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THE INTERPLAY OF SPATIAL POLICY, TRAVEL BEHAVIOUR AND AIR QUALITY IN ISKANDAR MALAYSIA

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Abstract
Iskandar Malaysia has been emerging as a centre of economic growth in the southern corridor of Malaysia. While the present spatial policy has emboldened the growth centre that inspires the urban development in the region to flourish, the spatial development has brought a substantial environmental consequence to urban areas. With the support of travel behaviour of the citizens as a catalyst, the interplay between spatial policy and urban air quality in the region becomes a major concern. This study began by undertaking spatial policy analysis at local and federal levels. Then, an origin-destination study was carried out to assess the travel behaviour of citizens and the concentricity or poly-centricity of the region as an eventual reflection of spatial policy. Based on the information on travel behaviour and number of vehicles in Iskandar Malaysia, the vehicle-kilometre travelled (VKT) was estimated as well as the carbon emission from the transport sector. An ethnographic survey was also conducted to understand the non-motorized travel behaviour of the citizens i.e. willingness to walk. This survey was to crosscheck and confirm the willingness to walk of the citizens resulting from questionnaire survey. Results of the study reveal that the spatial policies of Iskandar Malaysia along with the travel behaviour of the citizens have strongly shaped the present spatial structure of Iskandar Malaysia region, and ultimately lead to ever increasing air pollution in the region.

Keyword: Spatial policy, spatial structure, travel behaviour, growth centre, transport energy, air quality.

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INTRODUCTION

Spatial policy may be influenced by various determinants, for example, political agenda (Chen et al., 2015), economic motive (Chen et al., 2005), social, and financial and business power (Mirabaud & Deberre, 2006). The power of developing, implementing and enforcing spatial policy is mostly in government's hands through their legislative and executive powers. In a city, the authority of implementing and enforcing power on spatial policy is commonly in the hand of the mayor. By the presence of spatial policy powers at the city authority with various driving forces and motives, the spatial policy is therefore reflected in the existing land use and urban form. This study recognized that the existing urban form and the performance of its elements are the ultimate reflections of the city stakeholders. Accommodating the various aspirations of every single city stakeholders is impossible to be reflected in the city. However, there is a common interest of all city stakeholders towards liveable and sustainable cities. City policy will be reflected in the performance of city itself (City of Westminster, 2016).

Spatial policy of a city, as reflected in urban land use, brings different impacts in the downstream process, for example, on transport and environment (Permana et al., 2015a). Many studies have been done on land use and transport articulations as well as energy and transport interplays. As a result, land use, transport, energy and environment nexus has been well articulated for quite a while, for example by Permana et al. (2015a), Brandi, Nigro and Petrelli (2015),Wang, Monzon and Ciommo (2014), Koomen and van Beurden (2011), Hickman and Banister (2007), Cervero (1996), Banister and Liechfield (1995), and Newman and Kenworthy (1989). Within this nexus, the energy and environment relationship study has also been adequately carried out, as exhibited by Permana et al. (2015b), Proost and van Dender (2012), Permana et al. (2008), Warren and Enoch (2006), Steemers (2003), Keuken (2002), Ahearn (1997), Anderson et al. (1996), Breheny (1995), Owens (1992) and many others. In contrast, only few studies on the linear nexus of land use, transport, energy use and environment have been undertaken. This nexus exhibits linearity among elements, and therefore, is a multi-disciplinary research arena due to their interconnectivity. This nexus emerges a potential climate change co-benefits if the elements are properly synergized (Figure 1).

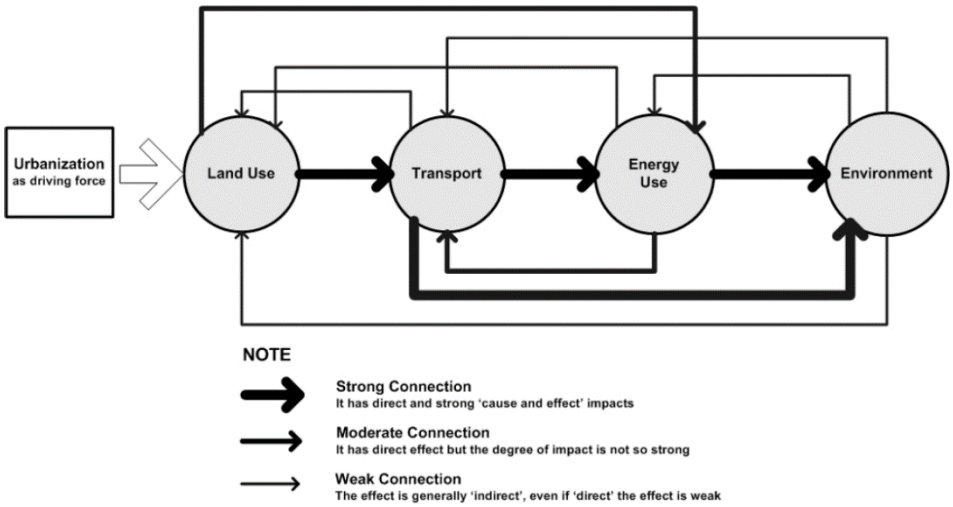

Figure 1 Land Use, Transportation and Environment Nexus

RESEARCH BACKGROUND

Iskandar Malaysia was established in accordance with the establishment of Iskandar Regional Development Authority (IRDA) by Act 664. The purpose of IRDA, as reflected by the Act 664, is to provide the proper direction, policies and strategies in relation with the development within Iskandar Region; and to provide the coordinating platform among government agencies to promote trade, investment and development within the Iskandar Region (Iskandar Regional Development Authority Act 664, 2007). As a prominent southern economic corridor of Malaysia, Iskandar Malaysia is located in the State of Johor and plays a significant role in promoting the development in the region, which was formerly known as Iskandar Development Region and South Johor Economic Region. Iskandar Malaysia region covers several areas, which are *Bandaraya Johor Bahru*, *Bandar Johor Bahru Tengah*, *Bandar Pasir Gudang*, *Bandar Kulai* and *Daerah Pontian*. The special region of Iskandar Malaysia is being managed by Iskandar Regional Development Authority.

The fast urban development in Iskandar Malaysia, which has been largely fuelled by the Malaysia National Physical Plan, has made the Iskandar Malaysia region an interesting research arena particularly with respect to urban planning and development, and other associated fields. Five flagship zones have been set in Iskandar Malaysia (IRDA, 2016). The zones have different emphasis but synergistically work towards the accomplishment of Iskandar Malaysia's vision as a strong and sustainable metropolis of international standing.

METHODOLOGY

The study was conducted in Iskandar Malaysia by undertaking (1) household-based questionnaire survey to understand citizen's travel behaviour, their transport energy consumptions, 'stated willingness to walk' of the respondents and other relevant attributes (2) origin-destination survey to understand the poly-centricity of the study area (3) analysis on vehicle-kilometre travelled (VKT) in the study area (4) estimation of carbon emission in Iskandar Malaysia based on VKT (5) ethnographic survey to understand the 'revealed willingness to walk' and to crosscheck with the 'stated willingness to walk' of the citizens of Iskandar Malaysia.

A convenient random sample survey was undertaken. The number of sample in each area was taken as close as the proportion of population size, strength of influence and size of the area. The strength of influence of an area of Iskandar Malaysia was very subjective and thus needed an academic judgement, which was based on the information received by the researchers. An ethnographic survey was also done where the researchers candidly observed the walking behaviour of the randomly selected respondents. This was to crosscheck and confirm the willingness to walk of the citizens, and this will be discussed further in the subsequent sections.

RESULTS AND DISCUSSIONS

The Spatial Structure in Iskandar Malaysia: The Concentricity that matters

The micro spatial structure of Iskandar Malaysia is reflected in the development of neighbourhoods *(Tamans)*. As required by law, the elements of a *Taman* in Iskandar Malaysia commonly consist of mix-development of residential and commercial premises. Industrial areas are separated from this mix-development *Taman* by a distinguished *Taman Perindustrian* (Industrial Park). The idea of mix-development of residential and commercial area within a *Taman* was to accomplish the 'within walking distance' concept. It is thus expected to minimize the needs for motorized travel, and subsequently reduce the transport energy consumption and improve urban air quality. This study shows that most citizens of Iskandar Malaysia, or *Johoreans*, are willing to walk (WTW) for social purpose for only 252 meters (stated WTW). Ethnographic research in some neighbourhoods in Johor Bahru reveals a very surprising fact that three different races in Malaysia exhibit different walking habits as shown in the Table 1.

Table 1 Walking Distance of Malaysian Race in the Study Area (Revealed WTW)

No	Three Primary Races of Malaysian	Number of Sample	Average Distance of Walk for different social purposes (Meter)			Probability of WTW for walking distance of >250 m (%)
			Shopping Purposes	Religious Purposes	Social Visit	
1	Malay	32	45	155	60	6.0
2	Chinese	25	78	ND*	75	18.0
3	Indian	23	56	70	55	13.0

**NOTE: The Chinese race can do their religious practices in their own premises. Thus distance may be zero*

Although the above information may not statistically represent the entire Malaysians - because to acquire the truly statistically representative data may require 3 years of ethnographic research - but the ethnographic survey shows that generally Malays have the lowest probability of willingness to walk for general purpose with the distance of more than 250 meters. Surprisingly, Malays have the longest walking distance for religious purpose e.g. praying in the *masjid* in comparison to the other two races. The fundamental reason of this fact is due to the strong belief of Muslim Malay on the reward of every single foot-step of him to pray in the *masjid*. In the meantime, Chinese has no preference on the religious duty since most of them can do their religious practices in their own houses, and thus, the distance may be zero.

By the above facts, the present neighbourhood design in Malaysia, by adopting mixed development concept, may not be able to encourage most Malaysian to travel with non-motorized mode of transportation. Thus, the concept of 'within walking distance' of mixed development may not accomplish its mission to minimize transport energy consumption and improve urban air quality. Still, to some extent, energy consumption reduction exists. The present horizontal mixed development seems failed to minimize energy consumption for transport purpose by the above reasons. The paradigm shift of mixed development is therefore necessary towards (1) vertical high-density (HD) mixed development and/or (2) horizontal mixed development with equidistance for shopping and primary education. This concept has been successfully implemented in, for instance, Singapore and Bangkok with full support from the public transportation system.

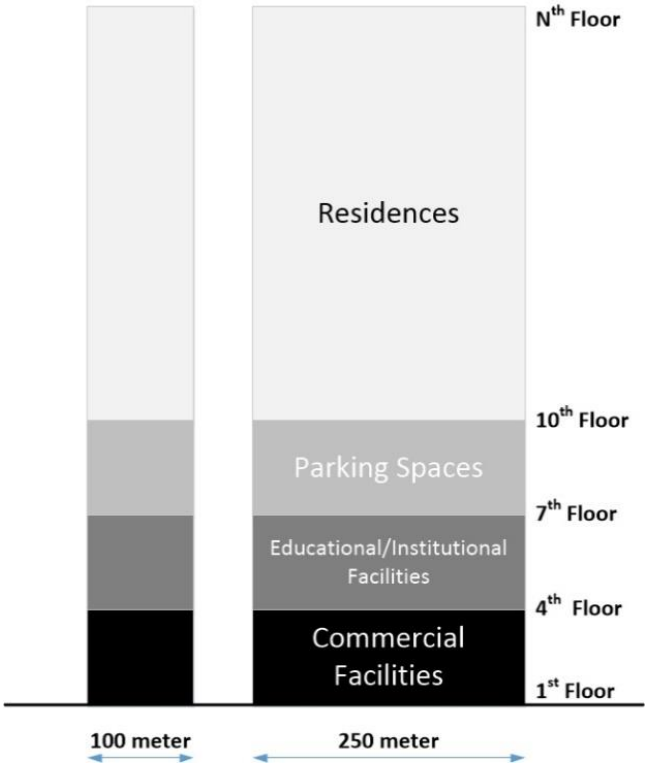

Figure 2 Vertical HD Mixed Development Concept

Vertical high-density mixed development means the development of residential, commercial and educational facilities are within the same premise but different strata, such as a superblock multi-storey condominium or apartment where the first three floors are intended for commercial facilities, the fourth to sixth floors are for educational and institutional facilities, the seventh to tenth floors are for parking, and the remaining eleventh floor and above are for residential premises. The basic concept of vertical high density mixed development is shown in Figure 2. The prominent appearance of the vertical high density mixed development in Bangkok, for example, reflects only single purpose apartment or condominium i.e. residential purpose with complimentary utilities and amenities. The same approach is also adopted in Iskandar Malaysia region, particularly in Johor Bahru, except few examples such as KSL Resort and Water Front Danga Bay and Skudai Parade, although these examples reflect only the mixture of residential and commercial purposes with complementary utilities and amenities such as parking lots. In this condition, present mixed development approach in urban development to accomplish 'within walking distance' concept prevails.

Another approach is by adopting horizontal mixed development. This concept means that the development of residential, commercial and educational areas follow a radial zoning pattern with equidistance feature where primary educational area is in the core of the area. The circumferential zone next to the core is commercial area, and then in the outside part of the zone is residential area. The maximum radius of the zone is 250 meters, or the distance of the centre point to the centre of gravity of the residential areas is 250 meters. This is considering the willingness to walk of the citizens. Otherwise the concept of 'within walking distance' will again fail. The basic concept of horizontal mixed development is shown in Figure 3.

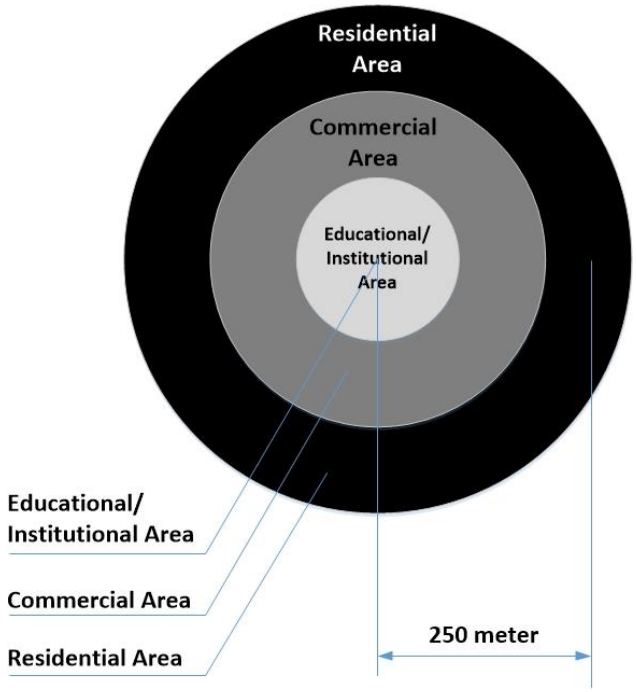

Figure 3 Horizontal Mixed Development with Equidistance Feature

Even though at micro-level, which is basically shaped by present mixed development, the development in Iskandar Malaysia does not reflect the fundamental reduction on motorized travel demand. However, at the macro-level, the spatial structure of Iskandar Malaysia reflects a polycentric quality. The polycentric quality would be able to reduce the distance of motorized travel demand and traffic congestion.

The urban features towards low carbon emission which should be available in Iskandar Malaysia are (1) 'within walking distance', (2) the willingness of Citizens to walk for shorter distance travel, and (3) the absence of

micro element of urban design of pedestrian friendly environment. The quality of 'within walking distance' has actually been implemented to some extent in Iskandar Malaysia through mixed development, although some improvement to suit the travel behaviour of the citizens may be necessary. On the other hand, the travel mode of citizens in Iskandar Malaysia is predominantly motorized travel, even for short distance, due to easy and affordable private car ownership. These facts are seemingly leading to the ever-strengthening interplay between land use, transport and air quality in Iskandar Malaysia.

The Interplays of the Nexus' Elements

The linear interplay of land use (as reflected by urban structure), transportation, and environment (as exhibited by air quality) shows very strong association in Iskandar Malaysia. Figure 4 shows that the VKT is steadily increasing over the years, and shows predominant feature of private cars in aggregated VKT. The private car ownership in Iskandar Malaysia was 0.40 car/person and private vehicle ownership (cars and motorcycles) was 0.90 vehicle/person in 2014, and these figures may increase tremendously every year.

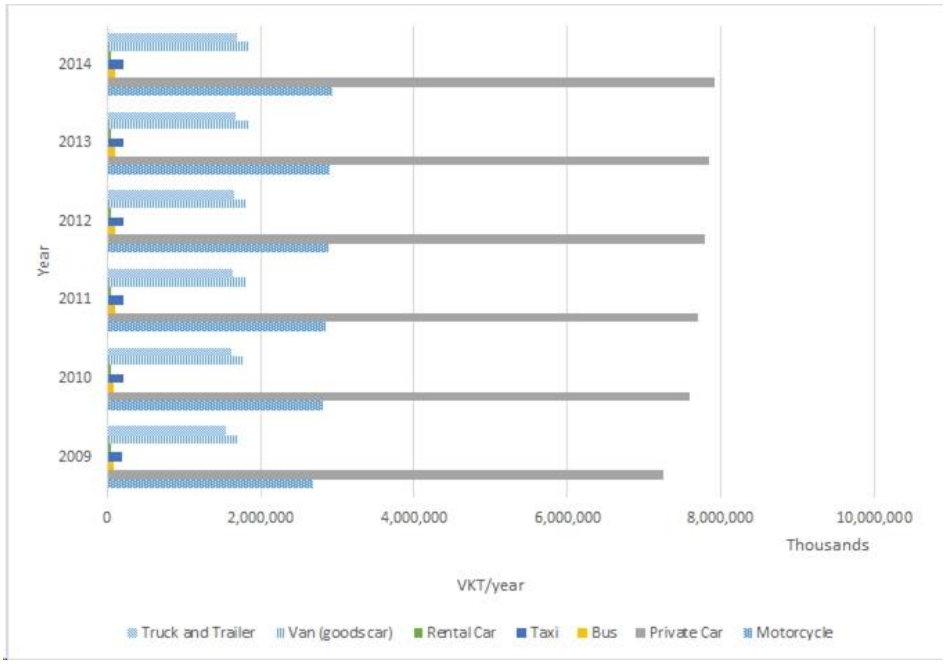

Figure 4 Vehicle-kilometer traveled in Iskandar Malaysia

CO_2 reduction was estimated based on Emission Factor from various sources, among others are studies by Mittal and Sharma (2003), European Environmental

Agency (2001) and Ramachandra and Swermala (2012). Based on the EF, the trend of CO_2 Emission Equivalent in Iskandar Malaysia is shown in Table 2.

Table 2 The Trend of CO_2 Emission Equivalent in Iskandar Malaysia

Source	EF CO_2 (g/km)	2009	2010	2011	2012	2013	2014
Motorcycle	60.30	177,859	186,283	188,912	191,127	192,441	194,376
Private Car	223.60	2,431,725	2,546,902	2,582,841	2,613,121	2,631,091	2,657,551
Bus	515.20	906,793	949,743	963,145	974,436	981,137	991,004
Taxi	208.30	68,172	71,400	72,408	73,257	73,761	74,502
Rental Car	208.30	31,248	32,728	33,189	33,579	33,809	34,149
Van (goods car)	515.20	1,748,795	1,831,625	1,857,471	1,879,247	1,892,170	1,911,199
Truck and Trailer	515.20	1,584,749	1,659,810	1,683,231	1,702,965	1,714,675	1,731,919
TOTAL (tonne CO_2 equivalent)		6,949,341	7,278,491	7,381,198	7,467,731	7,519,085	7,594,702

NOTE: Estimated based on VKT and its trends

The spatial pattern in Iskandar Malaysia has been driven by the spatial policy of IM with five Flagship Zones that strongly encourage economic activities to flourish and growth. Amid current trend of development in Iskandar Malaysia, there is, however, no guarantee that current spatial policy will be able to decelerate the rate of air quality degradation that stems from transport sector without sociological cognizance from the whole citizens on their travel behaviour, particularly on the importance of their non-motorized travel activities.

WAY FORWARD: MAXIMIZING THE BENEFITS OF EACH ELEMENT OF THE NEXUS TOWARDS LOWER CARBON EMISSION.

This study recognized the elements in the nexus, which are, urban space, transport, transport energy and air quality. Maximizing the benefits of each element towards economically rich, socially responsive and environmentally sound will be necessary on the way to sustainable Iskandar Malaysia development.

Most citizens living in Iskandar Malaysia travel by using private vehicles even for only 250 meters, although most housing neighbourhoods *(Tamans)* in Johor Bahru adopts mixed use development with 'within walking distance' principle. Spatial pattern exhibited in Iskandar Malaysia driven by spatial and economic policies in the region has resulted in the poly-centricity of Iskandar Malaysia with multiple economic centres, thus relieving the concentrated traffic loads and accomplishing the shorter trips for shopping and working purposes. At

micro-level, the mixed development, to a certain extent, has accommodated the principle of 'within walking distance' to reduce the need of motorized travel for shorter distance thus reducing energy consumption and improving urban air quality. The new approach of mixed development that encourage citizens to walk is therefore necessary. The proposed new approach of mixed development is by introducing vertical high density mixed development and horizontal mixed development with equidistance feature. The approach is to accomplish two-pronged objective that is usually present in non-cooperative form in the study area. The objectives to create 'within walking distance' performance of urban development while accommodating non-motorized travel of the citizens in Iskandar Malaysia should be promoted in the urban development in Malaysia.

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