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05-3742716
uitmperakpress@gmail.com

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Transit-Oriented Development (Tod) For Sustainable Urban Growth In Alor Setar: Site-Scale Landscape Design Strategies For Walkability And Liveability Towards Resilient Communities

Akmal Abdul Talib¹, Izham Ghani²

^{1,2} Department of Built Environment Studies and Technology, Faculty of Built Environment, Universiti Teknologi MARA Seri Iskandar, 32610 Seri Iskandar, Perak

Abstract

Transit-Oriented Development (TOD) has emerged as a vital planning approach to support sustainable urban growth by integrating land use, transportation, and pedestrian-oriented environments. In Alor Setar, Kedah, rapid urban development remains largely car-dependent, resulting in reduced walkability, limited liveability, and underutilised public spaces. This study aims to evaluate the potential of TOD in promoting sustainable urban growth in Alor Setar by identifying key walkability and liveability elements and formulating integrated landscape architecture design strategies. The research adopts a qualitative descriptive approach, focusing on Terminal Bas Shahab Perdana as the case study. Data were collected through systematic on-site observations using structured walkability and liveability checklists, and the findings were analysed thematically using ATLAS.ti 24 software. The results indicate that while the study area demonstrates moderate to good performance in terms of pedestrian connectivity, greenery, and public space usability, several deficiencies remain, particularly in pathway continuity, crossing safety, shading provision, seating distribution, and traffic buffering. These shortcomings limit pedestrian comfort, safety, and overall urban experience. The study concludes that integrating landscape-based design interventions such as continuous shaded walkways, improved pedestrian safety measures, enhanced public spaces, and green infrastructure can significantly strengthen both walkability and liveability within the TOD framework. The findings provide valuable insights for planners and designers to guide people-centred, resilient, and sustainable TOD development in mid-sized Malaysian cities.

Keyword: Transit-Oriented Development (TOD), Walkability, Liveability, Landscape Architecture, Sustainable Urban Growth, Alor Setar

INTRODUCTION

Transit-Oriented Development (TOD) has emerged as a globally recognised planning and urban design strategy to address challenges associated with rapid urbanisation, climate change, traffic congestion, and unsustainable mobility patterns. TOD sees a compact urban form, mixed land use, high-density development, and strong integration with public transportation systems to reduce reliance on private vehicles while encouraging walking, cycling, and public transit use (Cervero & Kockelman, 1997; Newman & Kenworthy, 2015). Numerous international studies have demonstrated that TOD contributes to lower carbon emissions, improved accessibility, and enhanced urban liveability by prioritising people-centred environments over car-oriented development (Ewing & Cervero, 2010; ITDP, 2017). Successful TOD implementations in cities such as Singapore, Hong Kong, and Tokyo illustrate how coordinated land

use planning, efficient transit systems, and high-quality pedestrian environments can create vibrant, economically competitive, and socially inclusive urban areas (Bertolini, 1999; Dittmar & Ohland, 2004). In these cities, walkability and liveability are reinforced through continuous pedestrian networks, shaded walkways, integrated public spaces, and transit-linked commercial and residential developments. In Malaysia, TOD has increasingly been promoted within major metropolitan regions such as Kuala Lumpur and Penang through MRT, LRT, and commuter rail projects (Hamid & Mohd, 2019). However, the application of TOD in mid-sized cities remains limited despite facing similar issues of car dependency, fragmented pedestrian networks, and declining public realm quality (Ahmad et al., 2022). Alor Setar, as a growing state capital, exemplifies these challenges. Urban development in the city is predominantly car-oriented, resulting in limited walkability, underutilised public transport infrastructure, and reduced liveability of public spaces. Within this context, TOD presents an opportunity to reorient urban growth towards a more sustainable and resilient trajectory. Landscape architecture plays a crucial role in this transformation by shaping walkable streetscapes, green infrastructure, and inclusive public spaces that enhance both mobility and quality of life (Gehl, 2010; Abdul Latip et al., 2023). Integrating landscape architectural strategies within TOD planning is therefore essential to achieving people-centered, liveable, and sustainable urban environments in Alor Setar. The objectives of this research are thus threefold: (i) To identify the walkability element of Transit-Oriented Development (TOD) in enhancing sustainable urban growth in Alor Setar, (ii) To examine the liveability element of TOD in enhancing sustainable urban growth in Alor Setar, and (iii) To propose design strategies that integrate walkability and the liveability element of TOD for sustainable urban development in Alor Setar.

RESEARCH AIM

To establish landscape design strategies that enhance the potential of Transit-Oriented Development (TOD) in promoting sustainable urban growth in Alor Setar, identify key walkability and liveability elements, and formulate integrated landscape design strategies that strengthen both aspects within the urban context.

RESEARCH OBJECTIVES

1. To identify the walkability elements of Transit-Oriented Development (TOD) towards sustainable urban growth in Alor Setar.
2. To examine the liveability element of TOD in enhancing sustainable urban growth in Alor Setar.
3. To propose landscape design strategies that integrate both walkability and liveability elements to enhance sustainable urban development within the TOD context of Alor Setar.

PROBLEM STATEMENT

Urban development in Alor Setar remains heavily car-dependent, resulting in traffic congestion, limited pedestrian accessibility, and a decline in environmental and social quality. While Transit-Oriented Development (TOD) has proven effective in larger Malaysian cities such as Kuala Lumpur and Penang, its application in mid-sized cities like Alor Setar is still limited. The lack of integration between transit systems and surrounding urban areas reduces opportunities for sustainable mobility and liveable public spaces. Furthermore, the absence of well-planned walkable environments and quality open spaces weakens the overall urban experience. Therefore, it is essential to identify and examine the elements of walkability

and liveability within the TOD framework that can enhance sustainable urban growth in Alor Setar, and to propose landscape architecture design strategies that integrate these elements to create a more connected, inclusive, and resilient urban community.

LITERATURE REVIEW

Global Perspective

Transit-Oriented Development (TOD) has been widely discussed in global urban planning and design literature as a comprehensive strategy that integrates land use, transportation, and public realm design to promote sustainable urban growth. Early foundational studies by Calthorpe (1993) and Cervero (1998) emphasise that TOD is not solely defined by proximity to transit stations, but by the creation of walkable, compact, and mixed-use environments that encourage active mobility and reduce automobile dependency. These studies highlight walkability and public space quality as critical determinants of TOD success, positioning landscape architecture and urban design as central components of TOD implementation. In European cities such as Copenhagen, TOD is strongly supported by high-quality pedestrian and cycling infrastructure integrated with transit corridors. Newman and Kenworthy (2015) note that TOD areas in Copenhagen prioritise human-scale streets, continuous pedestrian networks, active ground-floor uses, and extensive green spaces, resulting in high levels of walking and cycling despite cold climatic conditions. Similarly, Stockholm integrates TOD with green wedges and ecological corridors, ensuring that transit-oriented growth does not compromise environmental quality. These examples demonstrate that TOD can successfully balance density, mobility, and environmental sustainability when supported by robust landscape and public realm strategies. In Latin America, Curitiba, Brazil, is frequently cited as a benchmark TOD city due to its Bus Rapid Transit (BRT)-based development model. According to Cervero and Dai (2014), pedestrian-friendly streets, linear parks, and integrated public spaces along BRT corridors enhance accessibility and social inclusion, particularly for lower-income populations. The Curitiba model illustrates how TOD can function effectively in developing contexts when supported by strong spatial planning and public space provision. In Vancouver, TOD is implemented through compact, high-density development around SkyTrain stations, where pedestrian plazas, greenways, and waterfront parks enhance liveability and urban vitality (Dittmar & Ohland, 2004). More recent TOD literature expands the discussion to include climate resilience, public health, and social equity. The OECD (2025) emphasises that TOD contributes to low-carbon urban development by reducing greenhouse gas emissions, encouraging active transport, and improving access to public amenities. Cities such as Freiburg demonstrate how TOD integrates renewable energy, green infrastructure, and compact urban form to support climate-responsive urban living. Collectively, these global examples reinforce the view that TOD is a multidimensional urban design approach in which walkability, liveability, and landscape quality play a central role in shaping sustainable cities.

Malaysian Context

In the Malaysian context, TOD implementation has been most visible in large metropolitan regions, particularly within the Klang Valley and Penang. KL Sentral is frequently cited as Malaysia's most comprehensive TOD hub, integrating multiple rail systems with commercial, office, hotel, and residential developments. Studies indicate that its success is supported by continuous pedestrian connections, covered walkways, and integrated commercial podiums that encourage walking between transit modes and surrounding developments (Hamid & Mohd, 2019). Similarly, TOD areas such as Bandar Utama and

Subang Jaya demonstrate increased transit ridership and urban activity intensity when pedestrian accessibility and mixed-use development are effectively integrated (Khalid & Samsudin, 2023).

However, literature also highlights persistent challenges. Ruslan et al. (2023) found that despite high transit accessibility in Kuala Lumpur City Centre, pedestrian comfort is often compromised by insufficient shading, fragmented walkways, and exposure to traffic. In Penang, TOD-related developments around Bayan Lepas and George Town face constraints related to limited pedestrian continuity, heritage sensitivity, and traffic congestion, requiring more context-sensitive and landscape-driven TOD approaches. Studies focusing on Northern Malaysian cities, including Kedah and Perak, indicate that TOD implementation remains limited due to lower density, weaker public transport networks, and strong car dependency (Ahmad et al., 2022; Din et al., 2023). These findings suggest that TOD strategies in mid-sized cities such as Alor Setar must move beyond replicating metropolitan models. Instead, they should prioritise landscape architecture interventions that enhance walkability, thermal comfort, public space quality, and local identity. By integrating green infrastructure, shaded pedestrian networks, and multifunctional public spaces, TOD can be adapted to local socio-cultural and climatic conditions, supporting more inclusive and resilient urban development.

Challenges and Barriers to TOD Implementation

Despite the widespread recognition of Transit-Oriented Development (TOD) as a sustainable urban development strategy, the literature consistently highlights that its implementation faces complex and interconnected challenges across institutional, physical, environmental, socio-cultural, and economic dimensions (Cervero et al., 2009; Dittmar & Ohland, 2004). One of the most significant barriers is institutional and governance fragmentation, where responsibilities for land use planning, transportation systems, and public realm design are distributed among multiple agencies with limited coordination, often resulting in TOD projects that emphasise transit infrastructure while neglecting pedestrian connectivity, public space quality, and last mile accessibility (Bertolini, 1999; Curtis et al., 2009). Physical and spatial constraints further undermine TOD performance, particularly in built-up urban areas dominated by wide roads, high traffic volumes, large intersections, and discontinuous sidewalks, which create hostile pedestrian environments and discourage walking despite proximity to transit (Ewing & Cervero, 2010; Gehl, 2011). These challenges are intensified in tropical contexts, where climatic factors such as high temperatures, humidity, and heavy rainfall significantly influence pedestrian behaviour; without adequate shading, ventilation, and weather protection through landscape and streetscape design, walking and public space use become uncomfortable and unattractive (Yuen & Wong, 2015; Shamsuddin et al., 2012). Socio-cultural and behavioural factors also pose barriers, as long standing car-oriented travel habits, perceptions of safety, comfort, and social status associated with private vehicle use reduce willingness to walk or use public transport, even when transit facilities are available (Newman & Kenworthy, 2015; Goh et al., 2016). Economic and market-driven pressures further complicate TOD implementation, as high land values around transit stations often encourage profit-oriented development that prioritises commercial returns over inclusive public spaces, environmental quality, and long-term maintenance (Cervero & Murakami, 2009; Suzuki et al., 2013). In the Malaysian context, these challenges are compounded by gaps between national TOD policies and local implementation capacity, particularly in secondary cities where limited technical expertise, weak enforcement, and insufficient urban design guidance result in TOD initiatives that focus primarily on transit provision rather than integrated walkability and liveability (Hamzah & Wong, 2019; PLANMalaysia, 2018). Overall, the literature suggests that without a people-centered, landscape-led

approach that addresses these interrelated barriers holistically, TOD developments risk functioning as transit-adjacent projects rather than truly liveable and sustainable urban environments (Jacobs, 1961; Gehl, 2011; Newman & Kenworthy, 2015).

Role of Landscape Architecture

Landscape architecture plays a vital role in translating TOD principles into people-centered environments that support walkability and liveability. Well-designed landscapes enhance pedestrian comfort through shading, greenery, microclimate regulation, and visual quality, particularly in tropical urban contexts (Abdul Latip et al., 2023). Streetscapes, green corridors, and transit plazas contribute to continuous and legible pedestrian networks, improving both functional and experiential aspects of walking. Beyond mobility, landscape architecture contributes to place-making by transforming transit nodes into community anchors. Public spaces such as plazas, pocket parks, and green buffers around transit stations encourage social interaction, cultural expression, and recreational activities (Redzuan et al., 2022). Incorporating local identity, ecological features, and sustainable landscape practices enhances the sense of place and supports environmental resilience within TOD areas. Moreover, landscape-based solutions such as green infrastructure, rain gardens, and urban trees improve stormwater management, reduce urban heat island effects, and support biodiversity. These functions align TOD with broader sustainability and climate resilience goals, reinforcing the importance of landscape architecture as an integral component of TOD planning and design.

RESEARCH METHODOLOGY

Research Design

This study adopts a qualitative descriptive research design to examine how walkability and liveability elements support sustainable urban growth through Transit-Oriented Development (TOD) in Alor Setar. A qualitative approach is suitable because it allows an in-depth understanding of the physical, social, and environmental factors that influence TOD outcomes, particularly in the context of a mid-sized city where detailed, contextual insights are crucial (Creswell & Creswell, 2018). The study focuses on Terminal Bas Shahab Perdana and its immediate surroundings as the primary case area, selected for its role as the city's main transit hub. This aligns with TOD research emphasising the importance of transport nodes as focal points for promoting pedestrian-friendly environments and enhancing urban liveability (Cervero, Guerra, & Al, 2017).

Site Selection

The study area is Shahab Perdana Bus Terminal, the main intercity and local bus terminal in Alor Setar (refer to Figure 1), strategically located along major road networks and functioning as a key mobility hub for residents and regional commuters. To ensure comprehensive and reliable observation, each unit within the study area will be visited at different times of the day which is in the morning, afternoon, and at night to capture variations in pedestrian activity, spatial usage, and environmental conditions. The surrounding area comprises commercial, institutional, and residential uses, offering strong potential for TOD integration and the development of walkable, mixed-use neighborhoods. A 200-meter buffer zone is delineated around the terminal, representing a pedestrian-friendly catchment area and aligning with the study's focus on immediate walkability and urban interaction zones, consistent with TOD guidelines (Ewing & Cervero, 2010). The delineated study boundary and are shown in Figure 1 for clearer visual reference.



Figure 1. Map of study area Shahab Perdana Bus Terminal,

Data Collection Methods

On-site observations will be conducted at Terminal Bas Shahab Perdana to assess TOD-related walkability and liveability elements using a direct observation method, where physical and spatial conditions are systematically recorded in situ through a structured observation checklist. This method enables objective documentation of actual built environment characteristics and is widely applied in urban design and walkability studies to evaluate human environment interactions (Gehl, 2010; Yin, 2018).

This research employs a purposive sampling strategy using the observation method focused on Terminal Bas Shahab Perdana, Alor Setar. The site is selected due to its role as a major transit hub that demonstrates key characteristics of Transit-Oriented Development (TOD), including accessibility, connectivity, and pedestrian activity. Purposive sampling is the most suitable method because the study aims to obtain in-depth, context-specific insights rather than broad generalisations, as this approach allows researchers to intentionally select information-rich sites that best align with the research focus (Palinkas et al., 2015). It enables the deliberate selection of a location that reflects the conditions necessary to examine walkability and liveability elements within the TOD framework, consistent with TOD principles that emphasise transit accessibility and pedestrian-oriented environments (ITDP, 2017). By focusing on a site with high transit relevance and urban interaction, this method ensures that the collected data are directly aligned with the study's objectives of assessing sustainable urban growth in Alor Setar.

The site checklist is a structured assessment tool used to systematically evaluate the study area in terms of walkability and liveability elements. The checklist guides on-site data collection by recording physical characteristics such as pedestrian pathways, connectivity, shading, street furniture, safety features, and spatial comfort. This instrument ensures consistent and objective observation of elements influencing walkability and liveability within the TOD context of Alor Setar (Gehl, 2010; Ewing & Handy, 2009; Whyte, 1980).

The qualitative data will be analysed using ATLAS.ti software to identify themes related to walkability and liveability within the Transit-Oriented Development (TOD) framework in Alor Setar. ATLAS.ti supports systematic qualitative coding by helping researchers organise, categorise, and interpret large sets of textual and visual data, enabling clearer identification of patterns and relationships (Frieze, 2019). This analytical process will reveal how TOD principles contribute to sustainable urban growth by highlighting key walkability and liveability factors, consistent with established TOD guidelines (ITDP, 2017). The resulting insights will then be used to guide the development of integrated landscape design strategies to enhance a more walkable and liveable urban environment in line with TOD objectives (Ewing & Cervero, 2010).

ANALYSIS AND DISCUSSION

Walkability Elements within Alor Setar's Transit-Oriented Development (TOD) for Sustainable Urban Growth

This section discusses walkability conditions within Alor Setar's transit-oriented areas, focusing on pedestrian connectivity, street configuration, and access to transit nodes. The findings address Objective 1 by outlining existing spatial and mobility conditions that influence pedestrian movement and support sustainable urban growth within the study area.

The walkability data analysis derived from Table 1 indicates that the study area demonstrates an overall moderate to good level of walkability, particularly along the primary pedestrian corridors surrounding the Shahab Perdana Bus Terminal. Pedestrian connectivity between the terminal and adjacent commercial areas is consistently rated as good, confirming that key Transit-Oriented Development (TOD) destinations are physically accessible on foot and located within reasonable walking distances. This reflects a spatial structure that supports transit use by enabling pedestrians to move efficiently between transport facilities and surrounding land uses without excessive detours, which is a fundamental principle of TOD and pedestrian-oriented urban design (Calthorpe, 1993; Cervero & Kockelman, 1997). Network linkages are also largely rated as good, with most walkways connected and minimal dead ends, indicating that the pedestrian network is legible and functional at a basic level within the defined 200-metre TOD catchment area, a distance commonly identified in walkability and TOD studies as a critical pedestrian influence zone (Ewing & Cervero, 2010).

Despite these strengths, Table 1 reveals several structural and qualitative weaknesses that reduce the overall effectiveness of walkability. Pathway continuity and surface continuity are predominantly rated as fair, indicating interrupted pedestrian routes, inconsistent alignment, uneven surfaces, and varying construction materials. Such physical deficiencies have been widely identified as key barriers to walking, particularly for vulnerable groups such as elderly pedestrians, wheelchair users, and parents with strollers (Southworth, 2005; Gehl, 2010). Safety-related indicators further highlight significant shortcomings. While zebra crossings are generally rated as good, the provision of signalised pedestrian crossings is rated poor, suggesting that pedestrian priority is inadequately addressed at intersections with higher traffic volumes. Previous studies emphasise that inadequate crossing facilities and poor pedestrian priority significantly increase pedestrian-vehicle conflicts and negatively affect perceived safety, which strongly influences walking behavior in TOD environments (Ewing & Handy, 2009; Litman, 2017). Comfort-related indicators further reinforce these observations. Continuous shading from trees is mostly rated as fair, while structural

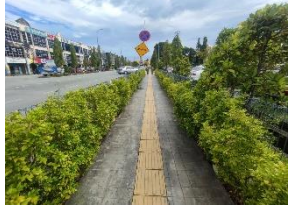
shading performs slightly better but remains limited in coverage and continuity. In hot and humid tropical climates such as Alor Setar, inadequate shading directly reduces thermal comfort and discourages walking, particularly during peak daytime hours (Yuen & Wong, 2015).

^A Table 1. Walkability elements checklist signage are rated as fair, reflecting insufficient clarity, consistency, and strategic placement, which limits spatial legibility and orientation for first-time users and transit passengers (Gehl, 2011). In summary, the table-based analysis confirms that while the study area satisfies minimum functional walkability requirements, deficiencies in pathway continuity, pedestrian safety, shading provision, and navigational clarity result in a fragmented pedestrian experience. These findings align with established walkability and TOD literature and highlight the need for comprehensive landscape and streetscape interventions to enhance continuity, safety, comfort, and legibility in order to strengthen walkability within the TOD framework (Gehl, 2011; Ewing & Cervero, 2010)

Table 1. Walkability elements checklist

Walkability Elements					
No.	Observation Focus	Indicator	Condition	Function	Image
1.	Pedestrian Connectivity	Clear connection between the bus stop terminal	Good	Fair	
		Clear connection between the commercial areas.	Good	Poor	
2.	Network Linkages	Walkways link without dead ends or disconnected routes.	Good	Fair	
3.	Pathway Continuity	Walkway is uninterrupted with no missing segments.	Fair	Fair	

4.	Surface Continuity	Smooth and consistent surface across the entire route.	Fair	Good	
5.	Crossing Safety	Safe and continuous crossing points at every intersection.	Good	Good	
6.	Safety – Lighting	Adequate lighting along pathways for night visibility.	Good	Good	
7.	Safety – Pedestrian-Vehicle Separation	Clear barrier between walkway.	Good	Good	
		Clear barrier between traffic lanes.	Good	Good	
8.	Crossing Safety	Presence of zebra crossings.	Good	Good	
		Presence of signalised crossings.	Poor	Poor	

9.	Shade for comfort	Continuous shade from trees.	Fair	Fair	
		Continuous shade from structures.	Good	Good	
10.	Wayfinding	Clear pedestrian signage and directional information.	Fair	Fair	

The Role of Liveability Elements in Transit-Oriented Development for Sustainable Urban Growth in Alor Setar

This section examines liveability factors within the TOD setting, including public space quality, environmental comfort, safety and opportunities for social interaction. The discussion responds to Objective 2 by identifying key opportunities and constraints affecting urban experience and community well-being in transit-oriented areas.

The liveability analysis based on Table 2 demonstrates that the study area achieves a moderate level of environmental comfort and public space quality, with several indicators showing relatively strong performance. Key elements such as shade quality, airflow, seating comfort, resting point availability, and greenery coverage are predominantly rated as good, indicating that the public realm provides a basic level of comfort and usability for daily users. The presence of tree canopy and planted areas contributes positively to visual quality and microclimate regulation, supporting outdoor activities within the TOD environment, which aligns with established findings on the role of vegetation in enhancing urban comfort and liveability (Whyte, 1980; Gehl, 2011). Cleanliness is rated as excellent, significantly enhancing user perception, safety, and the overall image of the area as a functional and well-maintained urban space, consistent with studies emphasising the importance of maintenance and management in public space use (Carmona et al., 2010).

However, a closer examination of Table 2 highlights several limitations that constrain overall liveability quality. Biodiversity quality is consistently rated as fair, reflecting limited plant species diversity and a landscape composition that prioritises aesthetic greenery rather than ecological function. Previous research

highlights that insufficient biodiversity reduces environmental resilience and limits the ecological contribution of urban public spaces (Tzoulas et al., 2007; Beatley, 2011). Noise comfort also shows mixed performance, with several locations rated only fair due to proximity to vehicular traffic and the lack of effective buffering elements such as dense vegetation or physical barriers. Studies on TOD and urban environments indicate that traffic-related noise significantly affects comfort and reduces the attractiveness of public spaces for prolonged use and social interaction (Newman & Kenworthy, 2015).

Although public spaces are generally usable, their capacity to support diverse and flexible activities remains limited. Many spaces function primarily as transitional or resting areas rather than active social spaces capable of accommodating informal gatherings, cultural activities, or community events. Urban design literature emphasises that successful and liveable public spaces require flexibility, social programming, and active edges to support everyday urban life (Jacobs, 1961; Montgomery, 1998). Safety perception based on visibility is rated as fair in selected locations, suggesting that lighting alone is insufficient without active frontages, continuous user presence, and clear sightlines (Gehl, 2011). Amenity availability, including bins and toilets, is generally rated as good, but uneven spatial distribution reduces convenience in some areas, while inconsistent traffic buffering further weakens comfort and safety. In summary, consistent with liveability literature, the table-based findings indicate that liveability elements are present but unevenly distributed and weakly integrated, highlighting the need for improvements in shading continuity, biodiversity enhancement, noise mitigation, traffic buffering, and multifunctional public space design to create a more liveable and socially responsive TOD environment (Carmona et al., 2010; Gehl, 2011).

Table 2. Liveability elements checklist

Liveability Elements					
No.	Observation Focus	Indicator	Condition	Function	Image
1.	Shade Quality	Presence of adequate shade.	Good	Good	
		Presence of good airflow.	Good	Good	
		Presence of low heat exposure.	Fair	Fair	

2.	Seating Comfort	Clean and usable shaded seating areas.	Good	Good	
3.	Resting Points Availability	Seating located at appropriate intervals for user needs.	Good	Good	
4.	Greenery Coverage	Availability of vegetation, tree canopy, and planted areas.	Good	Good	
5.	Biodiversity Quality	Presence of varied plant species that enhance ecological value.	Fair	Fair	
6.	Public Space Aesthetic Quality	Visual appeal of landscape design, cleanliness, and maintenance.	Good	Fair	
7.	Cleanliness	Litter-free, well-maintained surroundings.	Excellent	Excellent	
8.	Noise Comfort	Acceptable noise levels from traffic and surrounding activities.	Good	Fair	

9.	Public Space Usability	Spaces adequately designed for rest, socialising, and community use.	Good	Good	
10.	Safety Perception	Feeling of safety based on lighting.	Good	Good	
		Feeling of safety based on visibility.	Good	Fair	
		Feeling of safety based on active usage.	Good	Good	
11.	Wayfinding & Signage	Clear, readable, and well-placed signage for public spaces.	Good	Fair	
12.	Amenity Availability	Presence of bins.	Good	Good	
		Presence of toilet.	Good	Good	

13.	Buffer from Traffic	Distance or barrier separating public spaces from roads.	Good	Fair	
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Landscape Design Strategies Integrating Walkability and Liveability Elements in Enhancing Sustainable Urban Development within Alor Setar's TOD Context

This section presents proposed landscape design strategies that combine walkability and liveability considerations in Alor Setar's TOD context. The strategies address Objective 3 by offering site-scale design directions to improve pedestrian experience, public realm quality, and sustainable urban development around transit environments.

The integrated analysis for Research Objective 3 synthesises the walkability findings from Table 1 and the liveability findings from Table 2, with all observation checklist data analysed using ATLAS.ti through a thematic qualitative approach. The data were systematically coded, categorised, and grouped to identify recurring patterns, relationships, and overlaps between walkability and liveability elements within the TOD context. This process enabled the integration of physical, environmental, and social attributes into higher-order design themes, ensuring that the proposed strategies are grounded in empirical observation rather than conceptual assumptions (Saldaña, 2016). The analysis indicates that although individual walkability and liveability indicators generally perform at a moderate to good level, their implementation remains fragmented, disconnected, and insufficiently coordinated. Table 1 identifies recurring weaknesses in pathway continuity, pedestrian crossing safety, shading provision, and wayfinding clarity, while Table 2 highlights deficiencies in biodiversity quality, noise buffering, seating distribution, and public space flexibility. TOD literature consistently emphasises that such fragmentation limits overall TOD effectiveness, as pedestrian mobility, environmental comfort, and social activity must function as an integrated system rather than isolated components (Cervero et al., 2009; Newman & Kenworthy, 2015). When walkability and liveability are addressed separately, TOD environments tend to function as transit-adjacent developments rather than fully integrated, people-centered urban places. Figure 2 responds directly to these data-driven gaps by proposing continuous shaded pedestrian corridors, enhanced pedestrian crossings, green buffers, and strategically distributed seating and activity nodes, reflecting best practices in TOD and public realm design. Continuous shaded walkways improve thermal comfort and route continuity, encouraging walking throughout the day, particularly in tropical climates (Yuen & Wong, 2015). Green buffers and planting strips mitigate traffic noise, enhance microclimate conditions, and strengthen pedestrian-vehicle separation, contributing to environmental comfort and safety (Beatley, 2011; Newman & Kenworthy, 2015). Improved crossings and clearer spatial legibility enhance pedestrian safety and orientation, while integrated seating and activity spaces promote social interaction, passive surveillance, and extended public space use (Gehl, 2011; Jacobs, 1961). In summary, consistent with TOD and landscape urbanism literature, the synthesis confirms that landscape-led integration of walkability and liveability elements is critical to strengthening TOD performance in Alor Setar, transforming the area from a transport-oriented node into a people-centered, liveable, and resilient urban environment appropriate for a

mid-sized Malaysian city (Dittmar & Ohland, 2004; Gehl, 2011).

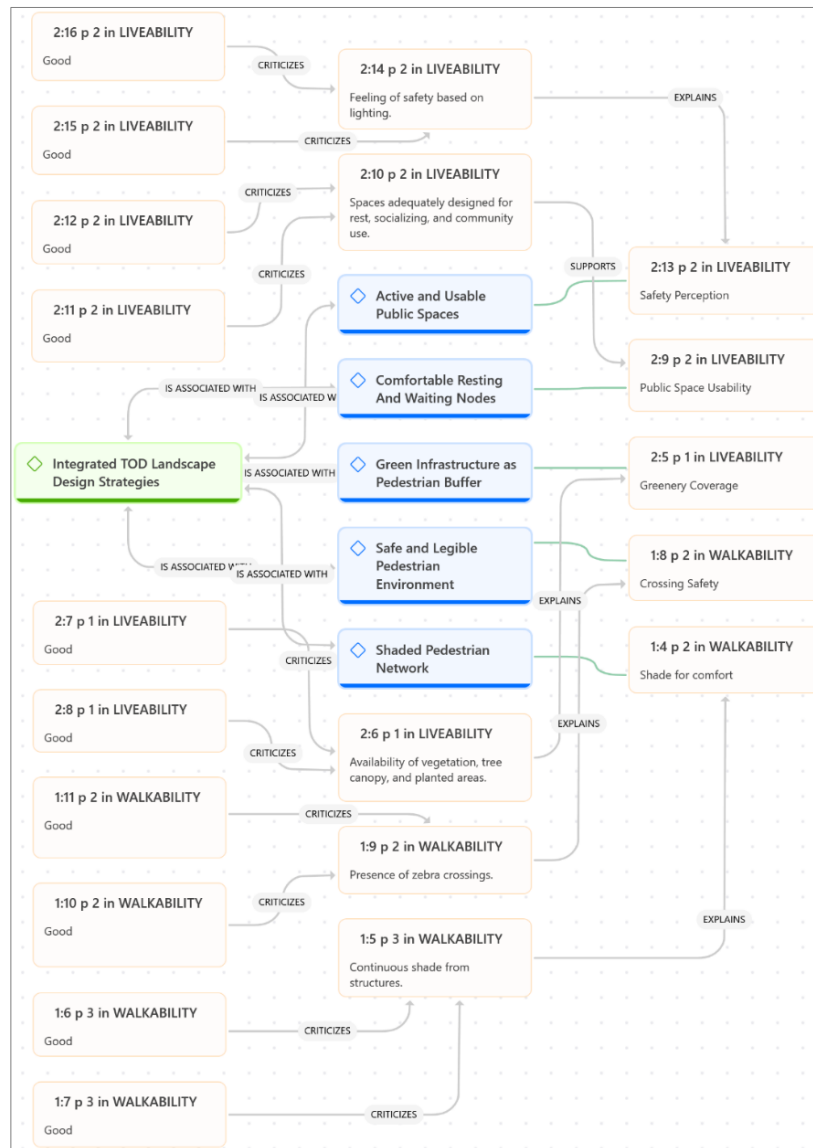


Figure 2. Proposed landscape design strategies that integrate both walkability and liveability elements

This research highlights the importance of integrating Transit-Oriented Development (TOD) principles with landscape architecture design strategies to promote sustainable urban growth in Alor Setar. As the city continues to face challenges such as car dependency, limited pedestrian infrastructure, and underutilised public spaces, a new planning approach is needed to balance mobility, livability, and environmental sustainability. By identifying the walkability and liveability elements of TOD, this study emphasises that well-connected pedestrian networks, green open spaces, and human-scaled urban design are essential for creating inclusive and resilient communities. Furthermore, the research demonstrates that landscape architecture plays a vital role in enhancing the quality of urban life by shaping comfortable, accessible, and ecologically responsive environments around transit nodes. Through design strategies that combine green

infrastructure, public realm improvements, and community-oriented spaces, TOD can be reframed not only as a transport model but also as a catalyst for sustainable and people-centered urban transformation. Ultimately, the findings of this study aim to guide the future development of Alor Setar toward a more connected, liveable, and resilient city, setting an example for other mid-sized urban centers in Malaysia.

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