Transit Oriented Development used to formulate design guidelines for an improved bus network in Malaysia

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Abstract

Transit Oriented Development (TOD) underpins the innovative use of urban spaces to create more compact and walkable (more accessible) urban infrastructure. The TOD approach is an innovative form of development that helps diversify transportation systems and provides a new range of development patterns for households, businesses, and cities. In this paper, we outline the TOD method and show how it was used to influence design guidelines for an improved public bus network in Malaysia. We use the TOD Standard Metrics Scorecard to evaluate the current bus system in Kuala Lumpur and highlight the main issues requiring design intervention.

The TOD Standard scoring system distributes 100 points across 12 categories and these points reflect the level of impact of each area when using TOD. The accumulated points within the TOD scoring system refers to how well the studied area is supporting sustainable urban infrastructure. Applying the TOD principles for Kuala Lumpur is intended to form a long-term solution, with short-term impact. As the changes required according to the TOD principles can involve significant urban restructure, there are suggestions given that are not possible in the short-term but should be considered for long-term benefit. A longer-term change proposal will reflect the TOD principles as an optimal outcome to improve the current state of Kuala Lumpur's public transportation networks (beyond 10-years), however, for this paper a shorter-term change is put forward with realistic implementation possibilities within the next 5-years.

Understanding how to use the TOD Standard metrics helps assess existing infrastructure against proposed improvements and gives a clear view of how TOD can radically change the urban landscape with public transportation at the core of all activity. There are obvious limitations to this as certain infrastructure simply cannot change, such as surrounding buildings and major road networks. However, it is important to include TOD principles where possible to establish a framework for design with consideration of what is possible, what is impossible, and what could be possible. From a design point of view, TOD provides a strong justification for design decisions used to better educate stakeholder's around future change. By supporting design proposals with evaluative research underpinning the design intent, we provide greater certainty for design when used to inform decision makers that may not understand or appreciate the impact design intervention can have on urban environments.

Author keywords

Transit Oriented Development; Human Centred Design; Public Transportation; Design Intervention

Introduction

Aligned with the Malaysian governments response to the National Automotive Plan (NAP), this study provides a structured plan to improve the current state of the bus network in Kuala Lumpur, Malaysia. The NAP includes bus development to increase the patronage of sustainable public transport, which is identified as the weak link in the current Mass Rapid Transit (MTR) in Kuala Lumpur. This study presents the outcomes of using Transit Oriented Development (TOD) as a tool to evaluate eight core criteria against the current Malaysian network which is then used to guide design interventions. We provide opportunities for improvements for the Malaysian government to prioritise a sustainable bus system with an aim of increasing patronage for the ailing public transportation network.

Transit Oriented Development was first identified by an American architect and planner named Peter Calthorpe in 1993. As a leader of the New Urbanism Movement, Calthorpe describes TOD as a mixed-use community within walking distance with transit stops and core commercially developed areas (Calthorpe, 1993). Calthorpe argues that transit is more than merely the transportation system; it also comes with fundamental land use logic. He established the general accepted walking distance of 0.8 km in between train stations and 0.4 km walking distance in between bus stops. This is further noted by Jarrett (2012) who describes the unglamorous but essential struggle over the spacing of consecutive stops or stations on a transit line being an area where there's a huge difference in practice around the world.

Figure 1. The geometry of stop spacing as identified by Jarrett (2012).

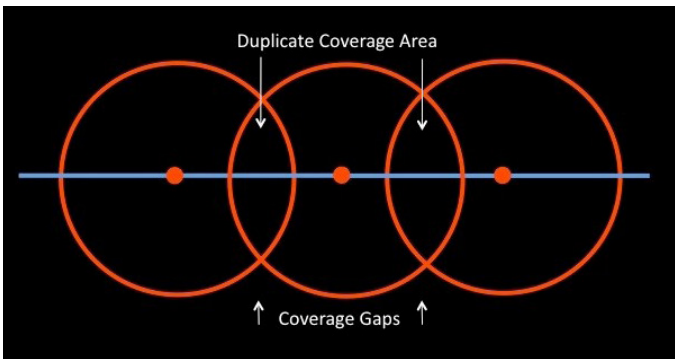

Figure 1. The geometry of stop spacing as identified by Jarrett (2012).

Literature

Support for walking and cycling has a clear need in urban planning (Newton & Bai, 2008). Most current public transportation models operate at the metropolitan scale and fail to include aspects of local scale walking and cycling (Stradling et al., 2007). However, there should be an emphasis on walking and cycling support when developing a public bus system with a human centred design approach (Kuys et al., 2022). This is particularly important to Kuala Lumpur where temperatures rarely drop below 27 degrees Celsius. The hot, humid, sub-tropical climate is uncomfortable and this leads many people to the comfort of their air-conditioned vehicles. While it will be very hard to replicate the comfort of an air-conditioned private vehicle, there will be many other benefits to using an improved bus system that will be much better than a private vehicle such as costs, commuter time, parking, sustainability, safety and the ability to complete other tasks along the journey rather than having to concentrate on driving.

These positive reflections can be evaluated using TOD principles to provide the necessary guidelines to improve the current state of transportation systems in developing countries. By using a TOD approach it aims to reduce vehicle usage and encourage the use of public transit and human-powered transport modes through high density, environmentally friendly development within areas of walking distance (Sung & Oh, 2011). Such TOD approaches have been recognised as one of the key planning methods to solve traffic congestions and to promote uptake in public transportation usage in Asian countries such as Korea, China, and Taiwan (Sung & Oh, 2011). TOD has been increasingly promoted and implemented as a solution to the problems of urban growth (Galelo, Ribeiro & Martinez, 2014). Using the TOD approach provides greater potential in the reduction of vehicle use, increased public transportation usage, and giving a sense of community to the neighbourhood (Newman & Kenworthy, 1999). TOD can be done in different scales depending on the local context it is implemented in. Some cities can implement minimal change while still improving the neighbourhood while others can implement maximum change that drastically improves the community.

Kuala Lumpur has the density which gives locational advantage for using the TOD approach to be successfully implemented. Human centred design studies conducted prior to this study (Kuys et al. 2015; Kuys et al. 2022) shows there are more pedestrians negotiating their way around public infrastructure than those using the public transportation options available. Understanding human behavioural factors is critical to achieving the successful implementation of sustainable public transport systems through more effective and more considered urban design. An improvement in public transportation service quality can attract new users and promote modal shift from private vehicle to public transportation (Eboli & Mazzulla, 2007). Public transport users in the city are mainly concerned with safety, reliability, ease of transit, comfort level while using the public transport system, safety and supervision of the bus stop (Andaleeb, Haq & Ahmed, 2007). These elements can be addressed when introducing the TOD approach in such public transportation development. The TOD approach will not only provide possible future solutions, but also give highly feasible outcomes.

Method

To better understand the present problems with the public transportation in Kuala Lumpur, Malaysia, a field research study based on user observations was carried out. The "fly on the wall" technique was employed as a tool to gather accurate user data in a covert and cost-effective manner (St. Matthew-Daniel & Kamper, 2001). Following this, an online questionnaire was conducted to better understand the present issues that require attention and to demonstrate the value of a HCD strategy. The structured questionnaire was completed by 102 Malaysians and asked ten questions about the participants' experiences with public transportation were posed (refer to Kuys et al. 2022). Major findings from the user observation revealed common pain points and issues when using the current bus system in Kuala Lumpur. Six key themes were identified as follows:

1. Getting on and off the public transport (ingress and egress)
2. Access to remote bus stops and train stations (safety)
3. Smart ticketing system (better integration)
4. The road condition (physical constraints)
5. Real-time display (wayfinding and timetables)
6. Stricter rules around other road users (dedicated bus lane)

These findings were then used to formulate key questions for the questionnaire. Major findings from this phase showed significant favouritism for private car transportation revealing that 75 % of all respondents use their private car daily. Disturbingly, bus usage was one of the least popular choices of daily (7-days per week) and/or often (4–6 days per week) transportation at 8 %, and further to this, over 60 % of respondents had never used the bus system before. 80% of respondents were dissatisfied of the physical design of the bus (interior and exterior), and when evaluating the HCD principles associated with the current bus system, convenience formed the overwhelming majority, followed by the choice of daily transportation and improving the bus shelter location and access (Kuys et al. 2022).

The outcomes of both the user observation research and the questionnaire were used to evaluate the TOD scorecard which is the focus of this paper. We highlight the TOD Standard method used to identify objectives for each principle with measurable indicators evaluated according to the closest approximation of performance against the objectives. The scorecard evaluated the eight key principles of TOD against a score for each section. The maximum score for the evaluation is 100 points divided amongst the following, and the evaluation was determined through careful review of the literature and the aforementioned research from the authors (Kuys et al. 2015; Kuys et al. 2022).

Table 1. Scorecard of the TOD Standard metrics developed by ITDP.

TOD principle	Maximum score
Walk: Walkways, crosswalks, visually active frontage, physically permeable frontage, shade and shelter	15
Cycle: Cycle network, cycle parking at transit stations, cycle park-ing at buildings	5
Connect: Small blocks, prioritised connectivity	15
Transit: Walking distance to transit	Requirement
Mix: Complementary uses, accessi-bility to food, affordable hous-ing	15

Evaluation

To triangulate data and verify our evaluation, a workshop was organised with Dr Luc Nadal, Technical Director of the Institute for Transportation and Development Policy (ITDP) Urban Development to support the proposition of using TOD as a method for improving the current state of Kuala Lumpur's transportation network. This workshop was held in New York and formed a critical part of this study by setting boundaries around TOD principles to help focus the design intent. ITDP is an organisation that was prominent within the literature for TOD principles. ITDP manages a wide range of sustainable urban transportation solutions to improve urban living worldwide and were responsible for developing the eight key principles for the future of mobility in cities with multimodal integration.

For this research, the focus was on the bus network for Kuala Lumpur, however the conversation around TOD principles is relevant to all areas of urban design linking people to transport. The workshop which ran for 3-hours and consisted of four members from ITDP and both authors of this paper, broadened the scope of this research by focusing on the external influences associated with design development, rather than just the design outcome itself. Discussions were focused on implementation using real-world examples where TOD has successfully been implemented. The authors used this workshop as a key milestone to ensure the research had direction from ITDP for validation and oversight of this project.

This demonstrates the translation of literature and research methods into research outcomes based off referenced theory. Along with this previous research, the below evaluation received expert advice from Dr Luc Nadal at ITDP during our workshop. The following summary relates to the TOD Standard Metrics Scorecard used to evaluate the current bus system in Kuala Lumpur. This was useful to provide an informed understanding of the current context to identify areas in need of design intervention.

Table 2. TOD Standard Metrics Scorecard used to evaluate the current bus system in Kuala Lumpur.

TOD principle	TOD Evaluation	Max. score	Score given
Walk	• Walkways: 0 points. Less than 100 per cent of block frontage had safe wheelchair accessible walkways. • Crosswalks: 1 point. 90 per cent of intersections or more have basic requirement meeting local accessibility standards. • Visually active frontage: 2 points. 50 per cent or more have visually active frontage segment measured by windows and accessible open space located along the street wall. • Physically permeable frontage: 2 points. Average number of entrances such as shop entrance per 100 metre of block frontage is 5 or more. • Shade and shelter: 0 points. Less than 75 per cent of all walkways have adequate shade or shelter amenities.	15	5
Cycle	• Cycle network: 0 points. Less than 90 per cent of street is safe for cycling resulting in maximum walking distance to cycling streets is more than 200 metres. • Cycle parking at transit stations: 0 points. Multi-space racks are provided only in some transit stations. • Cycle parking at buildings: 0 points. Less than 95 per cent of buildings provide ample secure cycle parking. • Cycle access in buildings: 0 points. Cycle access is not required by building codes or bylaws.	5	0
Connect	• Small blocks: 4 points. Some blocks within the development is less than 150 metres in length. • Prioritised connectivity: 1 point. Number of intersections representing prioritised connectivity ratio is low.	15	5
Transit	• Walking distance to transit: Does not meet TOD standard requirement. Maximum walking distance is more than 1 kilometre to a high-capacity transit station or more than 500 metres to a direct service station.	—	—
Mix	• Complementary uses: 0 points. Less than half of the floor area of a development in predominantly residential uses have non-residential uses. • Accessibility to food: 1 point. 80 per cent or more of the buildings are within walking distance to a source of fresh food. • Affordable housing: 4 points. 20 per cent or more of all residential units are affordable.	15	5
Densify	• Land use density: 0 points. Total residential population, jobs and visitors is lower than the baseline density. Baseline density is determined by estimation of total residential population, number of jobs in the area.	15	0
Compact	• Urban site: 1 point. One side adjoins built-up sites creating low interaction points. • Transit options: 1 point. Minimal number of different transit options that are accessible within walking distance.	15	2
Shift	• Off-street parking: 1 point. Non-residential parking area is equivalent to 35 per cent or less of site area. • Driveway Density: 2 points. Average driveway density is 2 or less driveways per 100 metre of block frontage. • Roadway area: 5 points. Motor vehicle area is 20 per cent or less of site area.	20	8
	TOTAL	**100**	**25**

This evaluation shows significant improvement required for the Malaysian bus network having received a score of 25/100 when scored against the TOD Standard Metrics Scorecard. Results were then used to convert the TOD metrics into specific issues with suggested plausible solutions. Key criteria for this evaluation showing how the initial TOD analysis led to design intervention is as follows:

- To identify gaps and opportunities for improvements.
- Implement walkability and cycle friendliness where possible.
- Evaluate existing structure to identify investment opportunities.
- To provide guided policy and regulations relevant to urban planning, transport planning and urban design.

This criterion was then used to effectively highlight defined issues mapped against proposed design intervention as follow:

Table 3. Main issues identified as needing design intervention to improve the current bus system in Kuala Lumpur.

Issue identified	Design intervention
Getting on and off the public transport (ingress and egress).	Ensure buses have a low-floor platform and the bus stop aligns with the bus floor, while accommodating all users (eg. Wheel-chair bound patrons).
Access to remote bus stops and train stations.	Overlaying TOD principles to the entire bus network ensures walking distances to bus stops are reduced and network recon-figurations connects different modes of transport to the new bus network.
The condition and size of the pave-ments (and roads) – public infra-struc-ture.	Recommendations to prioritise public transport usage over private car ownership. Development of new bus stops to im-prove the public infrastructure along the bus routes. Emphasis on a human centred design approach to ensure the user is at the forefront of development.
Efficiency of service – frequency of bus-es.	It is anticipated that an improved bus network will increase patronage allowing for more frequent services. Infographics and improved bus stops will be more informative and users will better understand waiting times. Dedicated bus lanes and priority given to the bus network will significantly improve the efficiency of the service.
Comfort and recog-nition of bus stops.	Complete redesign of bus stop allowing for modular construc-tion for installation in different contexts – such as terrain, space allocation, popularity of area (heavy tourist usage), and existing infrastructure.
Wayfinding and public communica-ti-ons including timetables.	Digital displays (solar powered) integrated into each bus stop and buses are colour coded to align with each route. Bus routes are developed to be more recognisable and link to each bus within the network. Bus service times are displayed on each bus to allow the user to know exactly how long the waiting time is. Clear and accurate information improves the overall customer experience.
Stricter rules around other road users – dedicated bus lanes that are not infringed upon.	Proposing clearly defined dedicated bus lanes which could include concrete step barriers on the central reservation of motorways. This would physically prevent vehicles from using these dedicated lanes and will ensure they are reserved specifi-cally for the Kuala Lumpur bus network.

These suggestions are realistic and based off significant research by those that would use the newly developed bus system for Kuala Lumpur. The solutions identified above through the TOD evaluation were all advanced into design proposals. Due to size limitations of this paper, we provide two examples. The first shows the inclusion of dedicated bus lanes, improved footpaths and dedicated cycling lanes to existing infrastructure, and the second shows an improved bus stop which includes multiple solutions listed above.

Application

TOD principles have helped define parameters for change – some significant, and others incremental. The below section shows how TOD principles can be used to change existing city infrastructure with minimal negative effect to the streetscape. This has been done by many cities around the world ensuring that buses, pedestrians and cyclists have priority over vehicles. By making positive change to the infrastructure, the bus and the developed bus stops will further be enhanced. The holistic view of this system needs to address all negative elements seen within the research to maximise acceptance of this new system. The two examples provided below have been developed within one identified area of Kuala Lumpur. These examples show how TOD principles informed design development and are used for others to better understand how a design method (TOD) is applied to design recommendations.

Dedicated bus lanes, improved footpaths and dedicated cycling lanes

The Kuala Lumpur CBD centres around the high tourist area of the Patronas Twin Towers. Surrounding this highly populated area is a network of two and three-lane highways circling the city. A network of interconnected roads in a city that is dominated by private car ownership makes this area highly congested. Figures 2 and 3 show one identified area on the fringe of the CBD – A three-lane highway with adequate room for improvements without having to change much of the infrastructure. The main changes would be dedicated bus lanes either side of the highway, a dedicated cycling lane on one side of the highway, and improvements to the footpaths on both sides of the highway. It is understood that this would still cost a considerable amount of money, however this is significantly lower than major public transport interventions such as improved rail. Private car owners and bus drivers will also need education of the changes suggested and the laws will need to be enforced to ensure bus lanes are not interfered with.

The inclusion of dedicated bus lanes (burgundy), improved footpaths (yellow) and dedicated cycling lanes (blue) are all possible in the current infrastructure without radical development. By doing this, we would immediately address a number of issues identified in Table 3.

Bus stop design

A major intervention based off the TOD evaluation is the design of an improved bus stop. Research showed that promoting bus usage requires wider consideration of the whole system. When people have a poor experience at bus stops while waiting for the bus to arrive it directly relates to the whole bus riding experience. As mentioned by Beirão (2007) improving the quality of the bus stops will result in better service quality. Often time waiting at a bus stop can exceed the actual time on the bus, so the experience commuters have while waiting is just as important as the experience commuters have while travelling.

Figure 2. A major highway on the fringe of Kuala Lumpur CBD.

Figure 3. Intervention to the current road network of KL using TOD principles to suggest immediate change.

Designing a bus stop must consider user needs and should include user wants. Creating an informative and pleasant space for the users to wait for their bus is particularly important given the hot sub-tropical weather conditions in Malaysia. It is understood, however that creating an improved bus stop environment may actually cause a transverse effect and bus stops may become a social space people enjoy being at. Creating a multipurpose waiting area for people to use will have a positive reflection on using the bus, however intervention may be required if people misuse this space to simply relax and stay out of the sun if they occupy all the available space away from genuine commuters.

Effective and safe spaces need to be developed to understand the relationship between systems, environments and the entire systems structure which sets the design guidelines for design development in this area. The following is a selection of initial concept sketches exploring new developments for the bus stop for Kuala Lumpur, based largely off TOD principles.

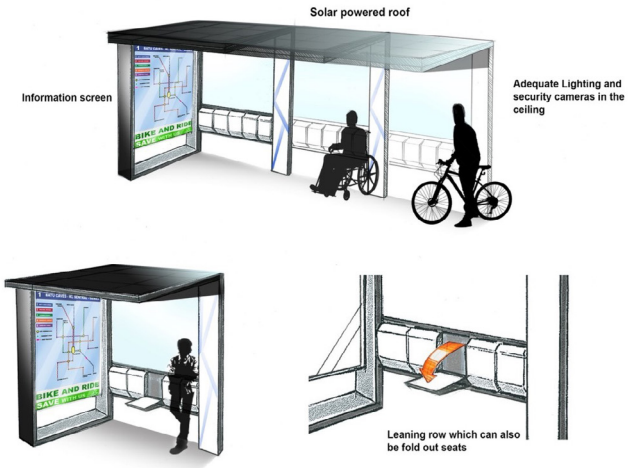

Figure 4. Concept sketching of bus stops incorporating proposed design solutions.

Refinement of selected concepts was completed with emphasis on passenger comfort during waiting, information graphics and wayfinding, as well as passive cooling techniques. Ingress and egress design elements were also a major focus to ensure the bus stops accommodate a wide range of users and integrate seamlessly with the bus network.

Conclusion

Field research and analysis of the questionnaire, along with the application of TOD principles, helped define the research objectives by narrowing down the focus in areas of specific importance to Kuala Lumpur. Observations found inadequate pedestrian and road conditions in Kuala Lumpur, as well as a lack of priority given to the bus network. Overall, the user experience of travelling by bus in Kuala Lumpur is poor. Alarmingly, the questionnaire revealed that over 60% of respondents never use the bus system available in Kuala Lumpur, showing the overwhelming majority of potential patrons are private car users creating a large segment to target with an anticipated modal shift. In order to entice people from their private car to a public transportation system, improvements must be made. This led to the urban planning metrics using the TOD Standard. This framework focused on an improved bus system to create a more sustainable city and attract patrons back to public transport. With an improved public bus system, there will be increased uptake resulting in more vibrant, sustainable communities. This is where the true value of TOD implementation lies and with small steps implementing these principles in critical areas comes large change. To put simply, a better system working off a very poor current base in Kuala Lumpur, will create greater uptake and influence modal shifts toward a more sustainable alternative. This is a slow process to implement, however governments must not be complacent and lead change in a positive direction. By supporting and changing the physical infrastructure and improving the existing networks, people will see the benefits. This is critical as the human behaviours toward such systems have to change and positive government intervention will help influence this change. TOD can be used as an alternative form of urbanism that reduces heavy reliance of the private vehicles (Cervero & Day, 2008). As highlighted in the eight principles of the TOD approach, integrating TOD principles will bring positive change to current lifestyles by better connecting people with the city they live in. Many successful businesses and organisations embrace user involvement methods in their innovation process (Steen, 2011). TOD is used to support community vitalisation and to gain great benefit for the community, not only environmentally but also socially.

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