficient to accommodate future mobility needs. Therefore, the primary solution is to transform the mass transportation system toward a rail-based mass transit system, which offers higher capacity, greater efficiency, and stronger compatibility with the principles of Transit-Oriented Development (TOD).

SWOT Analysis of the TOD Area

The Medan Fair Plaza area and its surroundings represent one of the key urban fronts of Medan City and constitute a highly strategic urban zone. This multifunctional area accommodates a variety of land uses, including hotels, educational office buildings, central markets, shopping plazas, and other commercial activities. The identification of strengths, weaknesses, opportunities, and threats (SWOT) related to the implementation of the TOD concept in the study area is based on field observations and a review of relevant literature. The results of the SWOT analysis are presented as follows.

The findings reveal several strengths that support the potential of the study area to develop into a TOD precinct. First, the area is characterized by a mixed-use urban structure, which aligns with one of the key criteria for successful TOD development. Second, in terms of service level, the area functions as a primary hub for trade and service activities at a regional scale, supported by the presence of major commercial centers such as Medan Fair Plaza and Petisah Market. Furthermore, the area is well served by various short- and long-distance transit modes, including Bus Rapid Transit (BRT), local buses, and minibuses, thereby enhancing connectivity and accessibility. The study area is also strategically located along primary road corridors that facilitate regional mobility. Finally, the area is identified as having a low level of disaster vulnerability, which increases its suitability and resilience for future TOD development.

Despite these strengths, the study area also exhibits several weaknesses that may hinder the realization of TOD principles. The area lacks dedicated infrastructure for non-motorized transportation modes, such as cycling lanes and pedestrian pathways, thereby limiting safe and comfortable mobility options. In addition, there are no designated lanes for public transport stopping areas, nor are there specific

facilities for intermodal transfers, which reduces the efficiency of transport integration. The presence of unregulated street vendors contributes to spatial disorder and further constrains pedestrian space. Moreover, the high intensity of activities within the area frequently leads to traffic congestion, which may adversely affect mobility performance and overall urban environmental quality.

The analysis also identifies several opportunities that can support the development of the TOD area. TOD principles have been incorporated into the spatial planning policies of Medan City, providing a strong regulatory foundation for future development. In addition, a significant proportion of land ownership around major transit nodes is held by the government, which facilitates land acquisition processes for TOD-related projects. Furthermore, the presence of vacant or underutilized land offers substantial potential for the development of TOD-supporting infrastructure, such as intermodal transit facilities or high-density residential developments, including apartment buildings. These conditions provide strategic advantages for advancing TOD initiatives within the study area.

In addition to opportunities, this study identifies several threats that may pose challenges to the successful implementation of TOD. One of the primary concerns is the high cost of infrastructure development, which may constrain investment and project realization. Furthermore, Medan's transportation system is not yet supported by digital-based technologies, potentially limiting the effectiveness of planning, operation, and integration across multiple transport modes. Moreover, as TOD remains a relatively new concept in Medan, it has not yet been comprehensively regulated or elaborated within the city's spatial planning framework. These factors may slow down or complicate the realization of a fully functional TOD area.

EFE and IFE Analyses

The Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) analyses were conducted to provide a strategic understanding of the strengths, weaknesses, opportunities, and threats identified within the study area. These analytical tools are used to systematically evaluate internal and external factors that influence the feasibility and direction of development in the Medan Fair Plaza area. The results of the IFE and EFE analyses for the Medan Fair Plaza area are presented as follows.

Table 3. IFE Matrix – Strengths and Weaknesses

Internal Factors	Weight	Rating	Weighted Score
Srenghts			
Mixed-use area consistent with TOD principles	0.10	4	0.40
Regional-scale commercial and service center	0.08	4	0.32
Availability of multiple transportation modes (local buses, DAMRI, minibuses)	0.08	3	0.24
Strategic location along a primary urban corridor	0.07	3	0.21
Low disaster vulnerability	0.05	3	0.15
Weakness			
Absence of dedicated pedestrian and cycling infrastructure	0.10	2	0.20
Lack of dedicated lanes for public transport crossings and intermodal integration	0.08	2	0.16
Poorly organized street vendors encroaching on pedestrian space	0.07	2	0.14
Traffic congestion due to high activity intensity	0.07	2	0.14
Total	**1.00**		**1.96**

Table 3 presents the internal factor evaluation of the study area, yielding a total score of 1.96. This result indicates that the internal strengths of the area are relatively adequate but not yet optimal to fully support the implementation of Transit-Oriented Development (TOD). The key strengths lie in the area's mixed-use character, its role as a regional-scale center for commercial and service activities, and the availability of multiple transportation modes that support community mobility. In addition, the strategic location of the area along major urban corridors and its relatively low level of disaster vulnerability further enhance its suitability for TOD development.

Table 4. EFE Matrix – Opportunities and Threats

External Factors	Weight	Rating	Weighted Score
Opportunities			
Regulatory support within the Medan City Spatial Plan	0.10	4	0.40
Government ownership of land at transit nodes	0.08	4	0.32
Availability of vacant or underutilized land	0.08	3	0.24
Potential for apartment development and intermodal facilities	0.07	3	0.21
Threats			
High infrastructure development costs	0.10	2	0.20
Lack of digital transportation technology support	0.08	2	0.16
Incomplete TOD provisions in existing policies	0.09	2	0.18
Total	**1.00**		**1.71**

Table 4 presents the results of the external factor evaluation, yielding a total score of 1.71. This score indicates that the study area continues to face considerable external challenges, despite the presence of several opportunities that support the development of Transit-Oriented Development (TOD).

3.2 Discussion

Based on the results presented above, the SWOT strategy formulation was conducted to integrate the identified internal factors (Strengths and Weaknesses) with external conditions (Opportunities and Threats). This approach aims to develop strategies that are effective, realistic, and goal-oriented. The outcomes of the SWOT analysis are described as follows:

Strength - Opportunity (S–O) Strategy. The combination of strengths and opportunities seeks to maximize existing advantages of the study area while leveraging favorable external conditions to support the development of a TOD area. This strategy emphasizes the need to conduct further comprehensive studies encompassing both physical and institutional aspects to ensure well-informed planning and effective implementation. In addition, it highlights the importance of improving the quality of the mass transportation system through the provision of clear service information, real-time bus arrival information, and the development of dedicated lanes to facilitate safe and efficient passenger boarding and alighting. Ultimately, this strategy also underscores the necessity of promoting dedicated routes for non-motorized transportation modes, such as cycling and walking, integrated across major activity centers to enhance accessibility and mobility throughout the area.

Weakness- Opportunity (W-O) Strategy. The combination of weaknesses and opportunities focuses on addressing existing limitations by capitalizing on available opportunities to support effective TOD development. This strategy includes the provision of designated intermodal transit areas, which are essential for creating an integrated and efficient transportation system. It also involves utilizing vacant or underutilized land to meet minimum infrastructure standards and core TOD principles, thereby improving the overall functionality and livability of the area. Furthermore, this strategy emphasizes the reorganization and management of informal street vendors to create a more orderly and pedestrian-friendly environment, contributing to more structured, accessible, and inclusive public spaces.

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Strength - Threat (S-T) Strategy. This strategy leverages the strengths of the study area to minimize or counteract potential threats that may hinder the implementation of a TOD area. One of the key approaches is to realize TOD development through Public–Private Partnership (PPP) schemes, capitalizing on strong transit accessibility and the area's mixed-use character to attract private investment and share the financial burden of infrastructure development. In addition, this strategy involves the development of a digital-based transportation system to enhance service quality by providing passengers

with real-time information on routes, schedules, and vehicle movements. Such technological advancements are expected to modernize Medan's transportation system and align it with the requirements of an integrated TOD framework.

Weakness - Threat (W-T) Strategy. The combination of weaknesses and threats identifies approaches to address internal limitations while simultaneously mitigating external challenges that could impede successful TOD implementation. One key initiative is redefining the role of informal street vendors, not merely as providers of informal goods and services, but also as potential urban attractions that can enhance the character and attractiveness of the area, thereby contributing to local economic development. Furthermore, this strategy encourages the adoption and adaptation of TOD concepts that have been successfully implemented in other regions, allowing best practices to inform local planning and policy formulation.

Synthesis of IFE and EFE Analysis. The results of the IFE and EFE matrix analyses indicate that the Medan Fair Plaza area possesses considerable potential for development based on Transit-Oriented Development (TOD) principles, although several constraints must be addressed through appropriate policy interventions. The total IFE score of 1.96 suggests that the area's internal strengths—such as its mixed-use characteristics, the presence of regional-scale commercial and service centers, and the availability of diverse transportation modes—constitute a solid initial foundation, albeit not yet fully optimized. Conversely, key weaknesses, including the absence of pedestrian and cycling infrastructure, the spatial disorder associated with informal street vendors, and recurrent traffic congestion, remain significant barriers to achieving TOD principles that emphasize connectivity, comfort, and mobility efficiency.

From an external perspective, the EFE matrix results, with a total score of 1.71, indicate that support from the external environment remains relatively weak. Although several opportunities exist—such as regulatory support within the Medan City Spatial Plan (*RTRW*), government land ownership at transit nodes, and the potential development of apartments and intermodal facilities—these opportunities have not yet been fully realized. This limitation is largely due to prevailing threats, including high infrastructure development costs, limited support for digital transportation technologies, and the absence of comprehensive TOD provisions in existing policies. Consequently, the study area is positioned within the hold and maintain strategy category of the IE matrix, suggesting that TOD development policies should prioritize the improvement and strengthening of internal conditions, while gradually optimizing external support through enhanced inter-agency coordination and stakeholder collaboration.

Overall, the relationship between the IFE and EFE matrix results and TOD policy implications indicates that the development of the Medan Fair Plaza area should be directed toward strengthening basic infrastructure, improving public space organization, and enhancing intermodal transportation integration. These efforts must be accompanied by consistent and collaborative policy implementation involving local government, developers, and the community, so that TOD principles emphasizing connectivity, efficiency, and sustainability can be effectively realized. Accordingly, the findings of this analysis provide a critical foundation for formulating more comprehensive policies aimed at establishing the Medan Fair Plaza area as an integrated, transit-oriented activity hub.

In terms of opportunities, the study area benefits from regulatory support embedded in the Medan City Spatial Plan, which serves as an essential framework for planning initiatives. Furthermore, government ownership of land at transit nodes and the availability of vacant or underutilized land offer significant potential for integrated area development. These opportunities are further reinforced by the potential construction of apartments and intermodal facilities, which can support the integration of residential and transportation functions within a single area. Nevertheless, several threats cannot be overlooked. High infrastructure development costs remain a major constraint to TOD implementation. In addition, the lack of digital transportation technology support and the incomplete articulation of TOD concepts within technical and operational policies hinder the acceleration of TOD-based development. The relatively low EFE score underscores the need for more concrete policy interventions, stronger financial support, and enhanced institutional synergy to fully capitalize on available opportunities while mitigating existing threats.

Despite these opportunities, several internal weaknesses require serious attention. These include the absence of dedicated cycling and pedestrian infrastructure, the lack of designated crossings and

intermodal connections, and the presence of informal street vendors encroaching on pedestrian space, all of which collectively reduce user comfort and safety. Moreover, high activity intensity resulting in traffic congestion poses a significant challenge that must be addressed through improved spatial planning and more integrated traffic management. The IFE matrix score further emphasizes the importance of strengthening institutional capacity, spatial governance, and supporting infrastructure to optimize the area's existing strengths and enhance its feasibility as a sustainable TOD development area.

4. Conclusion

The study area exhibits strong potential for Transit-Oriented Development (TOD). This is evidenced by its mixed-use character and function as a city- and regional-scale commercial center, its accessibility to both short-distance public transport (such as minibuses, Trans Metro Deli, and local buses) and long-distance transit services (DAMRI buses), and the potential of existing road conditions to support non-motorized transport, including pedestrian and cycling facilities.

Although the Medan Fair Plaza area benefits from favorable internal conditions and external support, particularly spatial planning policies and land availability, several challenges remain. These include inadequate pedestrian infrastructure, high infrastructure development costs, and limited integration of digital transportation systems. Addressing these constraints requires a holistic and adaptive approach focusing on institutional strengthening, improved public transport services, and enhanced public space management. With targeted infrastructure improvements and consistent policy support, the implementation of TOD principles is expected to enhance connectivity, reduce traffic congestion, and promote sustainable transportation by decreasing reliance on private motorized vehicles.

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