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The impact of spatial accessibility on mobility of wheelchair users at Kuala Lumpur, Malaysia

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ABSTRACT

Accessibility for people with physical impairment in public spaces has been a significant issue in architectural design and urban planning. Studies have shown that the participation of wheelchair users in society is strongly correlated to the quality of the built environment. Thus, this study explores the influence of spatial accessibility on the mobility of wheelchair users at Jalan Raja Laut, by which the study outcome is expected to contribute to future urban intervention. Accordingly, gate-count methods and static snapshots are conducted to identify the gathering spots of wheelchairs users in the study area as well as to observe their intention of using the streets. Next, the connectivity of pedestrian paths in compliance with universal design guidelines extracted from MS1184 was evaluated. Space syntax analysis was also employed to quantitatively measure the integration values as well as visibility level of the study area. The correlation between the data obtained from observations and the outcome of the study concerning street connectivity, integration and visibility is analysed. The study concludes that public space with commercial potentials and well-connected physical environment are two major factors that influence the mobility and participation of wheelchair users in the city centre of Kuala Lumpur.

KEYWORDS

Wheelchair Users, Space Syntax, Universal Design, Spatial Accessibility, Public Participation

1 INTRODUCTION

The empirical investigation into the link between the built environment and physical activity of human has been expanded noticeably in the past decades (Saelens & Handy, 2008). Extended from this investigation, the accessibility of disabled people from public spaces to a building has been emphasised as part of the political agenda, and at the same time, research has shown that inaccessible built environment is in fact one of main forms of discrimination against PWDs

(Imrie & Wells, 1993). This is due to the reason that there are numbers of physical barriers existed in urban environment, which have prevented the independent mobility of disabled people in accessing their living environment. This in turn hampered the social communication in their everyday life (Baris & Uslu, 2009). Besides, research has shown that social participation and civic engagement are highly dependent on the accessibility in the city (Mahdzar, 2008). Without an adequate provision of accessible built environment, wheelchair users often feel being excluded by society (Zahari, et al., 2020). And, acknowledging the fact that participation is the key to sustainable urban development (Fu & Ma, 2020), it is imperative to investigate their needs especially in major cities of the country.

According to the World Health Organisation (2011), there are 75 million wheelchair users worldwide that makes up 1% of the total world population. In Malaysia, there are 453,258 people registered as Person with Disabilities (PWD) at the Department of Social Welfare in 2017, and out of the total number, 35.2% of them are having physical disability (Department of Social Welfare, Malaysia, 2018). It is believed that this figure is still on the rise (Rahim, et al., 2014). At present, the Malaysian government is acting swiftly to invest in services and infrastructure upgrades. However, accessible design is regarded as a niche market in local industry, the needs of PWDs and their accessibility to public facilities have not yet catered despite those improvements (Sanmargaraja, et al., 2019). This study therefore aims to investigate the influence of spatial accessibility on the mobility of wheelchair users in the city centre of Kuala Lumpur with an objective to provide guides to the built environment in promoting inclusive design through the identification of the deficiency of current urban planning and the understanding of what opportunity the city has to offer.

2 LITERATURE REVIEW

2.1 The Application of Universal Design in Malaysia

Rapid growth of economic and socio-political stability in Malaysia since independence has resulted to the improvement of living standard among their citizens and increased concern over disability right in recent years (Chen, et al., 2007). Within a decade, legislations and regulations established pertaining to inclusive design and the welfare of PWDs, namely Code of Practice of Employment of Disabled Person in Private Sector, People with Disabilities Act in 2008, etc., has led to a noticeable improvement of accessibility system in this country (Kadir & Jamaludin, 2012). As part of the national urbanisation policy, the city hall has also envisioned the capital to become an inclusive city for all by 2040 (Kuala Lumpur City Hall, 2020). Despite taking several measures to facilitate the living of PWDs in terms of city planning and establishment of regulations and guidelines, there are still numbers of public buildings not compliant with standard codes due to the leniency in law enforcement as well as low awareness from the public. However, effort to refine current accessibility system in the city is still needed resulted by the

increasing number of registered PWDs in this country (Kadir & Jamaludin, 2012). It is undeniable that Malaysia has taken several initiatives to develop facilities that cater the need for disabled group of people at public spaces and building, nonetheless, efficient implementation of universal design in built environment, involvement of concerned professionals and researcher in the industry, and to revisit the available standard code are still yet to be expected (Kadir & Jamaludin, 2012).

2.2 Malaysia Standards and Universal Design

Up to the present, there are three applicable universal design standards in Malaysia, namely MS1184: 2014 Universal Design and Accessibility in the built environment - Code of Practice (Second Revision), MS 1331: 2003 Code of Practice for Access of Disabled Persons Outside Buildings (First Revision); and MS 1183: 1990 Specification for Fire Precautions in the Design and Construction of Building Part 8: Code of Practice for Means of Escape for Disabled People (Kadir & Jamaludin, 2012). In this study, MS1184 is adopted as the main evaluation instrument alongside MS1131 and MS1183. According to Malaysia Standard (2014), the ways of entering and leaving a building should be simple and safe to travel by diverse groups of users. Some fundamental considerations concerning outdoor paths design are encapsulated from MS1184, which will serve as the basis of reference for the connectivity study in this research (Table 1).

Table 1: Key design considerations when planning paths to the building

No	Planning Factors	Descriptions
1	Pedestrian Paths	• Pedestrian paths shall be separated from routes used by cyclists and motor vehicles • The width of the pedestrian paths should be at minimum between 1 500 mm to 1 800 mm. When there are obstacles along the path, the minimum distance between obstacles should be 1000mm
2	Outdoor facilities and amenities	• Outdoor facilities should be accessible to all people and sheltered against the weather (sun/rain)
3	Pedestrian Crossing	• Where necessary, crossing points should be provided with appropriate kerbs and tactile walking surface indicator (TWSI)
4	Kerb ramp	• Kerb ramp shall be provided if there is a change in level. The kerb ramp width shall be a minimum of 1000mm, and the gradient should not exceed 1:8
5	Grating	• Draining gratings should be located away the accessible paths where possible. If it is positioned in the way of the pedestrian route, it shall be set flush with the road surface
6	Obstacles	• Obstructions such as a free-standing post along the pedestrian walkway shall be avoided
7	Entrance design	• Suitable provision shall be made at the entrance. The means of building ingress or egress shall be approachable and accessible to all people

3 DATASETS AND METHODS

This study adopts multiple approaches to analyse the decision making of wheelchair users to access Jalan Raja Laut and its surrounding. Due to large number of design variables, this paper limits the scope to human activity, streets connectivity, integration and visibility.

The study of human activities in an area provides the understanding of public intention to use the space (Vaughan, 2001), two observation techniques, namely the gate-count and static snapshots are thus conducted to map the location of wheelchair users and understand how they use the streets. Gate counting is typically used to identify the density of pedestrian flows within a city network (Askarizad & Safari, 2020). In this research, 14 gates at several locations in the study area are selected to identify the gathering spots and frequencies of wheelchair users. As for the static snapshots, it is a method to observe and document stationary activities of the street users (Mahdzar, 2019). Subsequently, the purposes of wheelchair users accessing the study area is determined.

Next, a well-connected street is significant for wheelchair users to move around the city comfortably (Zakaria & Ujang , 2015). Thus, a survey of all architectural barriers is performed to evaluate the connectivity of the pedestrian paths along the 2km stretch of Jalan Raja Laut. A checklist of eight items is extracted from the Universal Design guidelines of Malaysian Standards, MS1184: 2014 Code of Practice on Access for Disabled Persons to Public Building for a review through field measurement and observation, which includes: a) provision of walkway, b) walkway with adequate width , c) sheltered walkway, d) provision of pedestrian crossing at the junction, e) dropped kerb before the road, f) location of grating along the path, g) physical obstruction in the middle of the route, and h) accessible entrance to buildings.

After that, space syntax is used as the syntactic tool to quantitatively identify the integration value and visibility level of the street. Integration, by definition, is a static global measure that describes the average depth of space to all other spaces in a street system (Klarqvist, 1993), or in other words, it measures how many turns and syntactic steps must be made from a street segment to reach all other street segments in the network, using the shortest paths (Hillier & Hanson, 1984). Theoretically, a space with high integration value denotes that it has a higher potential to become a place for public gathering and interaction (Yoo, et al., 2012). In this case, axial map is generated. As for the investigation of the visual configurations of the streets, this paper applied Visibility Graph Analysis (VGA) developed by Turner, et al. (2001) for further analysis. Visibility is a concept that code the visual sequence of a research subject at any point of sight (Mahdzar & Yahya, 2017). Research has shown that visibility level correlates with the accessibility of the spatial environment: i.e., the higher the visibility level, the more reachable and integrated a street network is (Heitor, et al., 2014). Regarding the visual aspect, high spatial

visibility is essential to allow wheelchair users to navigate streets safely and effectively (Grasso, et al., 2017).

Lastly, the correlation between the findings from the observation and the outcome of the study concerning street connectivity, integration and visibility is analysed.

3.1 Study Area

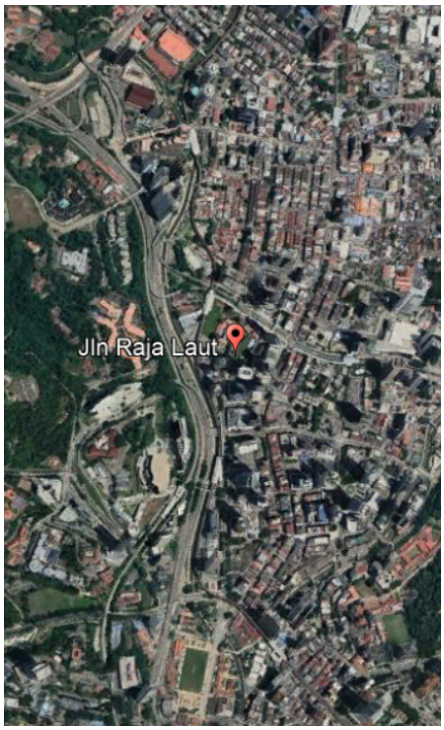

Figure 1: Location of Jalan Raja Laut on Google Map

Jalan Raja Laut is selected as the study area due to the presence of the city hall along the street. As the main governmental body in city planning, Kuala Lumpur City Hall (DBKL) has a significant role to spearhead the development of the city. Moreover, the users of Jalan Raja Laut constitute people of all ages and abilities include physically impaired and visually impaired persons due to its strategic location in the heart of the city, which is reachable by the well-connected public transport. This is definitely conducive to an effective data collection process.

4 RESULTS

The study area is being divided into three zones at the main junctions, which are the intersection points of Jalan Raja Laut and Jalan Esfahan as well as Jalan Raja Laut and Jalan Sultan Ismail (Figure 2). The study area is demarcated according to the distinctive attributes of each district. Zone 1 is an administrative and corporate zone mainly consists of government institutional buildings such as DBKL and the Employees' Provident Fund Headquarters (KWSP Tower); whilst Zone 2 is a commercial zone houses shopping malls and retail areas. Both zones featured

coarse-grained urban fabric and high-rise buildings for the most part. As for Zone 3, it is a residential and commercial zone with low rise housings and shophouses which characterised fine grained urban fabric.

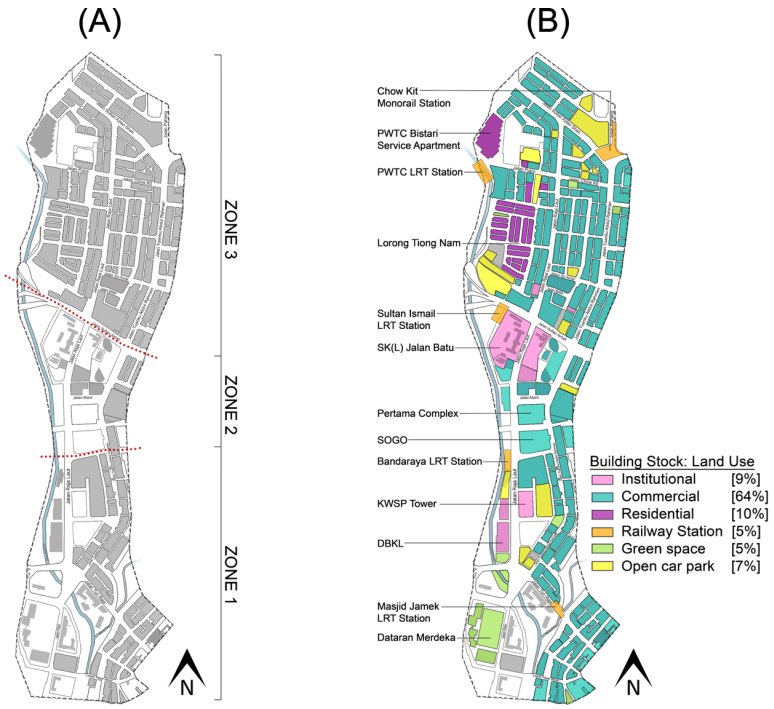

Figure 2: (A) The study area is divided into Zone 1, Zone 2 and Zone 3; (B) The existing land use in the study area

4.1 Gate-count and Static Snapshots Observations

There are two noticeable information in the findings of site observation through gate count methods: first, the presence of wheelchair users was only spotted in Zone 1 and Zone 2; second, wheelchair users were frequented at Jalan Tuanku Abdul Rahman (TAR) and Masjid Jamek LRT Station rather than Jalan Raja Laut (Table 2 and Figure 3).

Table 2: Comparing Gate Observation and Configuration of Spaces at Jalan Raja Laut

Gate ref. no.	Integration HH (Rn)	Segment	Total Density at Gate during Weekdays		Total Density at Gate during Weekends		Total Density
			Non-Wheelchair Users	Wheelchair Users	Non-Wheelchair Users	Wheelchair Users	
1	1.51	11126.8	3219	1	1425	1	4646
2	1.67	15160.5	336		156		492
3	1.64	15166.8	1920		312		2232
4	1.51	11276.7	1525	1	419	1	1946
5	1.76	15138	2976		852		3828
6	1.52	11237.8	3024		1344		4368
7	1.62	12697.3	1524		394	2	1920
8	1.76	11977.4	2196		252		2448
9	1.57	12996.5	696		300		996
10	1.65	15035.4	1620		600		2220
11	1.71	12802.4	600		132		732
12	1.43	11837.6	612		252		864
13	1.61	15038.6	924		472		1296
14	1.59	12933	696		888		1584
15	1.41	11862.1	600		684		1284
16	1.53	119941.7	2100		1692		3852
17	1.56	12079.6	912		1352		2264
18	1.43	10082.7	297		240		537
19	1.54	976.06	588		272		660
20	1.55	11276.8	781		418		119
21	1.45	11732.3	746		1472		2218
Correlation, R^2		**0.446**	**0.427**		**-0.278**		**0.198**

Figure 3: The gathering spots and frequencies of wheelchair users are identified through gate count methods: (A) is located at gate 7; (B) is at gate 4; whilst (C) is at gate 1

Table 3: Types of human activities and behavioural patterns in the study area

	Day Time				Evening			
	Able-bodied Persons		People with Disability		Able-bodied Persons		People with Disability	
	Local (%)	Foreigner (%)	Wheelchair user (%)	Others (%)	Local (%)	Foreigner (%)	Wheelchair users (%)	Others (%)
Zone 1								
Necessary	20.0	0	0	0	55.0	0	0	0
Optional	61.8	0	0	0	32.5	0	0	0
Resultant	14.5	0	1.0	2.7	12.5	0	0	0
Zone 2								
Necessary	26.0	3.7	0	0.1	18.4	3.5	0	0
Optional	41.8	6.1	0	0	39.8	7.8	0	0.1
Resultant	19.9	2.5	0.1	0.5	5.5	24.8	0	0.1
Zone 3								
Necessary	15.0	4.2	0	0	14.1	5.0	0	0
Optional	40.8	16.7	0	0	40.7	21.1	0	0
Resultant	14.1	9.2	0	0	10.1	9.0	0	0

Legend:

Necessary -
- Waiting

Optional -
- Shopping
- Sleeping
- Smoking
- On the phone
- Sitting
- Reading

Resultant -
- Busking
- Chatting
- Vendors

Figure 4: Wheelchair users along with other people with disabilities gathered outside SOGO shopping mall to earn their living by selling small items or busking

Findings from static snapshots observation suggest that wheelchair users in the study area are primarily vendors (Table 3). Several locations along Jalan TAR turned out forming nodes for them to seize commercial opportunities. Their typical gathering spots are in those retail areas sandwiched by Masjid Jamek LRT Station and Bandaraya LRT Station, which enhance their reachability to these areas. In addition, wide public spaces such as the open square in front of SOGO shopping mall (Figure 4) and landscaped walkway in front of the shophouses further benefit the vendors to conduct their business safely. The bottom half of Jalan Raja Laut which accommodates administrative and corporate buildings whilst facing the backside of SOGO shopping mall somehow failed to attract vendors with mobility difficulties to be actively engaged with the public spaces.

4.2 Evaluation of Pedestrian Walkways in accordance with Malaysia Standards

The design requirements of pedestrian walkway along the three zones were examined and summarised in Table 4. For the ease of results interpretation, the full score is set at 100. The highest achievable score for each section out of the eight evaluated items is therefore 12.5 points. Among the three zones, Zone 1 (scored 87.5 points over 100) demonstrated better connectivity, followed by Zone 2 (72.5/100) and Zone 3 (60/100).

Table 4: The Evaluation of Pedestrian Walkway Based on Universal Design Requirements Extracted from the Malaysian Standards

Zone	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	Score (Out of 100)
1									87.5
2									72.5
3									60

Legends:

(a) Provision of walkway
(b) Walkway with adequate width
(c) Sheltered walkway
(d) Pedestrian crossing (Connectivity)
(e) Kerb ramp (Continuity)
(f) Grating (Tolerance of error)
(g) Obstruction
(h) Accessible entrance to buildings

	Score	Description
	12.5	All requirement met
	10.0	Most of the requirements met
	7.5	Equal proportion of requirement met and not met
	5.0	Most of the requirement are not met
	2.5	Did not meet requirements

Based on the findings, the provision of pedestrian walkways along the entire stretch of the street is highly satisfied. Most of the walkways have met the requirement to allow for equitable use of public access by having a width of 1500-1800mm. However, only a minimal stretch of walkways in front of DBKL is sheltered with roof. Beyond the boundary of DBKL, those walkways are all totally unprotected despite having some trees for shading purpose. Integration of physical shelter and plantation into the streetscape are therefore recommended to serve as the protective devices against weather, and subsequently promote pedestrianism and inclusive street that is usable by users of all ages and abilities (Kuala Lumpur City Hall, 2020).

In zone 3, trees are scarcely found along the street, five-foot way (Kaki Lima) in front of shops thus becomes an alternative for sheltering. Nonetheless, the design of five-foot way is undesirable due to levelling issue and insufficient provision of ramps, which have hindered people with mobility disability to utilise it conveniently. Next, crossing the street would be very challenge to wheelchair users (Asha, et al., 2020), using crosswalk at the junction would definitely be a safer approach to be taken. Somehow, inadequate provision of pedestrian crossing in Zone 3 across the main roads has led to longer travelling distance and illegal trespassing issue. Regarding the dropped kerbs, they are vital to maintain the continuity of travelling paths by mitigating the level difference between the vehicular road and pedestrian walkway, yet this requirement is basically met. As for the drain grating, it is considered one of the hazardous

obstructions that shall either be located off the accessible pavement, or the slots of grating shall be placed in an angle that is perpendicular to the travelling direction. In this case, the overall achievement of the design requirement is not satisfying particularly in Zone 2 and Zone 3. Not to mention those plants and road infrastructure such as light poles and TNB substations that are installed in the middle of the walkway, which have further hampered the movement of people with mobility issues. Most buildings in Zone 1 and Zone 2 are adequately provided with public facilities such as entrance ramp to assist people with limited mobility to get into the building. However, the provision of entrance ramp in Zone 3 is relatively insufficient.

In summary, this study has shown the best achievement of universal design requirements along Jalan Raja Laut is basically in Zone 1, especially along the stretch of walkway right in front of the city hall. In contrast, the street connectivity in zone 3 failed to be on par with other zones. It can be concluded that despite the effort of local authority to implement Universal Design at public area is noticeable, but its influence over other parts of the city centre is still yet to be expanded. These results are corresponded to what have been observed through gate-count methods and static snapshots, whereby in contrast to Zone 1 and Zone 2, wheelchair users abstained from accessing Zone 3 due to its low connectivity.

4.3 Spatial Analysis by Space Syntax

Depthmap is used to generate axial map and visibility graph analysis (VGA) in this study. Axial map analysis computed the global measures of the proximity of each axial line against other axial lines in the street system, and subsequently describe the integration or segregation values along Jalan Raja Laut. The values obtained are vital to inform the researcher about the overall accessibility of the urban network (Omer & Zafrir-Reuven, 2010).

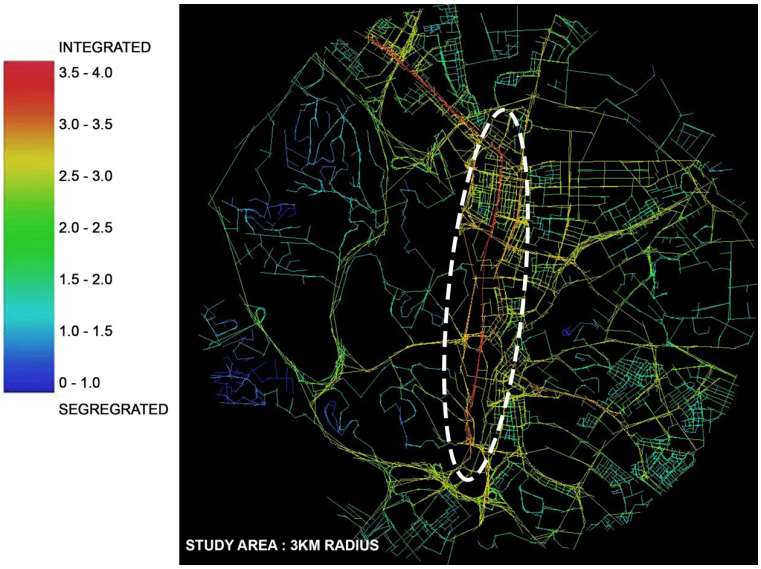

Figure 5: Spatial integration analysis of the street segment analysis at 3km radius

Based on the findings, Jalan Raja Laut is generally more physically integrated than other streets within close proximity, include Jalan TAR. The most integrated street segment is in Zone 2, which is the part that contains SOGO shopping complex and Bandaraya LRT Station. The highest integration value achieved is at 1.76. Whilst Zone 3 is relatively segregated in the street system, by which the lowest integration value achieved is at 1.42. Nonetheless, it has been noticed that wheelchair users barely visit Jalan Raja Laut despite it is more physically integrated than Jalan TAR in general (Figure 6) and more visually connected at the same time (Figure 7). Since all three zones have a close proximity to respective rail stations, namely Masjid Jamek LRT Station, Bandaraya LRT Station and Chow Kit Monorail Station. The accessibility of wheelchair users to the study area from other places in the city should therefore not be the major concern in this study. Based on what have been observed in the static snapshots, people with physical impairment visit the city centre chiefly for business purpose, Jalan Raja Laut obviously did not enable commercial potential similar to what has been showcased at Jalan TAR.

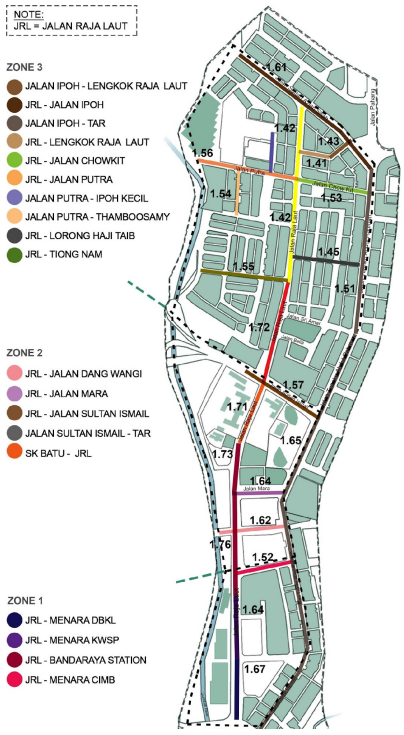

Figure 6: Integration values along and around Jalan Raja Laut generated by space syntax analysis

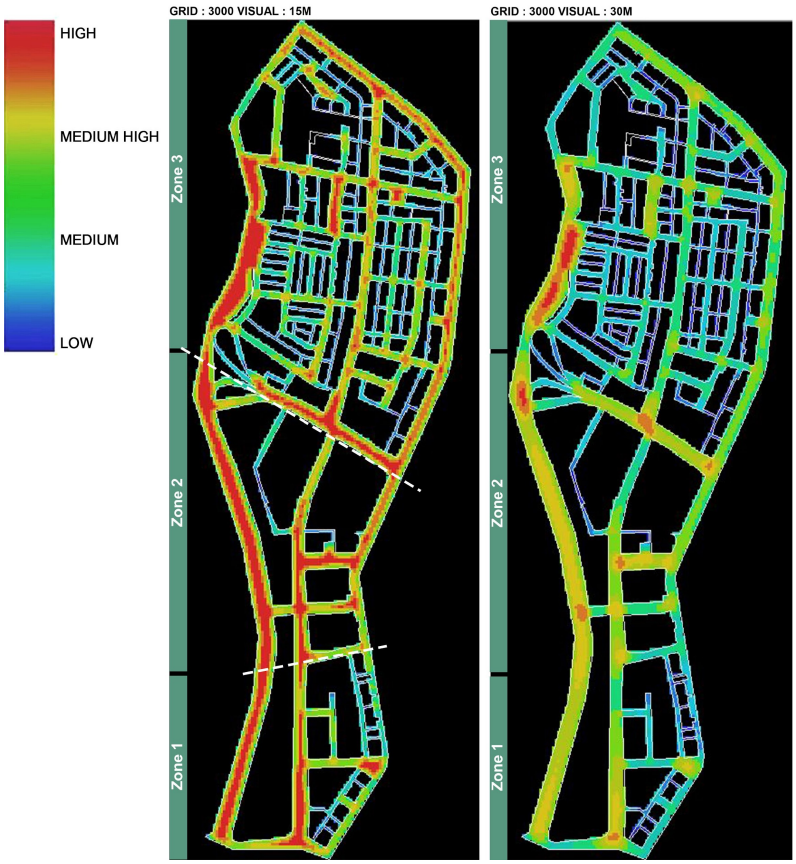

Figure 7: Visual Graph Analysis (VGA) at the visual distance of 15 metre and 30 metre in the study area

5 CONCLUSIONS

In the past decades, disability has always been portrayed in a negative shadow that it was deemed as an illness, and people with impairment shall be subject to medical care all the time without the ability to live and move independently (Brisenden, 1986). Nevertheless, recent studies postulated that architectural barriers are the major hindrance of the active participation of people with disability in society rather than the disability itself (Degener, 2016). Hence, it is essential to identify design factors that impact the inclusiveness of the built environment.

Realising the fact that the wheelchair community and many physically abled local citizens visit the study area for similar reasons, that is to travel daily to the city centre for work, it is crucial that the city provides significant business opportunities in order to attract the wheelchair community to be more engaging in the city. The results in this study posit that a well-connected street system is fundamental to inclusive urban living and has a direct impact on the mobility of wheelchair users in the city. On the contrary, the outcome of the investigation indicates that integration and visibility level of the street network did not justify the presence of wheelchair users at Jalan Raja Laut and their route selection process. Therefore, it can be concluded that business opportunities and good street connectivity are two major determinants influencing the

participation of people with mobility impairment in the study area. In present research, the sample size is rather limited and main focus is on static activities. Future research should extend to other regions in the city as well as to explore how wheelchair users get to their end destinations in the city through various observation methods, such as movement traces and people following.

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