Determining variations in rail public transport access using GIS in Klang Valley City, Selangor, Malaysia

Mohd Sahrul Syukri, Edie Ezwan Mohd Safian, Burhaida Burhan
Department of Real Estate Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia

*Email: mohd.syukri1691@yahoo.com

Abstract. About 75% of urban areas in Malaysia have an excellent public transportation system. Malaysian Intelligent Transport System (MITS) Blueprint 2017 – 2022 is developed and mentioned public transport as the infrastructure for traffic management and the Fourth Industrial Revolution (4IR) will change the global landscape of public transportation. The primary purpose of this paper is to use Geographic Information Systems (GIS) for identifying spatial accessibility to transport in Klang Valley, Selangor supported the movement of the walk-distance analysis techniques. A geospatial database was created that has the coordinate of urban public transport (railway mode), home residence distribution, and road networks. Accessibility index tool and geoprocessing by overlay analyses were selected because of the analysis tools for this paper. The paper results indicate that urban public transport in the Klang Valley districts of Selangor has fewer registered railway line stations. Several areas of Klang Valley region have low accessibility based on z-score either dispersion or clustering pattern to public transport because they fall outside the space-distance service area for every terminal. Local transport planners in Klang Valley may use the created application to allocate public transport in low access areas.

1. Introduction
Nowadays, the issue in many countries is a significant increase in the use of private cars over public transport due to the urbanization process, population growth, and a variety of land use [1]. Currently, the community has increased to more than 32.63 million [2]. This issue can lead to an imbalance in situations such as traffic congestion and unhealthy condition in most developing countries. In term of 75% of urban areas in Malaysia are having an excellent public transportation system. The strategies by Malaysian Intelligent Transport System (MITS) Blueprint 2017 – 2022 is developed and mentioned public transport as the infrastructure for traffic management and the Fourth Industrial Revolution (4IR) will change the global landscape of public transportation [3]. The introduction of rail transport currently has become popular in the Klang Valley as KTM Komuter, Light Rail Transit (LRT), Express Rail Link (ERL), Monorail, Mass Rapid Transit (MRT) and Skypark Link that aims to supply reasonable access within the geographic area. However, this rail transport is a similar system within London has a tube system; Edinburgh has the trams and Seoul, and Tokyo have a subway [4]. This study focuses on the variation of accessibility index among each station using the rail transport system. They prefer public transport access to the surrounding areas and geospatial techniques using GIS software. Geospatial using GIS analysis is useful to identify the accessibility index and the best conduct real situation [5, 6]. The variables like public facilities, point of interest, land use and residential location may be modeled in the GIS environment. Therefore, this study will determine the variation of rail transport for each station and identify the best station access performance and quality in the Klang Valley area. Thus, the rapid development of rail transport in Klang Valley is determined and increased the right impact on the economic status of the country.
2. **Research background**

2.1 **Rail Public Transport as an Urban Public Transport**

The development of the rail network in Malaysia provides the total length of railway lines and station numbers. The rail transport is the earliest urban public transport in Malaysia. In term urban public transport as the priority in urban areas and more road networking such as rail network. Malaysia has evolved many of years from year 1990 until currently to achieve good access in transportation management [7]. Until now, MRT is the changing rail development and half completed based on National Key Economic Areas (NKEA) that is integrated covers the Klang Valley areas [8]. Malaysia has a good terminal for urban public transport including bus stop terminal and rail terminal. It has about 6,000 bus stop services by taxi and mini bus and 100 rail station in the record last year 2019. According to the National Rail Industry Roadmap, National Blue Ocean Strategy (NBOS) and Vision 2030 will be competitive, conducive ecosystem and good access in a rail industry. The evolution urban rail transport starting from 1885 in Port Weld Taiping until East Coast Rail Link or Double Track in the year 2030. As total RM215 billion invested from the government to construct and develop rail industry [9]. The main operator for rail industry is Prasarana Malaysia Berhad (Prasarana) to transform of the urban public transport service [10]. Nowadays, Industry Revolution 4.0 may have the potential to robotize system and replace by intelligent machines driver. As result, these rail intelligent make more be efficient and faster for services.

2.2 **Concept of Accessibility**

Kuala Lumpur and Klang Valley Region as urban areas that have more access and availability of facilities like commercial, educational, recreational, health centers from the original place using a mode of public transport. Public transport is a vital use of space which reduces traffic congestion and air pollution. Accessibility is multidimensional situation issues. Accessibility is labeled because of physical access to goods, services, and destinations. Geurs and van Wee (2004) defined accessibility components include land use, transport, physical and human geography [11]. The better accessibility of public transport improves the accessibility to other services as well [12].

Many studies had utilized the application of GIS for analyzing the accessibility index and spatial analysis. In Melbourne and Alexandria, the network analysis was used to create public transportation access such as buffer and service area analysis [3]. Another study in Kuala Lumpur implemented GIS network analysis to achieve a transit station only. It overlaid the pedestrian route network dataset and demographic spatial, such as commercial area, housing area and job destination to measure the accessibility of a station to numerous land uses. The result will help connectivity and walkability index. During this study, the accessibility index is measured by constructing and integrating with the ArcGIS tool.

2.3 **Statistics of Rail Transport**

Rail transport scenario has improved in recent years from 1990 until 2019 by using KTM to MRT phase 2 (on build). In 2015, KTM has 49 million of passengers that it is the highest statistic users and drop out 32 million in 2018. For Kelana Jaya Line and Ampang Line shows that in 2008 the passengers are 55 million and 49 million respectively and this value increasing until 2015 to 82 million and 62 million [13]. However, the number is declining in 2016 before it has been increase 87 million and 60 million in 2018. Another train especially KLIA Transis is the only one train still maintain the number of passengers starting from 2009 to 2018. KLIA Express is the speed train to main airport producing the highest passengers on 2015 about 25 million. When the MRT launched on 2016 and operated by 2017 are the intelligent train without driver has 51 million of passengers which is two times number of passengers in 2016.

3. **Data and Methodology**

3.1 **Study Area**

The research focuses on rail station networks within the Klang Valley Region. Klang Valley is located in Selangor State between Kuala Lumpur and Putrajaya. This area has a higher density population and
fast urbanization development. It is affects the existence of urban rail transport. It is located at the center part of west coast Peninsular Malaysia and is delineated by Straits of Malacca. It takes in the area of 2,832 km² and a population of about 8.4 million peoples in the year 2019 [2]. The length of the rail and urban rail is 1,833 km and 328 km respectively in 2018 [14].

3.2 Data Variables of Accessibility index
The accessibility index has two main parameters: the travel cost using estimated by the spatial distribution of facilities and transportation network and the attractiveness of public access. The information was obtained from geolocation using GPS, Google Earth and the Ministry of Transportation Malaysia. The existing rail line and road network are used in the case studies to integrate accessibility index. The map of Selangor and Klang Valley is used to show the variation of access in the rail stations.

3.3 Process of Determine Accessibility Index
To determine accessibility index for every station, the neighborhood by analysis tool in ArcGIS validation point statistics estimates attributes either is adjacent or nearby of location using data from surrounding points. Geoprocessing tool and script that calculates an accessibility score for every station supported the space from a destination to any or all input features and therefore, the weight or population of these input features. The higher the accessibility index, the more accessible is the destination. Destinations closer to input features with high weight will have the next a higher score than destinations close to input features with low weight. During this study, we utilize this ArcGIS tool to visualize the spatial pattern of the rail stations.

4. Result and Discussion
The application of GIS with spatial statistics including cluster analysis by accessibility index tool to show a different patterns of train station based on the geographical issue. A Z-score result with as statistically significant 99% (p<0.01) indicates a high and low accessibility index for each train station. This result takes Moran’s range from -1 to 1 and close to 0 indicates random spatial.

4.1 KTM Seremban Line
Accordingly, to KTM Seremban Line consists of 18 stations in the Klang Valley area and the train started from Batu Caves to KLIA2. The result shows Kampung Batu Station has -4.15 indicates a low accessibility index (dispersed) and Kajang Station has 0.73 is useful accessibility index (clustered) for KTM Seremban Line as shown in table 1.

| Station        | Z_AI       | Pattern  |
|----------------|------------|----------|
| Batu Caves     | -0.73905894161 | Dispersed |
| Taman Wahyu    | -0.6687477717  | Dispersed |
| Kampung Batu   | -4.15577035   | Dispersed |
| Batu Kentonmen | -0.44658231968 | Dispersed |
| Sentul         | -0.18826135706 | Dispersed |
| Putra          | -0.10573215526 | Dispersed |
| Bank Negara    | -0.03235248743 | Dispersed |
| Kuala Lumpur   | 0.02295243324  | Clustered |
| KL Sentral     | -0.07461142413 | Dispersed |
| Mid Valley     | -0.13968472109 | Dispersed |
| Seputeh        | -0.11029315320 | Dispersed |
| Salak Selatan  | 0.18211098999  | Clustered |
| Bandar Tasik Selatan | 0.20742806640 | Clustered |
During KTM Port Klang Line, table 2 shows that accessibility index has more accesses in Kuala Lumpur Station 1.16 (clustered) than Port Klang Station -1.72 (dispersed area). The origin station from Tanjung Malim to Port Klang.

**Table 2. Z-Score for Accessibility index by KTM-Port Klang Line.**

| Station                        | Z_AI          | Pattern      |
|--------------------------------|---------------|--------------|
| Tanjung Malim                  | -2.30473204109 | Dispersed    |
| Kuala Kubu Bharu               | -0.83256916635 | Dispersed    |
| Rasa                           | -0.6031771553  | Dispersed    |
| Batang Kali                    | -0.4265350846  | Dispersed    |
| Serendah                       | -0.15958920171 | Dispersed    |
| Rawang                         | -0.21761424197 | Dispersed    |
| Kuang                          | -0.17262701198 | Dispersed    |
| Sungai Buloh                   | 0.19990520866  | Clustered    |
| Kepong Sentral                 | 0.57402622993  | Clustered    |
| Kepong                         | 0.65741190502  | Clustered    |
| Segambut                       | 0.88926060061  | Clustered    |
| Putra                          | 1.11080065319  | Clustered    |
| Bank Negara                    | 1.14416868729  | Clustered    |
| Kuala Lumpur                   | 1.16801612215  | Clustered    |
| KL Sentral                     | 1.13134538969  | Clustered    |
| Abdullah Hukum                 | 1.05795417411  | Clustered    |
| Angkasapuri                    | 1.06197804523  | Clustered    |
| Pantai Dalam                   | 1.03806662102  | Clustered    |
| Petaling                       | 0.99546818576  | Clustered    |
| Jalan Templer                  | 0.94245092713  | Clustered    |
| Kampung Dato Harun             | 0.76850564965  | Clustered    |
| Seri Setia                     | 0.68729137499  | Clustered    |
| Setia Jaya                     | 0.60101583885  | Clustered    |
| Subang Jaya                    | 0.39068265339  | Clustered    |
| Batu Tiga                      | 0.14008033001  | Clustered    |
| Shah Alam                      | -0.21041590548 | Dispersed    |
| Padang Jawa                    | -0.54342984588 | Dispersed    |
| Bukit Badak                    | -0.80073738533 | Dispersed    |
| Klang                          | -1.01144026824 | Dispersed    |
| Teluk Pulai                    | -1.20438470618 | Dispersed    |
| Teluk Gadong                   | -1.29367901440 | Dispersed    |
| Kampung Raja Uda               | -1.47809930722 | Dispersed    |
Jalan Kastam  
-1.57545085014  Dispersed
Pelabuhan Klang  
-1.72394819606  Dispersed

4.3 Ampang Line
Here, the accessibility index tool calculates from ArcGIS is used to show the designed pattern of the railway station. In this case, Cahaya and Ampang Station are the high accessibility index spatial clustered (1.435). The low accessibility for Ampang Line is -1.369 (spatial dispersed) as shown in table 3.

| Station       | Z_AI            | Pattern  |
|---------------|-----------------|----------|
| Ampang        | 1.43507449426   | Clustered|
| Cahaya        | 1.43576225579   | Clustered|
| Cempaka       | 1.35509020457   | Clustered|
| Pandan Indah  | 1.20505852518   | Clustered|
| Pandan Jaya   | 1.00347839315   | Clustered|
| Maluri        | 0.67650454945   | Clustered|
| Miharja       | 0.34603315456   | Clustered|
| Chan Sow Lin  | 0.24166765265   | Clustered|
| Pudu          | 0.07838897337   | Clustered|
| Hang Tuah     | -0.18619988333 | Dispersed|
| Plaza Rakyat  | -0.37895990277  | Dispersed|
| Masjid Jamek  | -0.66460931117  | Dispersed|
| Bandaraya     | -0.84155873593  | Dispersed|
| Sultan Ismail | -0.94292897698  | Dispersed|
| PWTC          | -1.06661582557  | Dispersed|
| Titiwangsa    | -1.11532610686  | Dispersed|
| Sentul        | -1.21167476469  | Dispersed|
| Sentul Timur  | -1.36918997595  | Dispersed|

4.4 Kelana Jaya Line
The trends in accessibility index for all lines, Kelana Jaya Line, involving Putra Heights to Gombak as shown in table 4, and the high and low access are Setiawangsa station and Putra Heights station.

| Station       | Z_AI            | Pattern  |
|---------------|-----------------|----------|
| Putra Heights | -1.66006714096  | Dispersed|
| Subang Alam   | -1.63676643775  | Dispersed|
| Alam Megah    | -1.57450778395  | Dispersed|
| USJ 21        | -1.33953515566  | Dispersed|
| Wawasan       | -1.16073156123  | Dispersed|
| Taipan        | -1.06370898814  | Dispersed|
| USJ 7         | -1.00032441434  | Dispersed|
| SS18          | -1.09024805766  | Dispersed|
| SS15          | -1.06905193009  | Dispersed|
| Subang Jaya   | -1.02561080465  | Dispersed|
4.5 Sri Petaling Line

Table 5 summarizes the Z-Score for accessibility index in Sri Petaling Line. There is 0.936 index level by Chan Sow Lin station and Putra Heights (-2.514).

**Table 5. Z-Score for Accessibility index by Sri Petaling Line.**

| Station                                  | Z_AI                   | Pattern     |
|------------------------------------------|------------------------|-------------|
| Putra Heights                            | -2.51425726680         | Dispersed   |
| Puchong Prima                            | -1.93000496759         | Dispersed   |
| Puchong Perdana                          | -1.65945574194         | Dispersed   |
| Bandar Puteri                            | -1.40842207362         | Dispersed   |
| Taman Perindustrian Puchong (TPP)        | -1.35873874474         | Dispersed   |
| Pusat Bandar Puchong                     | -1.22511916780         | Dispersed   |
| IOI Puchong Jaya                         | -1.04703126301         | Dispersed   |
| Kinrara                                  | -0.49059560411         | Dispersed   |
| Alam Sutera                              | -0.21274232953         | Dispersed   |
| Muhibbah                                 | -0.06021821509         | Dispersed   |
| Awan Besar                               | 0.09910889170          | Clustered   |
| Sri Petaling                             | 0.71155114760          | Clustered   |
From the data presented as shown in table 6, the ERL line consists of five stations. KL Sentral is a clustered pattern and high access. KLIA 2 indicated spatial dispersed -1.161.

### 4.6 ERL Line

| Station             | Z_AI         | Pattern    |
|---------------------|--------------|------------|
| KL Sentral          | 1.41068405712 | Clustered  |
| Putrajaya Sentral   | 0.35471672118 | Clustered  |
| Salak Tinggi        | 0.11786391111 | Clustered  |
| KLIA                | -0.72150643369 | Dispersed |
| KLIA2               | -1.16175825573 | Dispersed |

### 4.7 Monorail

For Monorail, the highest and lowest results are Bukit Bintang station and Titiwangsa as shown in table 7.

| Station             | Z_AI         | Pattern    |
|---------------------|--------------|------------|
| KL Sentral          | -1.02962326641 | Dispersed  |
| Tun Sambanthan      | -0.65215097028 | Dispersed  |
| Maharajalela        | 0.14977030019  | Clustered  |
| Hang Tuah           | 0.87680289855  | Clustered  |
| Imbi                | 1.13934117611  | Clustered  |
| Bukit Bintang       | 1.25601683265  | Clustered  |
| Raja Chulan         | 1.01280915173  | Clustered  |
| Bukit Nanas         | 0.29939091458  | Clustered  |
| Medan Tuanku        | -0.50116909586 | Dispersed  |
| Chow Kit            | -0.93883972638 | Dispersed  |
4.8 MRT Line
The built of MRT in 2016, and table 8 shows that Kwasa Sentral is dispersed and low access with Z-Score -1.85 compared by Sri Raya station show high access and clustering public access.

Table 8. Z-Score for Accessibility index by MRT Line.

| Station                | Z_AI             | Pattern   |
|------------------------|------------------|-----------|
| Sungai Buloh           | -1.69336178435  | Dispersed |
| Kampung Selamat        | -1.70324641190  | Dispersed |
| Kwasa Damansara        | -1.72836733504  | Dispersed |
| Kwasa Sentral          | -1.85790902907  | Dispersed |
| Kota Damansara         | -1.51412335664  | Dispersed |
| Surian                 | -1.24709529037  | Dispersed |
| Mutiaara Damansara     | -1.01694947999  | Dispersed |
| Bandar Utama           | -0.81450079557  | Dispersed |
| Taman Tun Dr. Ismail   | -0.84855352548  | Dispersed |
| Phileo Damansara       | -0.39862372238  | Dispersed |
| Pusat Bandar Damansara | -0.14162323277  | Dispersed |
| Semantan/Muzium Negara | -0.12620794757  | Dispersed |
| Pasar Seni             | 0.29656689655   | Clustered |
| Merdeka                | 0.36013905032   | Clustered |
| Bukit Bintang          | 0.44192240056   | Clustered |
| Tun Razak Exchange(S19)| 0.53150106885   | Clustered |
| Cochrane               | 0.57514143871   | Clustered |
| Aeon Maluri            | 0.62483921203   | Clustered |
| Taman Permata          | 0.65089060391   | Clustered |
| Taman Midah            | 0.67751465857   | Clustered |
| Taman Mutiaara         | 0.74283425688   | Clustered |
| Taman Connaught        | 0.76719486404   | Clustered |
| Taman Suntex           | 0.91377124007   | Clustered |
| Sri Raya               | 0.97385682179   | Clustered |
| Bandar Tun Hussein Onn | 0.96889016335   | Clustered |
| Batu Sebelas Cheras    | 0.93979057669   | Clustered |
| Bukit Dukung           | 0.88682767249   | Clustered |
| Sungai Jernih          | 0.91813144775   | Clustered |
| Stadium Kajang         | 0.91221993903   | Clustered |
| Kajang                 | 0.90852925298   | Clustered |

4.9 Skypark Link
In table 9, KL Sentral is the highest Z-Score for accessibility index whether Terminal Skypark contributed dispersed distribution.

Table 9. Z-Score for Accessibility index by Skypark Line.

| Station                | Z_AI             | Pattern   |
|------------------------|------------------|-----------|
| KL Sentral             | 1.10221999480   | Clustered |
The findings concluded that five types of trains have a clustered pattern and the only Skypark Link indicate dispersed pattern as shown in table 10. The largest number of stations is LRT (49 stations) followed by KTM (33 stations) and MRT Line (18 stations) based on the current location for each station. The rest existing train station is less than ten stations. Thus, the visualization results on the map are shown in figure 1 until 9.

Table 10. Summary of clustering station by type of train.

| Types of train          | Number of station (classes of pattern) |
|-------------------------|----------------------------------------|
|                         | Clustered  | Dispersed  |
| KTM                     | 33         | 28         |
| 1) KTM-Seremban Line    | 15         | 12         |
| 2) KTM-Port Klang Line  | 18         | 16         |
| LRT                     | 49         | 35         |
| 1) Ampang Line          | 9          | 9          |
| 2) Kelana Jaya Line     | 21         | 16         |
| 3) Sri Petaling Line    | 19         | 10         |
| ERL                     | 3          | 2          |
| Monorail                | 6          | 5          |
| MRT                     | 18         | 12         |
| Skypark Link            | 1          | 2          |
Figure 1. Z-Score KTM Line.

Figure 2. Z-Score Port Klang.

Figure 3. Z-Score Ampang Line.

Figure 4. Z-Score Kelana Jaya.
Figure 5. Z-Score Sri Petaling Line.

Figure 6. Z-Score ERL.

Figure 7. Z-Score Monorail.

Figure 8. Z-Score MRT Line.
Figure 9. Z-Score Skypark Link.

Table 11: Low and High Accessibility for Selected Train Station.

| Station                  | Accessibility Index |
|--------------------------|---------------------|
|                          | Low     | High    |
| Kampung Batu             | /        |         |
| Kajang                   | /        |         |
| Kuala Lumpur             | /        |         |
| Port Klang               | /        |         |
| Cahaya                   | /        |         |
| Sentul Timur             | /        |         |
| Putra Heights            | /        |         |
| Setiawangsa              | /        |         |
| Chan Sow Lin             | /        |         |
| KL Sentral               | /        |         |
| KLIA 2                   | /        |         |
| Bukit Bintang            | /        |         |
| Titiwangsa               | /        |         |
| Kwasa Sentral            | /        |         |
| Sri Raya                 | /        |         |
| Terminal Skypark         | /        |         |
| **Total**                | 8        | 8        |

In this final result, we can conclude that as shown in table 11 for 16 train stations, they have similar access within low and high accessibility index. Good access is much better for passengers to any destination or travel. The high accessibility index indicates that the relationship train station and public access are best for the urban transport system.

5. Conclusion
Based on the accessibility index tool using ArcGIS 10.5 taking Klang Valley rail station as an example, it assumed that a railway station occurred in the significantly access around each station as
the main object. The demand for accessibility for rail transport is the essential data to make decisions and knowing the spatial distribution that has been carried out the capability of ArcGIS. On the other hand, the result indicates significantly contribute to sustainable transportation in the Klang Valley area. Urban rail transport has many advantages: high-speed transport, saved energy, less emission and reduced accidental mortality of the city [15]. As future cases, new analysis incorporating the sub-district of the Klang Valley Region using rail transport as a mode of urban public transport and walking travel time to reach station is suggested. Then, the future of rail transport is done here in Malaysia became one of the leaders in the rail industry in the ASEAN region and the global.

Reference
[1] Hamid Motieyan and Mohammad Saadi Mesgari 2017 Towards Sustainable Urban Planning Through Transit-Oriented Development (A Case Study: Tehran). International Journal of Geo-Information. 6 1-16.
[2] Department of Statistics 2019 Population. Department of Statistics, Malaysia 2019.
[3] Saat Shukri Embong 2017 Future Trends in Transportation. MIMOS Berhad. http://www.llm.gov.my/doc/Paper%204%20(MIMOS)Future%20Trend%20in%20Transportation.pdf [Accessed 2020 Jan 10]
[4] Nabilah Naharudin, Mohd Sanusi S. Ahamad and Ahmad Farhan Mohd Sadullah 2017 Framework for Developing a Spatial Walkability Index (SWI) for the Light-Rail Transit (LRT) Stations in Kuala Lumpur City Centre using Analytical Network Process (ANP) and GIS. Proceedings of the International Conference of Global Network for Innovative Technology and AWAM International Conference in Civil Engineering (IGNITE-AICCE ’17) AIP Conf. Proc. 1892, 130002-1 – 130002-8.
[5] K. Chang 2012 Introduction to Geographic Information Systems, 6th ed. New York: McGraw-Hill Education
[6] P.A. Longley, M. F. Goodchild, D. J. Maguire, and D. W. Rhind 2011 Geographic Information Systems & Science, 3rd ed. Danvers: John Wiley & Sons.
[7] Bunnell, T., P.A. Barter and S. Morshidi 2002 Kuala Lumpur metropolitan area: A globalizing city-region Cities, 19 357 – 370.
[8] Suruhanjaya Pengangkutan Awam Darat (S.P.A.D.) 2016 Greater KL/Klang Valley Land Public Transport Master Plan. Kuala Lumpur: Suruhanjaya Pengangkutan Awam Darat.
[9] M. Foda and A. Osman 2010 Using GIS for Measuring Transit Stop Accessibility Considering Actual Pedestrian Road Network. J. Public Trans., 13 23-40.
[10] Noor Hafiza Nordin, Mohd Idrus Mohd Masirin, Imran Ghazali and Mohd Isom Azis 2015 Appraisal on Rail Transit Development: A Review on Train Service and Safety. IOP. Conference Series: Materials Science & Engineering.
[11] Gears, K. T., Ritsema Van Erk, J. R. 2001 Accessibility Measures: reviews and applications. Evaluation of accessibility impacts of land use transportation scenarios, and related social and economic impact. RIVM report 408505006.
[12] Abreha, D. A. 2007 Analysing Public Transport Performance Using Efficiency Measures and Spatial Analysis: The Case of Addis Abaha, Ethiopia. Thesis Report, International Institute for Geo-information Science and Earth Observation, Enschede, the Netherlands.
[13] Nur Ayuni Mahammad Zin 2018 Urban Transport in Greater Kuala Lumpur. Ministry of Transport Malaysia 13 September 2018.
[14] Naimah Md Khalil 2017 Polytechnic: Carving a Niche in the Rail Industry. Ministry of Transport Malaysia.
[15] Yang Yang, Peitong Zhang and Shaoquan Ni 2014 Assessment of the Impacts of Urgen Rail Transit on Metropolitan Regions Using System Dynamics Model. Transportation Research Procedia 4 521 – 534.