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IDENTIFYING URBAN DESIGN PRINCIPLES AND ITS ATTRIBUTES FOR WATERFRONT TRANSIT-ORIENTED DEVELOPMENT (WTOD)

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Abstract

The booming development of transit-oriented development (TOD) worldwide, especially in high-density urban areas, has shown that many cities have started to transform their urban spaces into more sustainable and liveable cities. TOD integrates the mixed-use development around the public transport stations and promotes a pedestrian-and bicycle-friendly environment as a city lifestyle. However, such developments often lack integration with the contextual condition of the surrounding area, which in the case examined in this study is the waterfront. Many cities in developed countries such as Singapore, U.S. and Canada have started to reintegrate their TODs with the water bodies. Recent trends show that TODs are widely established in areas near the water body such as dockland and waterfront, as part of urban regeneration. Various urban design principles of waterfront transit-oriented development are available, but most of them are scattered across many documents. Thus, this research aimed to identify the urban design principles for waterfront transit-oriented development. The principles were developed using a qualitative method that included content analysis of journals, reports, and guidelines on transit-oriented development (TOD), waterfront development, and waterfront transit-oriented development (WTOD). In the end, the urban design principles of WTOD can guide professional stakeholders such as architects, planners, engineers, and others relevant to the field to reintegrate the TOD with the waterfront in future planning.

Keywords: waterfront transit-oriented development, transit-oriented development, waterfront development, urban design

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INTRODUCTION

Waterfront and transportation have continuously developed along with cities since the beginning of civilization. Both have continuously developed along with cities since the beginning of civilization. Hence, many urban centres around the world are located near the water bodies. As urban populations have increased, the usage amount of transportation has also increased accordingly (Rahmat et al., 2016). Later, transit-oriented development, or TOD was introduced as one of the solutions to support the urban growth (Ramlan et al., 2021).

TOD is defined as a new compact, green, mixed use and sustainable development developed along with the transit station, in which the transit station is within the walking distance centres the TOD area. Generally, a TOD neighbourhood has a 400m to 800m radius, which represents the pedestrian scale distances (5-10 minutes' walk) (Azmi et al., 2021). It is mainly aimed at advocating the usage of public transportation and walking as a lifestyle in a city, thus reducing the dependence on private vehicles. In other words, it offers a safe and pleasant place to walk and bike around with a variety of local goods and amenities nearby (Straatemeier, 2013).

Meanwhile, the term 'waterfront' here represents the water edge area, where the city meets the water body. Each waterfront development has unique development approaches according to its geographical location, and this is one of the most important factors that influence the growth and image of cities (Redzuan, 2018). Following the notion of TOD and waterfront, the term of waterfront transit-oriented development (WTOD) used in this research can be defined as a TOD that located in a waterfront area.

TOD became popular years later once it was introduced by Peter Calthorpe in the late 1990s (Calthorpe, 1993). Likewise, waterfronts also started to redevelop and reconnect to cities for public use through mixed-use development. Many developed cities have adopted TOD as the key driver in urban regeneration. Realizing the importance of integrating the waterfront with TOD, developed countries such as U.S. and Canada (in cities such as Poughkeepsie, Vancouver, and Toronto) have started to integrate the waterfront into their TOD guidelines through the development of the waterfront TOD guidelines (Metropolitan Transportation Authority, 2017; Vancouver City Council, 2009).

The policies regarding the TOD are very general and not specific according to the current contextual condition, which in this case, is on the waterfront areas. Neither of the TOD design guidelines emphasizes the incorporation of the waterfront into the TOD design. Hence, this research aimed to identify the urban design principles of WTOD. The research objectives encompass identifying the principles of TOD and waterfront and generating the urban design principles of WTOD. This research will cover on the TODs that are

established and located on the waterfront area and only focus on those which are located in a waterfront area.

LITERATURE REVIEW

This section will cover studies on the TOD terminologies, the principles of TOD and waterfront development and the underpinning theory used as the basis of this research. These topics are important to identify the urban design principles and its attributes for WTOD.

TOD terminologies

Although the term of TOD has been used widely around the world, not all cities have employed the same term to describe their developments around transit areas. This phenomenon applies especially to European and few Asian cities such as Copenhagen, Amsterdam, Singapore, Tokyo and Hong Kong. According to studies, the integration of transport and planning development has started before the concept of TOD was introduced in the 1990s. (Chor, 1998; Pojani & Stead, 2015; Straatemeier, 2013).

Examples of terms related to TOD that have been used worldwide are as follows:

- i. Europe – Integrated Planning and Transport Network
- ii. Singapore – Integrated Land Use and Transport
- iii. Hong Kong – Rail + Property (R+P) Model
- iv. US and other cities – Transit-Oriented Development (TOD)

Despite these differences in terms used, the aim and objectives emphasized through the guidelines are the same, which is to create and prioritize pedestrian environment, reduce private automobile dependency and encourage the use of public transport.

Principles of TOD and waterfront development

As mentioned previously, TOD planning is different according to the region and cultural context. Calthorpe (1993) defined seven principles of TOD as the guideline in developing TOD. The principles outlined include:

- i. *organise growth on a regional level to be compact and transit supportive,*
- ii. *place commercial, housing, jobs, parks, and civic uses within walking distance of transit stops,*
- iii. *create pedestrian-friendly street networks which directly connect local destinations,*
- iv. *provide a mix of housing types, densities, and costs,*

- v. *preserve sensitive habitat, riparian zones, and high-quality open space,*
- vi. *make public spaces the focus of building orientation and neighbourhood activity, and*
- vii. *encourage infill and redevelopment along transit corridors within existing neighbourhoods.*

The TOD guidelines, according to Calthorpe (1993), are designed to provide direction and policies for all levels of planning: regional, comprehensive, specific area, and zoning ordinances. This strongly suggests that the principles of TOD defined by Calthorpe are not intended as a universal model but are meant to be used as a reference guideline to help researchers and other professional bodies to design TOD guidelines according to their regions and cultural contexts.

Since then, various TOD guidelines have been developed by many developed countries around the world, especially in the U.S., Portland, Canada, Netherland, China and so on. According to studies, there are seven TOD dimensions: physical design (urban design), transportation, environment, social community, economy, collaboration and accessibility (Straatemeier, 2013; van Lierop et al., 2017).

However, only the urban design aspect of TOD will be discussed further in this research as according to studies, it is the most important element in developing a successful TOD (Jacobson & Forsyth, 2008). Studies indicated that the urban design aspect of TOD consists of density, mixed use, built form, accessibility, connectivity, pedestrian friendly and identity (Loukaitou-Sideris, 2010). These principles will be later employed to identify the urban design principles of WTOD. In line with urban regeneration, various waterfront urban design guidelines have been implemented to reattract people to the waterfront.

Underpinning theory: An integrative theory of urban design

The knowledge base of urban design theory is integrative, as it consists of substantive and procedural elements. Substantive elements include urban form and space and urban activities. On the other hand, procedural elements include intuitive, scientific, functional, and artistic methods. These integrated rules and urban design principles establish the physical environment of a city (Bahrainy & Bakhtiar, 2016).

Although urban design supports integration of principles, most urban design principles are addressed separately by prominent urban design thinkers such as Lynch (1960) – Legibility, Norberg-schulz (1980) – Meaning, Jacobs (1961)(1992) – Vitality, and Sitte (1965) – Good Form (Abdul Latip, N.S. 2011). Regardless of that, they emphasised the significance of establishing the urban experience throughout all urban space to reintegrate the urban form with the surrounding context. On a side note, these principles have been discussed together as a whole by Ernest Sternberg (2000).

Thus, Ernest Sternberg's Integrative Theory of Urban Design is more appropriate to be applied, as the author discusses the concept as a whole, as opposed to other authors who discuss each principle separately. The theory reflects the integration of urban design principles, which are good form, legibility, vitality, comfort and meaning (Sternberg, 2000). The principles will be employed as the basis of developing the urban design principles for WTOD. This will allow the relevant attributes to be categorized under each principle.

METHODOLOGY

This research employed a qualitative method, using case studies and content analysis of journals and reports from researchers that are relevant to research. The term of 'WTOD' is still scarce, as only few cities have implemented the WTOD guidelines for TODs located on the waterfront. Thus, in order to develop the urban design principles for WTOD, the identification of WTOD urban design principles were derived from the TOD urban design principles, waterfront urban design principles, and WTOD urban design principles.

Fourteen (14) case studies worldwide that are suitable to the context of WTOD were selected and reviewed. The case studies are from TODs in the U.S. (Poughkeepsie, Portland, and Austin), Canada (Vancouver and Toronto), Sweden (Stockholm), Denmark (Nordhavn), The Netherlands (Amsterdam), Singapore (Punggol), Japan (Tokyo), Australia (Brisbane and Perth) and New Zealand (Auckland).

The urban design principles of TOD, waterfront development and WTOD from the case studies were analysed. Later, the principles were categorised based on Ernest Sternberg's Integrative Theory of Urban Design, which incorporated urban design principles such as (1) good form, (2) legibility, (3) vitality, (4) comfort, and (5) meaning. The next part will discuss the analysis on the urban design principles of WTOD based on the Integrative Theory of Urban Design.

DISCUSSIONS

Since TOD was introduced by Calthorpe (1993), many developed countries perceived TOD as a smart growth strategy and key driver in urban regeneration to mitigate urban sprawl and promote new development near the transit. Many cities have started to acknowledge the integration of TOD with its contextual surroundings, which in this case, the waterfront (Knowles et al., 2020).

WTOD guidelines have only been implemented in four cities, namely Vancouver, Toronto, Poughkeepsie, and Punggol. There are studies that discussed the waterfront aspect along with the TOD principles in their TOD guidelines. This can be seen in TODs located in Amsterdam (The Netherlands), Stockholm (Sweden) and Perth (Australia) (Metropolitan Redevelopment Authority, n.d.; Stockholm City Council, 2010). TODs in three cities, which are

Tokyo (Japan), Portland (U.S.) and Auckland (New Zealand) have been found to discuss the TOD aspects in their waterfront development guidelines (City of Portland Bureau of Planning and Sustainability, 2010; Waterfront Auckland, 2014).

Meanwhile, there are also some cases where the waterfront aspect has been discussed separately (Department of Infrastructure and Planning, 2010; Urban Design Division, 2016). Cities without the WTOD guidelines have implemented the TOD and waterfront development guidelines separately. This can be seen in TODs located in Austin, Texas (U.S.) and Brisbane (Australia). There are WTODs that located on a bay, a coast, a lake, a riverbank, and a canal/waterway. According to studies, different types of waterfront have different approaches that fit to the surrounding context (Redzuan, 2018).

Table 4: Analysis of the urban design principles of TOD, waterfront development (WD) & WTOD guidelines based on the Integrative Theory of Urban Design

UD Principle	UD Attributes	Types of Guidelines															
		Case Study															
		North America					Europe			Asia		Oceania					
		Vancouver (CA)	Toronto (CA)	Poughkeepsie (US)	Austin, Texas (US)		South Waterfront, Portland (US)	Nordhavn (NL)	Amsterdam (NL)	Stockholm (SE)	Punggol (SG)	Tokyo (JP)	Brisbane (AU)		Elizabeth Quay (AU)	Perth City Link (AU)	Wynyard, Auckland (NZ)
		WTOD	WTOD	WTOD	TOD	WD	WD	TOD	TOD	TOD	WTOD	WD	TOD	WD	TOD	TOD	WD
Good Form	Density	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Building height & scale	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Building orientation	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Building frontage	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Climate responsive	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Building architecture	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Legibility	Connectivity	Pedestrian walkways	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Cycling pathways	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		Streets	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Access	Ground level porosity									/						
		Visual access	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

	Transit access	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Pedestrian access	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Parking & services	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Direct access to water	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Waterfront link to the city	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Vitality	Mixed use	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Comfort	Seating	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Shading	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Greenery & landscaping	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Street furniture	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
	Lighting	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Meaning	Identity	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

According to Sternberg (2000), the ‘good form’ principle is pertinent in the integrative theory of urban design. As shown in Table 1, density, building enclosure, building orientation, building frontage, climate responsive, and building architecture styles are the attributes that are extensively discussed by most studies. However, studies related to waterfront development guidelines has been found not to discuss the attributes of ‘good form’ especially in Brisbane (Brisbane City Council, 2013). However, this is widely mentioned in the city’s TOD guidelines. Although the attributes are not mentioned in the waterfront development guidelines, they are highlighted in the TOD guidelines or vice versa.

The ‘legibility’ aspect is also considered as an important principle that makes a good urban design of a city. In the context of waterfront development, Abdul Latip, N.S. (2011) stated that the legibility is associated with people’s understanding of the city structure in getting near the water’s edge. As this research has focused on integrating the waterfront and TOD, the legibility aspect both in the context of TOD and waterfront are studied to develop the urban design principles of WTOD. According to some studies, the attributes of legibility are classified into two categories, which are connectivity and accessibility.

Based on Table 1, pedestrian walkways, cycling pathways, and streets are commonly discussed in most studies concerning the connectivity principle. Studies have shown that these attributes provide important linkages and enhance the walkability in the waterfront and TOD area.

Meanwhile, studies on the accessibility showed the attributes related to visual access, transit access, pedestrian access, parking and services, direct access to waterfront and waterfront link to the city are widely discussed in most of the studies. The principles related to accessibility not only provide a clear direction or path, but also offer a sense of welcome to the users, enhance comfortability

and instil a feeling of safety, especially when they are near to the water or any parts of the TOD area (Fang & Xi, 2017). On a contrary, the ground level porosity attribute is only discussed in the studies of WTOD in Singapore. According to Urban Redevelopment Authority (2019) a high degree of ground-level porosity is to be maintained to improve wind flows and views, as well as convenient public access through the precinct. No physical enclosures or boundary walls should be permitted around the site to ensure high pedestrian accessibility. Regardless of that, its importance remains acknowledged in developing the urban design principles of WTOD as ground level porosity is considered an important aspect when developing the TOD located on the waterfront in Singapore.

Another important principle in the Integrative Theory of Urban Design according to Sternberg (2000), is 'vitality'. According to Jacobs (1961), the vitality of a city is influenced by its physical diversity. Diverse development comprises a mixture of uses such as residential, commercial, industrial, institutional, and those related to transportation within a desirable walking distance. As shown in Table 1, the presence of mixed use has been extensively discussed by most studies. According to Sung & Lee (2015), a mixed of activities that are located nearby the transit and waterfront area will eventually encourage walking and cycling within the city.

'Comfort' is another principle that is important in the Integrative Theory of Urban Design. According to Carmona et al. (2003), environmental factors, physical comfort, and social and psychological comfort are components of successful public spaces. Based on Table 1, seating, shading, greenery and landscaping, street furniture, and lighting are the attributes that commonly discussed in many studies. Clifton et al. (2008) stated that the shade provides by the tree canopy, for instance, brings a sense of enclosure, which eventually provides comfort, particularly in hot climates. Environmental conditions in public spaces and buildings, such as microclimate, sunlight, shelter, air circulation, and lighting are vital in creating a comfortable space in a hot and humid country like Malaysia (Rahman et al., 2015).

The aspect of 'meaning' is also described as important as the previous principles in the integrative theory. In this research, meaning does not necessarily associated with history and tradition. Concerning the waterfront and TOD, meaning can also be derived from the combination of both physical and experiential attributes without any historical involvement. Referring to Table 1, the attribute of identity has been significantly highlighted in the studies. People create meaning based on their experiences in which is influenced by the physical settings and activities that occurred, to give themselves the sense of identity. Additionally, designing a good urban place requires the combination of all urban qualities – 'good form', 'legibility', 'vitality' and 'comfort' (Jacobs & Appleyard, 1987).

Density without liveability could bring back the 19th-century urban poor. Without small-scale, fine-grain development, public places would lead to vast and overscaled cities. An aesthetic place is meaningless without activities that occur within it. Activities give meaning to space and shape the experiences within it. A diverse and densely developed urban structure would create an urban setting that is more meaningful that could enhance the meaning among the users.

FINDINGS

Based on the case studies, it can be inferred that all the outlined principles and attributes can be applied within the context of Malaysia, as current urban development patterns show neither significant differences from other cities across the continents. This research establishes five (5) significant findings:

- (i) Only a few cities have adopted the waterfront development guidelines into their TOD guidelines.
- (ii) It is important to consider the waterfront development guidelines when developing the urban design principles of WTOD, especially if a city has not included the waterfront aspect in its TOD guidelines or vice versa.
- (iii) Different WTODs are relevant to specific types of waterfronts. Hence, not all urban design principles are suitable for all TODs located on the waterfront.
- (iv) Each WTOD is different, making suitable approaches differ according to the type of waterfront. This is significant in developing the urban design principles of WTOD.
- (v) For WTOD areas in which development is too dense and there is limited land for development, ground-level porosity has been found to be the best alternative to improve the wind flows and provide convenient public access through the area.

CONCLUSIONS

This research developed the urban design principles of WTOD. Based on the findings from the analysis of 14 case study WTODs across four continents, it can be concluded that achieving contextual integration between the WTOD and water body necessitates the integration of urban design principles classified as good form, legibility, vitality, comfort, and meaning.

For good form, the attributes include density, building height and scale, building orientation, building frontage, climate responsive, and building architecture. In terms of legibility, the attributes are categorized under two aspects, which are connectivity and accessibility. For the connectivity aspect, the attributes that are greatly discussed include the pedestrian walkways, cycling pathways, and streets. The accessibility aspect stresses ground level porosity, visual access, transit access, pedestrian access, parking and services, direct access

to water, and waterfront link to the city. Meanwhile, the attribute of mixed use is greatly emphasized in conferring the vitality aspect. Seating, shading, greenery and landscaping, street furniture, and lighting are the significant contributors to comfort. Finally, the establishment of place identity through the combination of physical and experiential attributes is eminent in pertaining to the principle of meaning. The integration of principles of good form, legibility, vitality, and comfort is what gives meaning to a place.

The presence of principles and attributes could influence and facilitate authorities, developers, consultants, and urban caretakers (building owners) to plan, design and manage buildings and spaces along the waterfront that contextually integrate TOD and its water body. The urban design principles of WTOD may also influence the economic value of a country and improve the image of a city by promoting a healthy and sustainable living lifestyle for the people.

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