INTEGRATED STOP TRANSIT FOR PEDESTRIAN IN PASIR GUDANG

Nur Syazwani Saari[1], Sharifah Salwa Mahdzar[2], and Sara Jaberolansar[2]

[1]Department of Urban and Regional Planning, Faculty of Built Environment, Universiti Teknologi Malaysia, Johor Bahru.

[2]Department of Architecture, Faculty of Built Environment, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

E-mail: nsyazwanisaari@gmail.com

ABSTRACT

Debatably, a successful transit stop is accessible with pedestrian and highly integrated with surrounding area activities; known as a node that bring people into the area. Pedestrian movement pattern is important to be understood and analysed as it could help various stakeholders to plan an efficient transit stop as well as its surrounding area. Space Syntax's theory of 'Natural Movement' and pedestrian typologies are the main theoretical foundation used to analyse pedestrian's movement pattern in the area. Nevertheless this study is an attempt to identify, understand and explain the pattern of pedestrian movement in Pasir Gudang using space syntax analysis to determine stop transit in the city. Thus researchers are particularly interested in identifying and have better understanding of pedestrian movement pattern in a city specifically within three kilometres radius from city centre of Pasir Gudang. Therefore most attention is given to local pedestrian movement pattern in weekdays and weekend as they are the main user of transit stop and public transport. Spatial urban network city of Pasir Gudang and pedestrian volume are analysed in order to develop Space Syntax modelling. Correlation analysis between integrated value of axial lines and pedestrian volume show that they are seemly associated with each other. Accordingly, findings of this research are expected to provide an evidence-based design approach to a better planning and designing of transit stop with respect to pedestrian movement characteristic in a city.

1. INTRODUCTION

Pedestrian often overlooked since the expansion of automotive industry in the beginning of 1900s. Therefore this process change the whole physical planning that favour vehicles orientation in global scale including Malaysia. This environment likely to cause many negative effect in terms of traffic congestion, urban sprawl, high carbon emission and more. Transit oriented development (TOD) is one of the solution to cater down many environmental urban problems and to encourage pedestrian mobility. Recent finding shows that the location of small scale transit stop for example bus stop is less integrated with surrounding and optimised by public transport user especially in Malaysia. Improving transit station and stops can increase convenience and comfort of public transit travel. Transit station and stops are also considered as one of the main streetscapes element in the city. One of the factors that influence transit station and stop evaluation is accessibility which considered distance from the transit station and station as well as quality of walking condition in the areas. A successful transit station and stop is one that is well connected and accommodated with community it serves. Hence to determine the location of transit station and stops is as important because it permit efficient, cost effective, and greener alternative transit operations.

In the other hand, another research and spatial model developed by Barlett School of Architecture and Planning University College London show that street configuration of a city expected to affect movement pattern. The space syntax model is based on the analysis of natural movement cause by the urban street configuration. This model basically based on topological-visual analysis of built environment to explain the movement of vehicles and pedestrians in urban space (Hillier et al. Turner 2007; Jiang 2009a). Since city itself is a complex urban structure it is wrong to conceive the city in term of origin and destination - movement tends to be broadly from everywhere to everywhere else (Hillier, 1996). The

central concept of space syntax is 'integration'. The distribution of integration across an urban area correlates with the movement pattern in that area. Urban areas can be distinguished by, and compared in terms of, different levels of integration. Integration is used as a measure of quality for urban areas. (Hillier, 1993). Previously Space Syntax researchers are able to predict pedestrian movement pattern up to 60% to 80% by the configuration of street in the city. Consequently this is an important evidence that show pedestrian movement pattern in the city is likely to be influence by the urban street configuration instead of by presence of attractors.

This paper aim to identify, understand and explain pattern of pedestrian movement in Pasir Gudang using space syntax analysis in order to find possible best location for transit station and stops within three kilometres. Pedestrian volume were collected and processed from gate count survey. Then some basic statistical analyses were done to find out the relationship between integration value and pedestrian volume within Pasir Gudang city.

2. METHODOLOGY

2.1 Study Area

The study was conducted in one of the southern city in Johor, Pasir Gudang. The city itself need to be given utmost considerations being one of the municipality region in Iskandar Malaysia due to the potential diverse land use activities and development. The site is within three kilometres from the city centre and is divided into 12 different zones that have been identified. (Refer Figure 1). Three kilometres radius is chosen as sample of analysis on the pedestrian route network due to the normal behaviour of the movement pattern of people. Various studies have proven that the three kilometre radius is comfortable travelling distance when people could walk within 15 minutes (Space Syntax Manual, 1993, Living Streets, 2004, Jacobs A.B 1993, South worth, M. & Ben-Joseph, 1997).

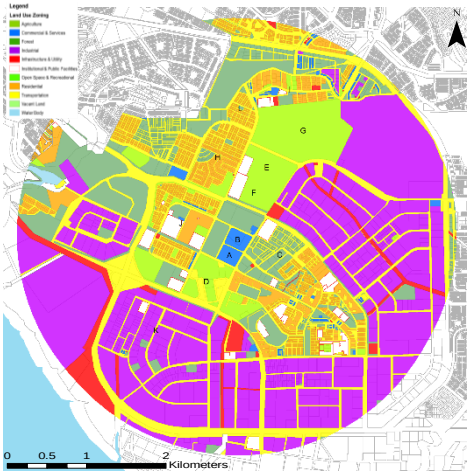

Figure. 1: Study area of Pasir Gudang within three kilometres (Source: IRDA, 2010)

2.2 Observation Technique

Gate method is one of the techniques established by UCL Space Syntax Laboratory that usually used in urban spaces and also inside the buildings. This method is done by counting the number of pedestrian on a study area of a particular street within specific period of time. The gate is placed in street and path of study area that might be used by local pedestrian. There are a total of 12 zones identified and 144 gates marked in this study area. These identified numbers of gates are important in order to provide clearer and precise data for this research - only 25 gates are required (Grajewski, T., et al., 2001). A gate is considered as an imaginary line crossing the streets space drawn by observers where he stand in a specific street or spaces while counting pedestrians that cross the line. This observation is done in two days of weekends and two days of weekdays since there might be differences in pattern of movement witness during these period.

Table 1 Gate Count Survey Time.

Time period	Duration	Description
1	8.00 - 9.00 am	Morning peak hour
2	9.00 - 10.00 am	
3	10.00 - 11.00 am	Mid-Morning
4	11.30 - 12.30 am	
5	12.30 - 1.30 pm	Lunch Time Peak
6	1.30 - 2.30 pm	
7	3.30 - 4.30 pm	
8	4.30 - 5.30 pm	Evening rush hour
9	6.00 - 7.00 pm	Early Evening
10	7.00 - 8.00 pm	

A total of 10 hours gate count are done that represents the whole day for both weekdays and weekend as presented in Table 1. The data collected is recorded in the observation table.

2.3 Analytical Framework

The analytical framework is divided into two parts; segment map modeling generated using University College London (UCL) Depthmap software and observation data collected from the survey.

3. ANALYSIS AND FINDINGS

3.1 Segment Map Analysis

Segment map analysis is one of the axial line analysis that could be found in the Depthmap software. It can identify the integrated and segregated line representing the city. One of its unique element is its ability to analyse accurately in any given radius. According to Chau (2009) in radius-radius analysis, a map has been set at the mean depth of a whole system from the most globally integrated line. It maximise the globality of analysis without inducing “edge effects”- the axial lines near the edge will appear highly segregated and will eventually affect the result. In this analysis the integration analysis of a segment map is evaluated in order to understand city area.

The most integrated lines are presented by the colour spectrum, red while the most segregated lines are indigo. It informative graphic allows one to form a picture of how integration spreads through urban structure (Hillier et al., 1993). Analysis on three kilometres Pasir Gudang is done in two scale of radius in order to present the area globally and locally. The global integration N (Refer Figure 2) and local integration is analyse in radius 400 metres (Refer Figure 3). The 400 metres radius integration is appropriate as it follow guidelines of Iskandar Malaysia Development Plan for any transit station and stop in Iskandar Malaysia region.

Figure. 2: Segment Map of Pasir Gudang in Global Integration (radius N)

Based on Figure 2, the most integrated lines found along street Jalan Mesjid and Jalan Besar represent by red line, while lowest integration value or the most segregated line indicates by the indigo. High integration value for streets Jalan Mesjid and Jalan Besar show that its function as one of the core commercial area in Pasir Gudang such as hospital, hotel, shops, office, school, etc. Both of the street also served as the main streets that connect east part of Pasir Gudang to west part through Pasir Gudang highway to the area. Besides, both of the streets connected to other branching streets making it one of the highly connected and major road in the system. This prove that within this highly integrated line, a possible transit station and stop could be plan along Jalan Mesjid and Jalan Besar street. The lowest integration line in Pasir Gudang can be found on the lower part of Pasir Gudang due to lower accessibility of the area as only one access mean to serve single purpose for example industrial activity.

The pattern of integration distribution in radius 400 metres shown in Figure 3 seem to be different compared to previous global integration – same analysis but with 400 metres angular depth on radius of the measure were set. This measure considered based on Iskandar Malaysia Comprehensive guidelines in order to promote Transit Oriented Development within their jurisdiction. In 400 metres analysis of segment map, Jalan Mesjid street again proved to be the highest integrated lines. However it witness only at the upper part of Jalan Mesjid street. The second high integrated lines followed by Jalan Rusa street and then by Jalan Besar street. These three street are mostly found in neighbourhood area. This also might explained due to the linear and highly connected branching streets reach out to these three streets.

Figure. 3: Segment Map of Pasir Gudang in Local Integration (radius 400 metres)

From the analysis it is found that Jalan Mesjid and Jalan Besar street has highly integrated streets that also one of the major street which connected to neighbourhood area. Thus it show that the area is suitable to determine transit stations and stop.

3.2 Correlation Analysis between Integration Values and Pedestrian Movement Flow Patterns

Correlation analysis is done to know the correlation between spatial configuration which is the integration value of each segment in the street and pedestrian movement flow pattern (pedestrian volume). The segment analysis is dived into 2 categories, weekend and weekdays. This is because we would like to test whether the theory of Natural Movement is applicable for pedestrian of Pasir Gudang.

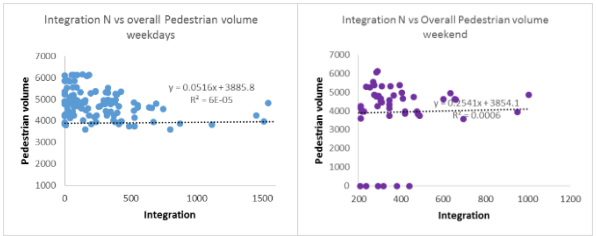

Figure. 4 (a) left & (b) right: Correlation between weekdays and weekend global integration value and pedestrian volume

Weak positive correlation are observed between local people movement flow pattern and integration values in both weekdays and weekends (Refer Figure 4a & 4b). This is much more related to the theory of Natural Movement as explained earlier. Yet, only about 1% of local people movement pattern is influence by configuration while the accepted value of R2 for a correlation to be accepted as significant is the values between 0.6 to 0.8. Hence it is possible to plan and

develop transit station and stop with better designated area to increase the quality of the pedestrian environment that usually a transit user.

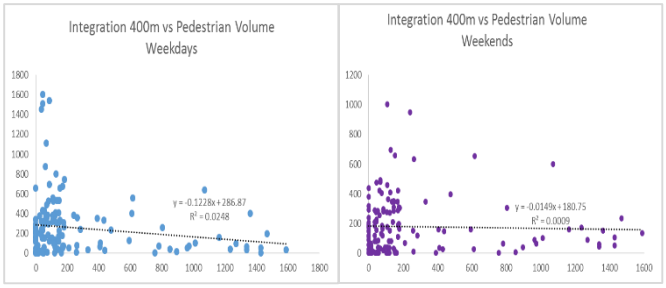

Figure. 5 (a) above & (b) below: Correlation between weekdays and weekends 400 metres Integration value and pedestrian volume

There is no significant correlation between pedestrian movement pattern and the spatial configuration (integration values) refer Figure 5a & 5b. This is shown by the R2 value which nearly reaching zero. In the theory of Natural Movement, it is established that the relationship between integration value and movement is directly proportional. This means that if the integration value of a line is high, the number of pedestrian passing through it will also be high, but in this analysis there is no correlation at all. This shows that pedestrian‟ movement flow patterns in the most probably attractor for both weekdays and weekends.

FINDING AND CONCLUSION

From the overall two analyses done, there are several key findings found:

1. From the global and local segment map analysis Jalan Mesjid street and Jalan Besar street play a major role in movement generator where variety of land uses could be found. This provide an important finding in order to determine which street are highly integrated to determine transit stations and stops.
2. From the correlation analysis between global and local integration value the site are most probably attractor based. This prove that the pedestrian movement pattern decision is influenced by attractions instead of road direction. Thus a better designated pedestrian planning should be considered in improving pedestrian quality hopefully would encourage flow of pedestrian movement (Online TDM Encyclopedia, 2015).
3. Some of the area experienced high pedestrian volume however its integrated value is low. Similar to condition above it is proven that the land uses is a dominant factor in determine movement pattern of people since the urban form of Pasir Gudang is prone to far distance that required vehicle to support mobility.

REFERENCES

Allan B. Jacobs. Great Street. Cambridge, MA: MIT Press, 1993.

Encyclopedia, T. D. M. (2015). Transit Station Improvements Improving Public Transit Waiting Conditions (pp. 1–12). Victoria Transport Policy Institute, Updated April 2015.

Grajewski, T., & Vaughan, L. Space syntax observation manual. *Space Syntax Laboratory*, 1–18, 2001.

Hillier, B. Cities as movement economies, 1996.

Hillier, B. A Penn, J Hanson, T Grajewski, J. X. Natural Movement: or Configuration and attraction in urban pedestrian movement, 1993.

Jiang, B. "Ranking Space for Predicting Human Movement in an Urban Environment." *International Journal of Geographical Information Science*, 23(7), 823–837, 2009.

Johor, S., & Region, E. *Comprehensive Development Plan for South Johor Economic Region 2006-2025*, 2006.

South worth, M. & Ben-Joseph. Streets and Shaping of Towns and Cities, ISLAND PRESS, 1997.

Turner, A. "From Axial to Road-Centre Lines: A New Representation for Space Syntax and a New Model of Route Choice for Transport Network Analysis." *Environment and Planning B: Planning and Design*, 34.3, 539-555, 2007.

Turner, A., Penn, A., and Hillier, B. "An Algorithmic Definition of the Axial Map." *Environment and Planning B: Planning and Design*, 32, 425-444, 2005.

Nur Syazwani Saari received a Bachelor of Urban and Regional Planning from Universiti Teknologi Malaysia. She is currently pursuing a Master degree under the supervision of Dr. Sharifah Salwa Syed Mahdzar. She also a research Assistant at UTM-Low Carbon Asia Research Centre. Her present research are urban planning and space syntax analysis

Sharifah Salwa Syed Mahdzar is a Senior Lecturer at the Faculty of Built Environment, Universiti Teknologi Malaysia. Her areas of expertise include architecture, urban design and planning. She is especially interested in urban design and urban architectural theory and Space syntax analysis as well as urban sustainability.

Sarah Jaberolansar received Master in Science Urban Design Architecture from Universiti Teknologi Malaysia. She is currently pursuing a PhD under the supervision of Dr. Sharifah Salwa Syed Mahdzar. Her interest including Architecture and human behavior, Space Syntax spatial analysis, urban architectural theory and urban sustainability.