INDICATORS FOR TRANSIT ORIENTED DEVELOPMENT (TOD) READINESS IN ISKANDAR MALAYSIA

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So verily, with the hardship, there is relief.

[94:5-6]

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May the Almighty God richly bless all of you.

ABSTRACT

Transit Oriented Development (TOD), an integrated approach for transportation and land use planning is seen as one of the best alternatives for urban sprawl. To date, there is lack of standard measurement indicators to assess TOD, especially in Malaysia. The lack of spatially measurement indicators will lead to a wrong perception of the best implementation criteria for successful TOD planning. The study examined indicators for TOD readiness in Iskandar Malaysia (IM) based on significant indicators that define the TOD concept. Four stations along Jalan Skudai- Jalan Wong Ah Fook were selected as they had been proposed for TOD development. In the first stage, based on literature review, four TOD indicators significant with IM context, namely density (population and employment), mixed use and land use diversity were analysed. To further analyse these indicators, secondary data that included the population and type of land uses obtained from Iskandar Regional Development Authority (IRDA) and Majlis Bandaraya Johor Bahru (MBJB) office were used. Based on the population and employment density analysis, Station 1 was found to have the highest density (295 persons per acre and 137 employments per acre). Meanwhile, the mixed use index between residential and commercial for all stations was dominated by low level of mixed use which was below 0.20. Similarly, for diversity indicators, all the stations had low variation in intensity of land use. Next, in the second stage, 'Weighted Overlay' analysis computed by ArcGIS10.1 software was used to identify the station ready for TOD. Besides that, ten structured interviews were conducted randomly with selected professional urban planners in the government and private sector to assign the weight of the selected indicators based on its level of significance in relation to the success of TOD. All the indicators were reclassified and percentages of the influence were assigned based on their importance. Respondents suggested that a weight of 35% should be assigned for population density and 30% percent for employment density. In addition, 20% of weight should be assigned for mixed-use whereas 10% should be for diversity indicators. The results from that analysis showed that Station 1 with TOD score of 1.00 was the most suitable to be developed as a TOD area. This was followed by Station 4 with a TOD score of 0.91, categorised as moderate but has a high potential to be developed as a successful TOD. The findings showed that, Station 1 and Station 4 relatively had the highest scores for the four selected indicators and proved that the current development is concurrent with TOD indicators. However, improvements on the level of mixed use and diversity are needed to ensure the readiness of TOD in IM. The study concludes that future developments in TOD nodes should possess high levels of population and employment density s well as mixed use and diversity as these four TOD indicators can determine the success of TOD planning.

ABSTRAK

Pembangunan berasaskan transit (TOD), satu pendekatan bersepadu untuk pengangkutan dan pembangunan guna tanah dilihat sebagai salah satu alternatif terbaik untuk rebakan bandar. Sehingga kini, amat kurang rangka kerja pengukuran indikator reruang TOD yang seragam terutama di Malaysia. Kurangnya indikator ini menyebabkan berlakunya salah faham terhadap kaedah perlaksanaan kriteria yang menyumbang kepada kejayaan TOD. Kajian ini mengukur indikator bagi kesediaan terhadap pembangunan TOD di Iskandar Malaysia (IM) berdasarkan indikator yang mencerminkan konsep TOD. Empat stesen di sepanjang Jalan Skudai-Wong Ah Fook dipilih memandangkan stesen tersebut telah dicadangkan untuk pembangunan TOD. Pada peringkat pertama, berdasarkan kajian literatur, empat indikator TOD yang signifikan dengan konteks IM iaitu kepadatan (penduduk dan pekerjaan), guna tanah bercampur dan kepelbagaian penggunaan tanah dianalisis. Untuk menganalisis lagi petunjuk ini, data sekunder yang merangkumi data populasi dan guna tanah yang diperoleh daripada Lembaga Pembangunan Wilayah Iskandar (IRDA) dan Majlis Bandaraya Johor Bahru (MBJB) telah digunakan. Berdasarkan analisis kepadatan penduduk dan pekerjaan, Stesen 1 didapati mempunyai kepadatan yang tinggi (295 penduduk per ekar dan 137 pekerjaan per ekar). Sementara itu, kadar guna tanah bercampur antara perumahan dan komersial untuk kesemua stesen adalah rendah iaitu kurang daripada 0.2. Begitu juga untuk guna tanah kepelbagaian, kesemua stesen mempunyai nilai kepelbagaian yang rendah. Seterusnya di peringkat kedua, analisis ‘Weighted Overlay’ dengan menggunakan perisian ArcGIS 10.1 digunakan untuk mengenal pasti stesen yang sedia dibangunkan sebagai TOD. Selain itu, sepuluh temubual berstruktur telah dijalankan secara rawak dengan pegawai perancang profesional dari sektor kerajaan dan swasta bagi menetapkan pemberat untuk setiap indikator berdasarkan tahap signifikannya terhadap kejayaan TOD. Setiap indikator diklasifikasikan semula dan peratusan diberi mengikut tahap kepentingannya. Responden mencadangkan bahawa 35% perlu ditetapkan sebagai pemberat bagi indikator kepadatan penduduk dan 30% untuk kepadatan pekerjaan. Di samping itu, 20% ditetapkan bagi indikator guna tanah bercampur dan 10% bagi indikator kepelbagaian guna tanah. Hasil analisis menunjukkan bahawa Stesen 1 dengan skor TOD 1.00 mempunyai kesesuaian yang tinggi untuk dibangunkan sebagai kawasan TOD. Seterusnya, Stesen 4 dengan skor TOD 0.91 dikategorikan sebagai sederhana tetapi mempunyai potensi yang tinggi untuk dibangunkan sebagai TOD yang berjaya. Dapatan menunjukkan bahawa Stesen 1 dan 4 mempunyai skor yang tinggi bagi empat indikator terpilih seterusnya membuktikan bahawa pembangunan pada masa kini sejajar dengan indikator TOD. Walau bagaimanapun, penambahbaikan terhadap indikator guna tanah bercampur dan kepelbagaian diperlukan bagi memastikan kesediaan terhadap pembangunan TOD di IM. Kajian ini merumuskan bahawa pembangunan masa depan dalam nod TOD perlu mempunyai tahap kepadatan penduduk yang tinggi dan pekerjaan serta guna tanah bercampur dan kepelbagaian kerana empat indikator TOD ini boleh menentukan kejayaan sesebuah perancangan TOD.

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BRT	-	Bus Rapid Transit
CBD	-	Central Business District
CDP	-	Comprehensive Development Plan
CIQ	-	Customs, Immigration and Quarantine Complex
FGD	-	Focus Group Discussion
FTE	-	Full-Time Equivalent
GEA	-	Gross External Area
GIA	-	Gross Internal Area
GIS	-	Geographic Information System
IEA	-	International Energy Agency
IM	-	Iskandar Malaysia
IRDA	-	Iskandar Regional Development Authority
JB	-	Johor Bahru
JBCC	-	Johor Bahru City Center
LRT	-	Light Rail Transit system
MBJB	-	Majlis Bandaraya Johor Bahru
MCA	-	Multi-Criteria Analysis
NIA	-	Net Internal Area
RICS	-	Royal Institution of Chartered Surveyors
RO	-	Research Objectives
RQ	-	Research Questions
TOD	-	Transit Oriented Development
UK	-	United Kingdom
UPTPP	-	Urban Public Transport Policy Paper
USA	-	United States Of America
VMT	-	Vehicles Miles Travel

LIST OF SYMBOLS

km	-	Kilometre
m	-	Metre
m^2	-	Square Metre

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Malaysia has experienced very rapid growth in urbanisation like most of developing countries. The population of Malaysia increased 53 percent from 18 million in 1990 to 27.6 million in 2010 (KeTTHA, 2011). The urbanisation rate in Malaysia continued to grow from 54 percent in 1994 to 61.8 percent in 2000 and expected to increase in the near future. By this mean, there are more people that will live in urban areas as cities is known as the engines of growth.

Likewise, Johor Bahru City as the third conurbation in Malaysia after Kuala Lumpur and Penang has undergone rapid urban development and international projects, especially in Iskandar Malaysia (IM) region. Urban areas in IM have expanded to 30,323 hectares of land area with an increase of 96% between 2005 to 2013 (refer to Figure 5.1). Emerged from an established urban conurbation anchored by Johor Bahru, the urban growth concentrated in the three development corridors of East, North and South. It also clearly showed that most of the developments are focusing along the major roads heading to Johor Bahru City Center (JBCC) (refer to Figure 1.2). Consequently, Johor Bahru development started to disperse at the edges of the cities and suburban area.

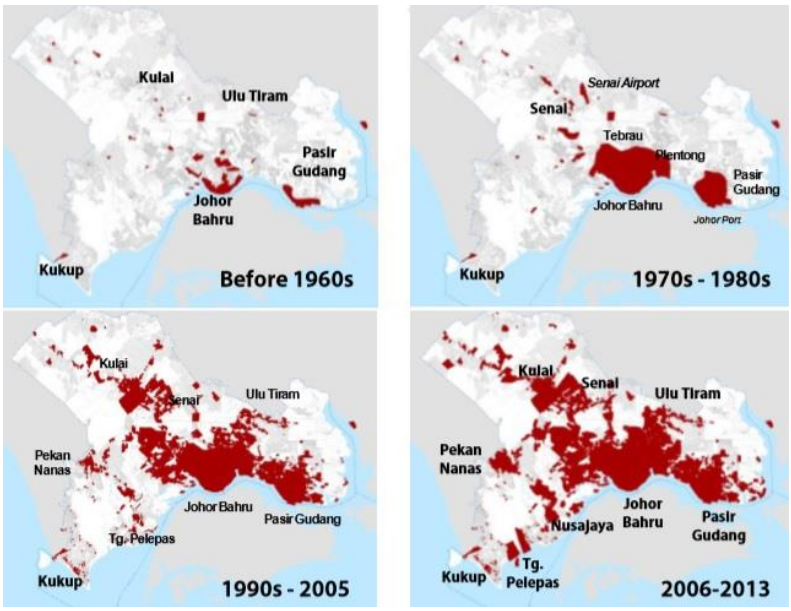

Figure 1.1 IM urban growth pattern and scenario

Source: Comprehensive Development Plan ii, 2014-2015

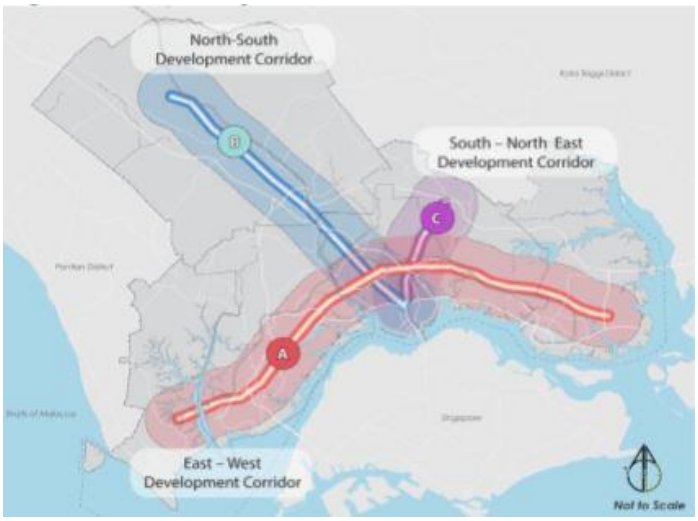

Figure 1.2 Development corridors in IM

Source: Comprehensive Development Plan ii, 2014-2015

Urban growth impact may bring both positive and negative impacts. However, if left unchecked, the negative impacts will override the positive sides. Uncontrolled and uncoordinated urban growth causes urban sprawl which responsible for changes in the physical environment. It appears that urban growth and sprawl are highly interlinked as urban sprawl induce growth in an urban area.

Urban sprawl caused by rapid urban growth is responsible for changes in the urban form and spatial structure of cities that pose a big challenge for the urban planner. Sprawl can be defined as an undesirable natural expansion of spatial structure of metropolitan area whether scattered, or leapfrog development (refer to Figure 1.3) as the population grows (Ewing, 2008). The increasing of the population in the urban area lead to massive sprawl, lack of affordable housing within the city and environmental problems. This will foster migration to the sub-urban area where most of the low-density development take part.

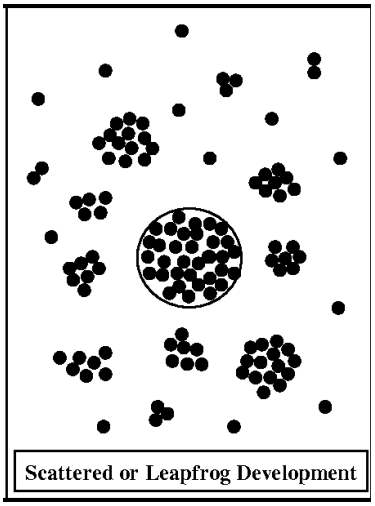

Figure 1.3 Scattered or leapfrog development

Source: Adaku & Adaku, 2012

People also start to move in the sub-urban area due to the increases of the living and property cost. Lack of affordable housing within the city, therefore, pushes people especially median household income to set their residences. The migration to sub-urban area creates demand thus encourages many developers to develop housing and other urban infrastructure that are resulting in a variety of discontinuous uncorrelated developments. In addition, it also consumes large quantities of land, segregates land use activities and highly dependent on the private car (Gurin, 2003).

The sprawl and uncontrolled development especially commercial and residential developments hinder transit ridership, thus has increased private vehicle usage. For instance, Kuala Lumpur vehicle ownership has increased 23 percent from

2009 to 2013, whereas Johor has increased 19 percent which has led to the urban problem such as congestion and pollution (refer to Table 1.1). Besides, the vehicle ownership significantly influences the traffic demand as once a car is owned, it is difficult to prevent its usage (Verma, 2014).

As for IM, based on Iskandar Regional Development Authority (IRDA) in Comprehensive Development Plan (CDP), traffic is estimated to grow at an average rate up to 4.2 percent in the year 2025 compared to 3.9 percent in the year 2001. Due to the fact that cities have grown, the mobility demand also increases and subsequently causes congestion which reduced travel speed especially in the urban centre. Besides, the road infrastructure expands along the economic growth as economic activities also created demand for more roads (Sillaparcharn, 2007).

The transportation infrastructures development is another factor that contribute to the urban sprawl and traffic congestion which at the end lead to the environmental deterioration. Based on world emissions by sector in 2012, the transportation sector accounted for 23 percent which reflected an increase of 3.0 percent between 2009 and 2010 (IEA, 2014) (refer to Figure 1.4). If left unchecked, growth in the transportation sector is expected to add carbon emission, increased transportation demand and uncontrolled urban development in the near future.

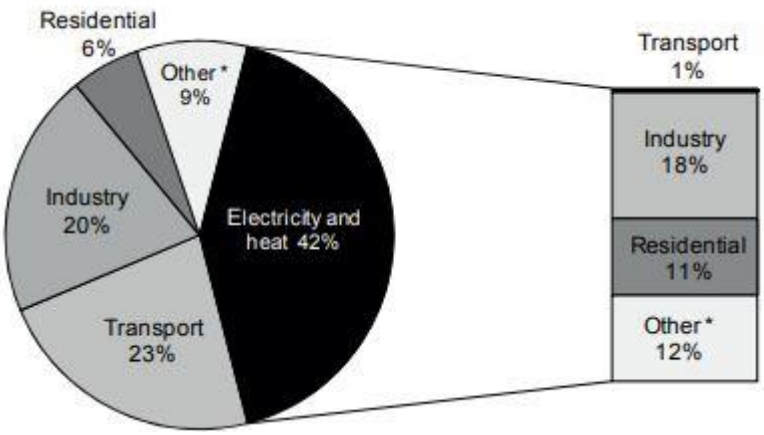

Figure 1.4 World CO_2 emissions by sector in 2012

Source: International Energy Agency (IEA), 2014

Table 1.1 Total of motorcar in Malaysia for the year 2008 to 2013

State	2009	2010	2011	2012	2013
Perlis	16,137	17,979	19,197	21,055	21,229
Kedah	241,360	257,193	274,700	292,997	300,868
Pulau Pinang	830,678	890,652	945,444	1,000,131	1,024,197
Perak	577,160	613,094	649,025	687,213	699,651
Selangor	947,802	987,024	1,020,981	1,052,353	1,037,243
Kuala Lumpur	2,650,317	2,867,830	3,093,778	3,332,767	3,442,319
Negeri Sembilan	265,636	280,914	294,579	309,135	312,156
Melaka	252,606	270,143	286,589	303,162	310,169
Johor	1,086,147	1,160,041	1,234,331	1,312,016	1,339,446
Pahang	285,061	305,042	325,611	345,883	346,939
Terengganu	146,091	158,860	170,705	183,793	188,275
Kelantan	215,020	232,322	248,874	267,542	273,140
Sabah	447,378	487,510	528,073	570,267	556,699
Sarawak	544,687	586,316	629,560	676,364	683,244
Total	8,506,080	9,114,920	9,721,447	10,354,678	10,535,575

(Source: Ministry of Transport, 2013)

In addition, the developments of road infrastructure give the flexibility of reaching multiple destinations and started to change their travel preferences from public transport to the private car. Therefore, people who are own a car tend to travel frequently and make longer journeys. As a result, they become reluctant to switch to other modes of transport which significantly affect the public transport ridership and walkability.

Undoubtedly, based on the discussion above, urban growth contributed to unintended problems such as urban sprawl that leads to the inefficient spatial configuration, inefficient transportation systems and environmental issues. Urban

planners are obligated to take measures to counter the occurrence of sprawl in a way to make the city's transportation and urban development more sustainable. By this mean, it is necessary to integrate the land use development with the transportation systems.

Transit Oriented Development (TOD) is an ideal concept that focuses on connecting transit systems physically and functionally with the surrounding development thereby create compact, lively, sustainable and pedestrian friendly areas (Belzer, Dena, & Autler, 2002). TOD is designed to maximise access by transit and non-motorised transportation by encouraging high density and mixed used developments. It also was suggested by Calthorpe as a supporting concept to increase the use of public transportation and at the same time reduce the use of private vehicles.

The increasing popularity of TOD, unfortunately, creates a tendency for any new development near a transit station to be labelled and marketed as TOD (Irvine, 2009). Incorrectly described as TOD, this so-called 'TOD development' are fail to include sufficient of the essential components of TOD and should not be promoted as TOD. In order to avoid misleading of the TOD concept, it is important to have practical measurement tools in planning TOD (Fard, 2013). Furthermore, measuring the TOD levels or TOD-ness contribute to more effective TOD plans with higher chances of success (Singh, 2015). Lukman (2014), Fard (2013), Singh, Zuidgeest, Flacke, & Maarseveen (2012) and Evans, Pratt, Stryker, & Kuzmyak (2007) have previously discussed this issue.

With the practical measurement tools, it will reflect the level and existing conditions of TOD concepts in particular areas. By understanding the existing situation, it will help urban planner and decision maker to plan and improve the TOD level, thus avoid the misconception of TOD. According to Fard (2013), there is no uniformly accepted method to measure the TOD level, and Singh et al. (2012) reveal that even though there are proposed indicators to evaluate quantitatively, it is not used comprehensively. Hence, this research aims to examine the TOD readiness by identifying on significant indicators that define the TOD concept in IM and the indicators that need to be improve in order to plan success TOD in future.

1.2 Problem Statement

TOD is one of the best alternatives for various sustainable challenges especially in preventing urban sprawl (Olaru, Smith, & Taplin, 2011; Sung & Oh, 2011). According to Thomas & Bertolini (2017) and Mu & de Jong (2012), TOD planning principles has been adopted around the world to control urban growth, reshape the quality of urban form and provide efficient transportation systems. The possibilities of TOD to address urban problems such as traffic congestion that resulting from urban sprawl also has been studied by various Asian government such as China, Hong Kong, Singapore and Japan (Hasibuan, Soemardi, Koestoer, & Moersidik, 2014; Mu & de Jong, 2012; Sung & Oh, 2011). Undoubtedly, as for this study, TOD is preferable to be adapted to promote sustainability in IM.

Over the years, IM devoted to enhancing sustainability, especially in the transportation sector. In IM, TOD is one of the infrastructure development initiatives (IRDA, 2014) by introducing an efficient public transportation system that links major centres. Following this, the public transit network of Bus Rapid System (BRT), rail and high-speed rail are designated as TOD zone where urban development within the TODs are to be planned integrated with the transit station (IRDA, 2014). The development of BRT creates both a physical and a visual connection which has an opportunity as an interim step to build ridership (Currie, 2006). In fact, allocating BRT services at major rail stations is seen to have a potential for TOD to spur.

Generally, TOD is about creating an urban environment with mixed and diverse land use and walkable to the transit stop that balances the need for sufficient density to support convenient transit services. Successful TOD implementations should have recognised these particular outcomes: provide mobility choices, increase transit ridership, reduce Vehicles Miles Travel (VMT), increase public safety and reduce environmental pollution. However, most of the current TOD projects failed to achieve these outcomes, but still labelled as TOD for the sake to acknowledge the connection that has been made between transit and development (D. Belzer & Autler, 2002).

Furthermore, most often the developments that claimed as TOD have conventional sub-urban single-use development patterns which actually is transit adjacent development (Irvine, 2009; Tumlin & Millard-ball, 2003; Bickerstaff, Tolley, & Walker, 2002). In fact, some of TOD projects such as Stesen LRT Miharja, Kuala Lumpur is located close to the transit stations but not pedestrian and cyclist friendly, failed the walkability test and lack of mixed use activities for the population that it is supposed to serve (KLCH, 2018). This proved that there is no interaction between urban development with the transit system. Similarly, unbalanced between residential and commercial developments with low employment densities is likely to not meet TOD concepts.

Henceforth, it is important to ensure the urban development strongly integrated with the transit to ensure the outcomes of TOD can be achieved. It appears that not all TOD projects in all places will or even can meet the standard by which true TOD should be defined. Measuring the success of TOD is subjective as it is about measuring how oriented an urban area is towards the use of transit. By measuring the existing TOD conditions or performance, it helps urban planners and policy makers identify TOD criteria that need improvement. According to Renne (2003), the indicators used to measure the TOD conditions should be able to be compared with regional and sub-regional TODs.

To date, there are lack of standard measurement indicators to evaluate TOD (Singh et al, 2014), especially in Malaysia. The lack of spatially measurement indicators will lead to a wrong perception of the best implementation criteria for successful TOD planning, especially in IM. Most often, the local policy document and guidelines focusing on the general principles and criteria that need to be implemented in the TOD catchment areas. For instance, Johor Bahru and Kulai 2025 Local Plan and Iskandar Malaysia Comprehensive Development Plan ii, 2014-2015 are only highlighted the requirements for high housing density and development intensity in identified TOD areas. In addition, the Housing Planning Guidelines by PLANMalaysia, 2016 also emphasis on the needs for high density and mixed use development within 400 metre of TOD area.

The information on how to measure the TOD criteria on existing or proposed TOD nodes is also limited especially in IM. There is lack of explanation on how to measure the TOD indicators in order to ascertain those areas are ready for TOD especially in term of land use zoning arrangements. The identification of significant indicators to assess TOD readiness based on the suitable criteria and indicators that define the TOD concept is important in order to determine how far the existing land use zoning and planning fulfil the TOD criteria and principles. The criteria and indicators for evaluation might be different depending on the stakeholder's objectives and expectations (Singh, 2015).

Therefore, there is a need in trying to apply and modify the assessment indicators which has been discussed earlier with proper adjustment to suit the IM context. As for this research, it is significant to identify the most significant indicators to evaluate the readiness of TOD specifically for IM. With those selected indicators, this study will measure the current conditions of proposed TOD in IM areas by using GIS in order to determine the potential of TOD. In the end, this research will assist local authority, urban planner, policy makers to determine what are the significant criteria and indicator that need to be considered for planning successful TOD. The overall formulation of the problem statement for this research is explained in Figure 1.5.

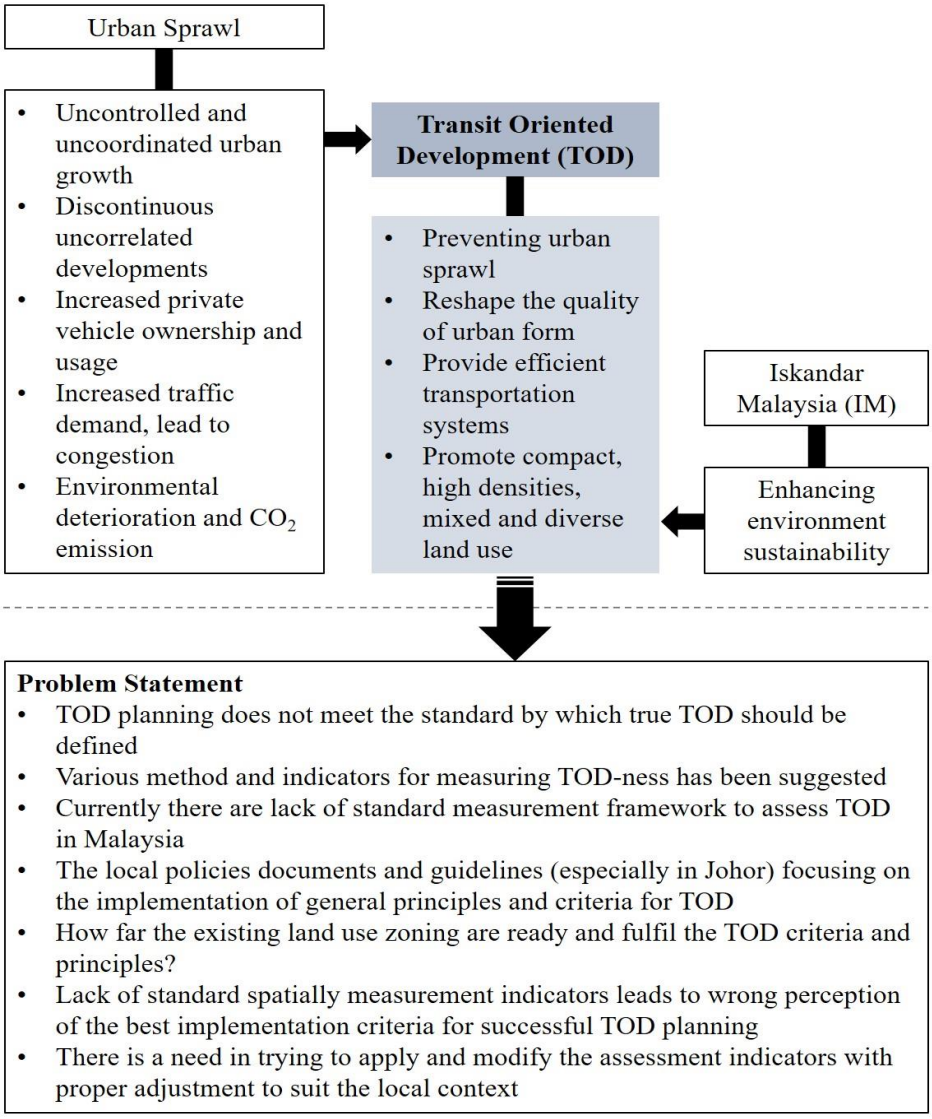

Figure 1.5 Formulation of the problem statement

1.3 Research Objectives

In response to the problem statements to identify the most significant indicators for TOD evaluation this study aims to examine "The indicators for Transit Oriented Development (TOD) readiness in IM based on significant indicators that define the TOD concept". To achieve this aim, the following objectives are formulated:

a) To identify the significant indicators for measuring the TOD readiness around the proposed TOD nodes in IM
b) To evaluate the significant indicators that affect the TOD readiness in IM by using GIS as analytical tools
c) To identify indicators that need to be improved around the transit nodes based on the TOD scores

1.4 Research Questions

The research questions are formulated on the basis of the objectives presented above:

a) What are the significant indicators to measure the TOD readiness around the proposed TOD nodes in IM?
b) How to measure the chosen indicators that affect TOD readiness in IM by using GIS?
c) What are the TOD indicators that need to be improve for each stations that can be suggested to the stakeholders?

1.5 Scope of Study

This research will focus on the proposed TOD station with new development along Johor Bahru-Skudai corridors, Johor Bahru district which is one of five municipalities in IM. This research considers 400 metre radius from proposed BRT stations for the primary area of TOD as it is standard radius for TOD catchment in Malaysia context. As for the secondary area, the two kilometres radius is decided as it is a suitable distance for park and ride planning which generates greater potential public transport users from a greater distance that accessing a station by car. The proposed BRT stations are used as study area since the stations are planned to be TOD nodes in IM in future.

For this research, the readiness of TOD in IM are evaluate based on the indicators that reflect the concept of TOD and factors that lead to the success of TOD implementation. Therefore, this research examines relevant literature related to the concept of TOD, criteria in developing successful TOD, the implementation of TOD and the evaluation method to assess TOD. As for the data, this research will include both primary and secondary data. The primary data will be obtained from interviews among urban planners and site inventory, meanwhile, the secondary data such as land use composition and population in GIS dataset will be obtained from IRDA and MBJB. Lastly, the analysis of this research will use ArcGIS 10.1 as spatial analytical tools to evaluate the selected significant TOD indicators in IM.

1.6 Research Framework

This research will involve five phases (refer to Figure 1.6). The first phase is the preliminary study and problem identification that include the basis needed for this research. The second phase contains the extensive readings for literature review that related with the TOD. At this phases, the evaluation of TOD criteria also will be studied and to be used as a guide for the data collection and analysis. Whereas for the third phases, it will involve the data collection and data analysis which related to achieving the research objectives. The fourth phases of this research will discuss the data analysis and findings. As for the last phases, it will conclude the overall findings and recommendation for future research respective to the TOD.

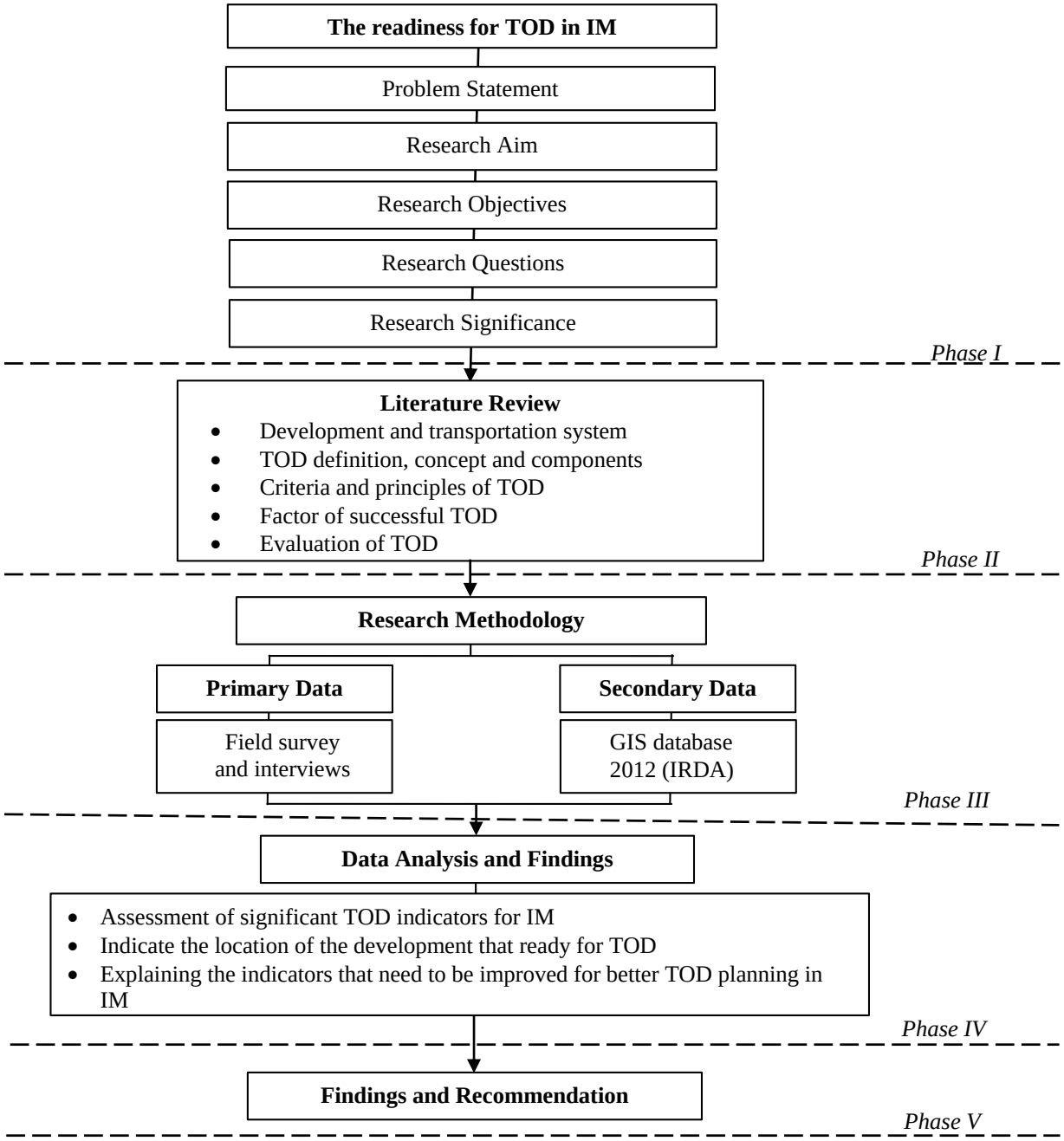

Figure 1.6 Research framework

1.7 Structure of Thesis

The thesis comprises of five chapters:

Chapter 1 presents a research background, problem statements, research objectives, research questions, and the significance of the study.

Chapter 2 presents a literature review discussing the theory of land development and urban sprawl. This chapter also emphasises the definition, concept and components of TOD planning which has been practised by other countries. Furthermore, this chapter will explain in details on criteria, characteristics and guiding principles of TOD. The method to evaluate TOD and uses of ArcGIS as tools also will explain in this chapter.

Chapter 3 presents the methodology used in this research, including research design, framework, variables and selected indicators based on literature review.

Chapter 4 presents details analysis and findings for each objective that has been highlighted. In the first stages, the analysis will cover on land use zoning distribution in order to determine whether the existing developments are ready for TOD planning. If yes, which criteria and indicators that already applicable thus can be used to evaluate the TOD nodes that have been chosen. In the second stages, the selected development project will be evaluated based on the criteria and indicators by using multi-criteria analysis. The results will identify the most important criteria and indicators that should be considered and need to be improved for TOD implementation in IM.

Chapter 5 presents the recommendations and conclusion based on the analysis that has been conducted. The potential for further study also will be explained in this chapter.

1.8 Significance of the Research

TOD planning is one of the most popular development concepts that have been practice to address the urban problems like urban sprawl and traffic congestion. TOD planning is still new in Malaysia, especially in IM. Even though there is an effort by IRDA and local authorities to implement the TOD planning, it is still in the early phase of implementation. To date, there are no planning tools provided to assess the readiness for TOD in Malaysia. Without appropriate assessment tools for TOD, the implementation of TOD may fail to achieve the outcomes of TOD itself.

Realise that it is important to have assessment method with significant TOD indicators, this study attempt to determine and measure the TOD indicators in the potential areas for TOD in IM. This study will help to identify whether the existing developments are complying with the TOD principles and at the same time may highlight the most important indicators that need to be improved for better future TOD planning. Furthermore, by identifying the significant TOD indicators, it can be used as a checklist for TOD requirements to guide the TOD planning in Malaysia cities. The evaluation of TOD indicators also will help the policy makers and urban planners explore the potential and suitability of TOD implementation.

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