

# PASSENGER BEHAVIORAL MAPPING AND STATION FACILITIES DESIGN AT COMMUTER LINE TRAIN STATION (CASE: TANGERANG STATION, INDONESIA)

Ahmad Zubair<sup>1</sup>, \*Lita Sari Barus<sup>1</sup> and Jachrizal Soemabrata<sup>2</sup>

<sup>1</sup>School of Strategic and Global Studies, Universitas Indonesia, Indonesia; <sup>2</sup> Faculty of Engineering, Universitas Indonesia, Indonesia

\*Corresponding Author, Received: 15 Oct. 2018, Revised: 30 Dec. 2018, Accepted: 12 Jan. 2019

**ABSTRACT:** Commuter Line became the best public transportation in Jakarta and surrounding cities. But unfortunately, there were still many Commuter Line passengers who did not aware of using the station facilities. This led to a "dilemma" for station managers to design station facilities that meet the needs of passengers. Therefore, the research was focused on the behavior of Commuter Line passengers based on the deviation that occurred. A behavior mapping approach was conducted to understand passenger behavior and its influence on the design of the train station facility. The research was instrumental case study, mean study of the case for external reasons was not merely an intention to know it's the origin, but the case was only an instrument to explained and proved the existing theory. By mapping the passenger behavior, station managers at least got an overview of the passenger's pathway, favorite places to wait for trains, crowded places during peak time, platform capacity, railway crossing capacity, the availability and lack of a primary, secondary and tertiary facilities. The research results told us many stories. The results showed some explanation about passenger movement behavior based on three components of station zone: arrival zone, main facility zone and platform zone. The conclusion of the research explained that in designing a station facility, the station managers have not fully understood the passenger behavior. In another way, they should pay attention to that vital aspect.

*Keywords: Passenger behavior, Passenger behavioral mapping, Station facilities, Commuter line*

## 1. INTRODUCTION

Commuter Line has become the best public transportation in Jakarta, Bogor, Depok, Tangerang and Bekasi [1] - [3]. If anybody asks "What kind of inexpensive, fast, safe and convenient transportation?" Then most of the people living in Jakarta and surrounding cities will answer the Commuter Line. Currently, Commuter Line is managed by PT. KCI (Commuter Train Indonesia)

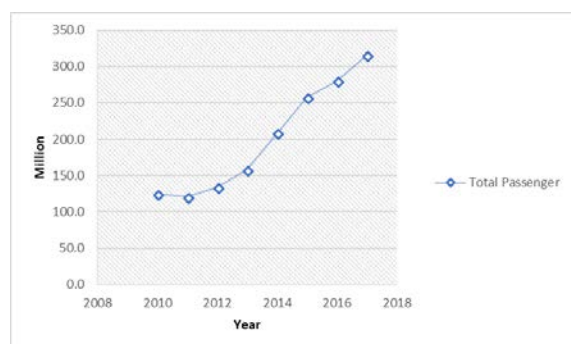


Fig. 1 Total commuter line passengers

Figure 1 shows the increased number of passengers occurred since 2010. In 2017, PT. KCI has achieved the highest passenger volume record in history with 1,045,823 passengers a day and a total of 315 million passengers a year.

Under these conditions, if the company/government is unable to provide facilities and infrastructure associated with increasing demand, it will lead to various transportation problems [4]. Woodson [5] argued that transport space should pay more attention to the diverse characteristics of passenger's attitude and behavior.

Understanding the attitudes and behavior of passengers is important to anticipate operational and service issues [5]. The arrangement of station space that is not in accordance with the passenger's need will result in the inconvenience and security of passengers. Such discrepancies can be reflected from how the passengers' attitude in responding to the space provided.

Sears [6] suggests that there are three components for viewing attitudinal forms, among which are the cognitive, affective and behavioral components themselves. Therefore, the behavioral mapping is urgently needed to study passenger's behavior in the station.

Researchers have used behavioral mapping to study people's activities in neighborhood open space, children's museums, schools and zoos [7], senior residences [8], grocery stores [9] and hospitals [10]. In this study, the main focus area is in Tangerang Station which becomes a major station in Jakarta's surrounding cities, especially Tangerang City. The purpose of this study is also to provide an overview of the passenger's behavior at Tangerang Station.

## 2. METHODOLOGY

This research is mixed method research with an instrumental case study. The study of the case for external reasons is not merely an intention to know the nature of the case, but the case only serves as an instrument to understand something other than the case to prove an existing theory. A behavior mapping approach is used to understand passenger behavior patterns. Data were collected by observation, video counting and in-depth interviews with the station manager. The data is processed through the mapping and design concept of station facilities by using GIS (Geographical Information System).

### 2.1 Behavior Mapping Approach

Observation using Behavior Mapping method. Behavioral or Behavior Mapping is a survey technique developed by Ittelson [11]. According to Ittelson [11], there are five basic components of behavior mapping: basic sketch of area or set to be observed; Clear definitions of behavioral forms to be observed, quantified, described and dichotomized; Inform a clear time plan at which the observations will be made; A clear systematic procedure shall be followed during the observation and; An efficient coding/tagging system to further streamline the observation work. The method is divided into two types. These two methods are named respectively place-centered and individual-centered mapping [12].

#### 2.1.1 Person-Centered Mapping

Person-Centered Mapping technique emphasizes the movement of passengers over a period of time. Thus, the technique will relate not only to one place or location but to multiple places or locations. The goal of these maps is to uncover

whether a location is used or not, at what time, by which type of people, and what activities are performed in different areas of the studied location [12]. The technique delivers a passenger mapping and describes the pattern of passenger behavior and activity.

#### 2.1.2 Place Centered Mapping

Place centered map method to see how humans organize themselves in a particular location [12]. The technique aims to find out how passengers, use or accommodate their behavior in a particular time at station. Thus, sketching a place or setting is required, including a physical element that is expected to affect the passenger's space. In other word, basic map is needed (Fig. 2).

### 2.2 Behavior Setting

Behavior settings can be considered the units of analysis in place-centered maps. The choice of the time when observations take place is fundamental because the same place can be used very differently depending on the time of the day.

Table 1 List of behavior settings

Settings	Weekdays		Weekend	
	Peak	Off peak	Peak	Off Peak
Arrival Zone	128	58	106	45
Main Facility Zone	36	27	33	30
Platform Zone	103	68	38	37

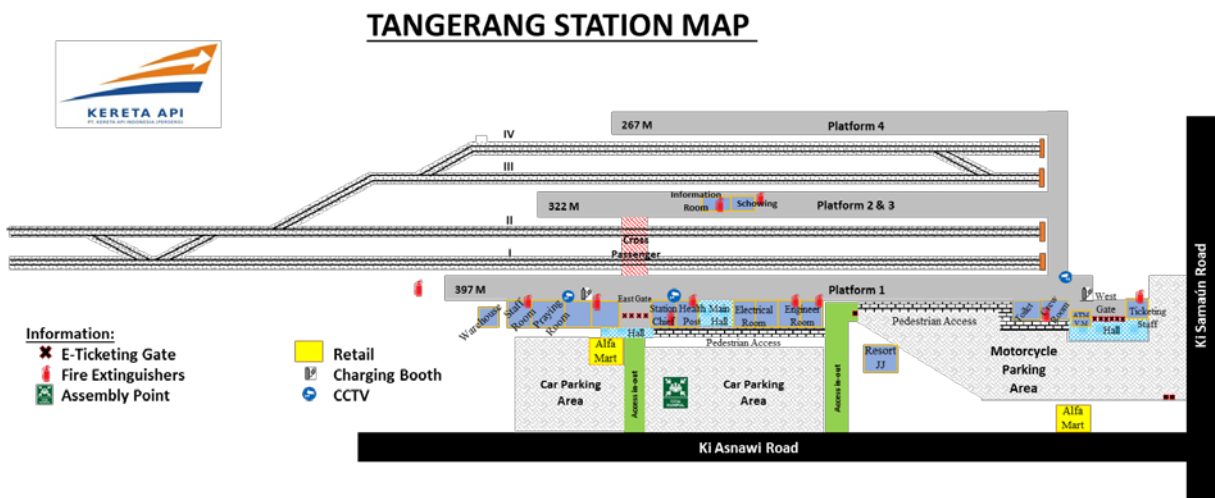


Fig. 2 Tangerang station basic map

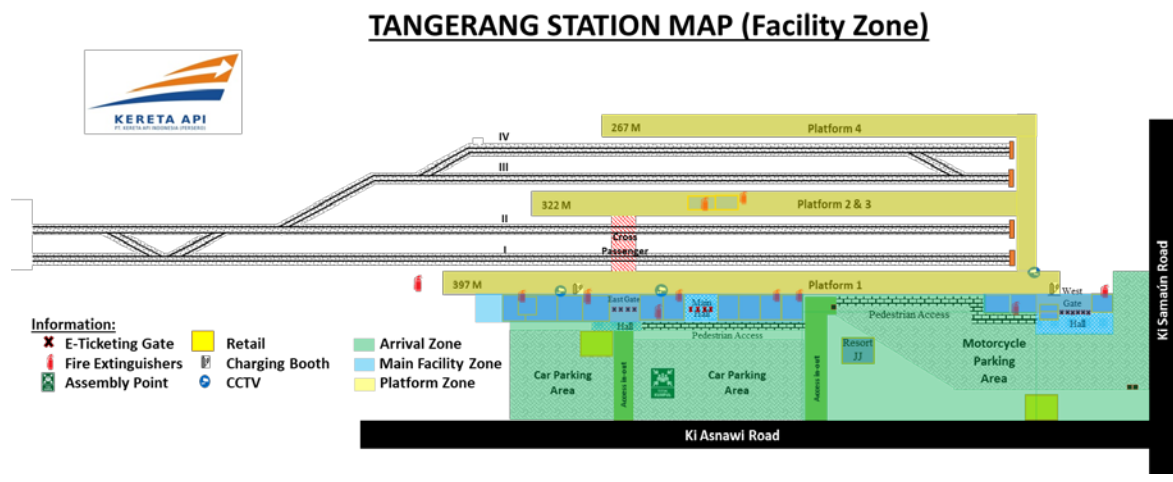


Fig. 3 Tangerang station with facility zone by Luis Vidal concept

The station settings were conducted by Vidal [13]. He divided station facility zone into three components: arrival zone, main facility zone and platform zone. Each zone has the characteristics of facilities and different forms of passenger behavior. Therefore, each zone is observed at different times (weekdays and weekend) and at different hours as well (peak hours and off-peak hours).

The analysis can be centered on a specific setting or focus on the movements of a passenger at each zone due to station facilities. The movements of the passenger can be counted and tracked by video analytics or using Closed Circuit Television [14]. It was also conducted by Larson [9] have used time-lapse photography, video recording, or radio frequency identification systems to collect behavioral data. Then consider and compare the data and check the interpretation meaning of field findings, use related cases and discard the non-steady relationship [15].

### 3. RESULT

#### 3.1 Behavior Mapping

The majority of total passenger observations were distributed across three types of passenger behavior: light, moderate and slow movement (Table 2). On weekdays, the majority (10%) of average passenger behavior at peak time (06-08 AM) was observed in three types of movement: light (81.50%), moderate (14.50%), slow (4%).

At a different time, 153 passengers were observed at an off-peak time (10-12 AM) on weekdays. The result showed that passenger behavior with light movement (56.00%) still dominant. The pattern was the same but the total of average passengers was different, light movement in the 1<sup>st</sup> position, moderate in 2<sup>nd</sup> (38.00%) and slow in 3<sup>rd</sup> (6.00%).

On weekend, the pattern was changed. It was because of the characteristic of passenger and their activity. At peak time (06-08 AM), 177 passengers were observed resulting dominant behavior by light movement (51.60 %), moderate (21.00%) and slow (27.40%). Table 2 showed that slow movement passenger was higher than moderate movement. At the off-peak time, the pattern was changed again. 112 passengers were observed resulting dominant behavior by moderate movement (44.70 %), slow (31.30 %) and light (24.00 %).

### 4. DISCUSSIONS

Differences in passenger movement created by different types of behavior setting and by different forms of the same type of behavior setting (arrival zone, main facility zone and platform zone). It was also created by the characteristics of the passenger. For workers on weekdays, it was clear that they had a light movement, indicating that they were not too concerned about the facilities in each zone. It was different for the family at weekend, they were more having a moderate and slow movement in each zone.

Table 2 Passenger movement by different time

	Time	Average Passengers	No. Observations	Light (%)	Moderate (%)	Slow (%)	Total
Weekdays	Peak (06-08 AM)	2670	267	81.50	14.50	4.00	100%
	Off-Peak (10-12 AM)	1530	153	56.00	38.00	6.00	100%
Weekend	Peak (06-08 AM)	1774	177	51.60	21.00	27.40	100%
	Off-Peak (10-12 AM)	1121	112	24.00	44.70	31.30	100%

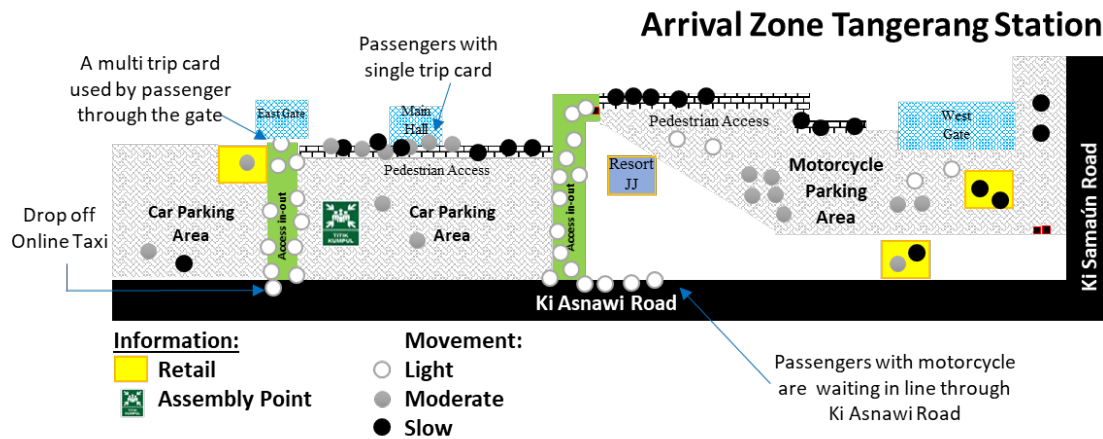


Fig. 4 Passenger behavior at arrival zone

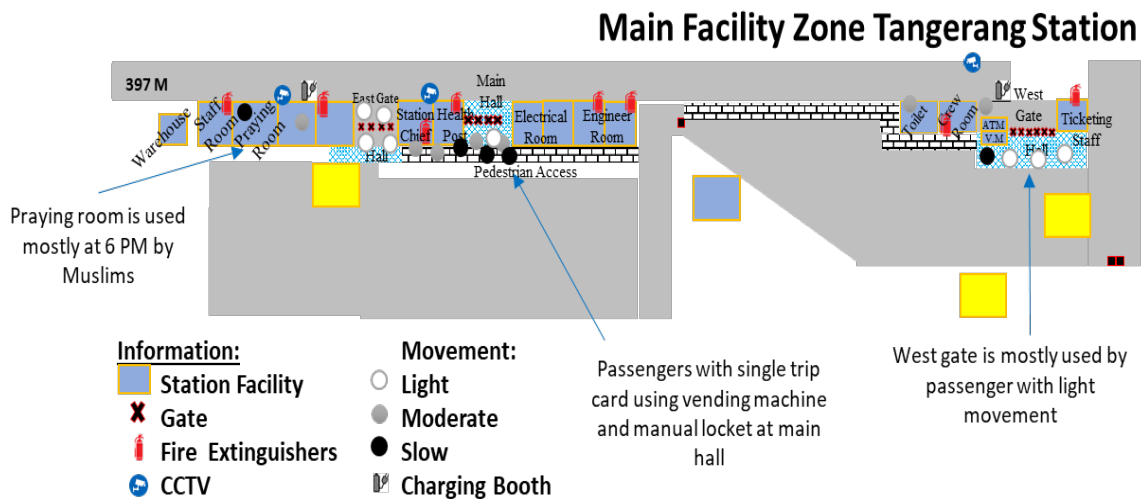


Fig. 5 Passenger behavior at main facility zone

#### 4.1 Arrival Zone

This area is the largest zone of the station. Thousands of passengers come down and meet to enter the station. Differences in passenger behavior are

Table 4. Passenger characteristic at arrival zone

Settings	Weekdays	Weekend
Arrival Zone	Mostly workers with light movement and used the multi-trip card, most of them used motorcycle, car and online taxi	Mostly family with children with moderate and slow movement and used the single trip card, almost used motorcycle

observed at two main access to the station (Fig 4). This zone is connected to three gates (west gate, east gate, and main hall). These three gates show significant differences in passenger behavior. East gate is mostly used by a passenger with the multi-trip card (Table 4). It means most of them to have light movement and use fewer facilities (e.g. ATM, vending machine, toilet). West gate is mostly used by a passenger with a motorcycle with light movement. These types of passenger usually commute from Tangerang to Jakarta daily.

Passengers with single trip card usually have a moderate and slow movement in this zone. They use a vending machine, buying drink and food in the retail area and most of them use pedestrian access. These passengers are commonly a family with children on weekend (Table 4). As described above, the behavior setting in this zone has a significant role by providing appropriate facilities to the passenger.

For the future station design, this zone will be developed a vertical parking area for a motorcycle. It means the capacity of this zone can be doubled up.



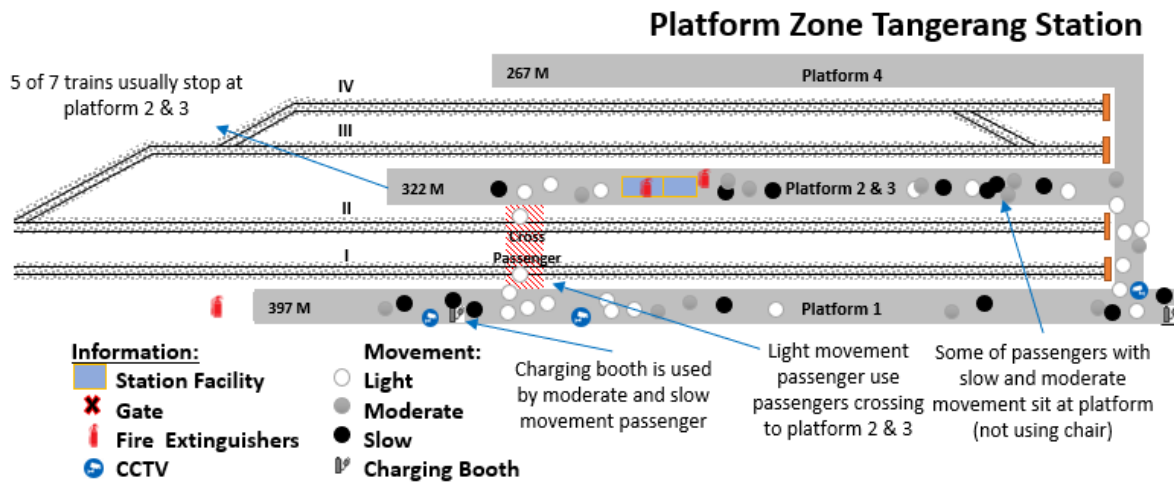


Fig. 6 Passenger behavior at platform zone

#### 4.2 Main Facility Zone

This area is the smallest zone in the station. It can make a problem because the station's main facilities are in this zone (Vending machine, manual lock, charging booth, toilet, praying room, information room). It means the facilities need a larger area to ease passenger's need.

Table 5 Passenger characteristic at facility zone

Settings	Weekdays	Weekend
Main Facility Zone	Mostly workers with light movement and use multi-trip card and walk directly to platform zone	Mostly family with children with moderate and slow movement and use the single trip card, most of them use a vending machine to top up

The most used facility is the vending machine for the single trip card. Mostly passenger has to queue to buy tickets at the main hall. On weekend, passenger queue line could be stretched until the pedestrian access, even the main road (Fig 5). It is a very common phenomenon in Tangerang Station and can make a serious impact on the traffic in the arrival zone. The problem was not the gate, but the lack of vending machine and manual lock. It should be considered that the station manager has to pay attention due to further facilities, especially the policies of the multi and single trip card. We can identify the problem and do the next step by designing the station facilities. We can conclude that the main facility zone should be larger and wider. Thus, the movement of passengers can be more efficient and effective.

#### 4.3 Platform Zone

Vidal [13] concept argued this zone basically used by passenger only for boarding. The facilities in the platform zone are only for boarding too (Information board, platform line, cross passenger). Based on the survey, this concept is no longer used by the station manager. There is dualism bias concept whether this zone is used by the passenger for only boarding or for waiting for the train too.

Table 6 Passenger characteristic at platform zone

Settings	Weekdays	Weekend
Main Facility Zone	Workers stand near the platform line, a passenger with light movement usually run for the train	Mostly family with children with moderate and slow movement, most of them sit in the platform (not using a waiting chair)

In Tangerang Station, there are several facilities in the platform zone (Charging booth, information board, cross passenger, chair, trash can, platform line) (Fig 6). These facilities influence passenger behavior. The passengers can charge the phone while the train is not coming yet and sitting in the platform (not using a waiting chair) (Table 6). Unfortunately, the station manager didn't see it as a problem. For them, it is more important that all the passengers in the platform zone are transported.

For the next plan, the station manager will build 2 additional platforms (platform 5 and 6). Therefore, the frequency of train departures and arrivals can be improved. In designing such facilities, it is necessary considered that the plan has to build a waiting room for the passengers separately.

## 5. CONCLUSIONS

Behavior mapping can be used to measure relationships between Commuter Line passenger behavior and station facilities. The method can be used to accurately link behavioral components and affordances of behavior settings to passenger movement. Such evidence may be used to develop policies and standards for adoption by station manager to help guide the station design and investment in station facilities. The station manager should more aware to identify specific passenger behavior components associated with increased passenger movement activity. Research results may provide guidance for facility design interventions that could help create an efficient and effective Commuter Line Station. Further research can focus on station manager training by increasing awareness about how the passenger behavior and its components influence the policies due to station facility design.

## 6. ACKNOWLEDGMENTS

This article is part of Grant of International Publications for Students Final Project of Universitas Indonesia: Analysis and Evaluation of Urban Community Behavior on Urban Transport Facilities and Policies.

## 7. REFERENCES

- [1] Basyarah Z., Affordances and Passengers Adaptation on Commuter Line, Universitas Indonesia, 2014, pp.1-57.
- [2] Kusumaningtyas Basyarah.M., Implementation of Railway Management Policy (Facilities and Infrastructure Study of Commuter Line Duri-Tangerang), Universitas Indonesia, 2014, pp. 1-114.
- [3] Hendro, A.P., Quality Service of Women's Special Train at Jakarta-Bogor Route, Universitas Indonesia, 2012, pp.1-94.
- [4] Adhi, P. R., Preference for Mode Selection in the Movement of Passengers Corridor Bogor-Jakarta Associated with the Selection of Residence (Case Study: AC Bus and Express KRL), Journal of Regional and City Planning, Vol. 23, No.1, 2012, pp.67-84.
- [5] Woodson, W., Human Factors Design Handbook: Information and Guidelines for the Design of systems, Facilities, Equipment and Products for Human Use, New York McGraw-Hill, 1981.
- [6] Sears, D. O., Freedman, J. L., & Peplau, L. A., Social Psychology 5<sup>th</sup> Edi, Jakarta Erlangga, 1992.
- [7] Cosco, Nilda G., Robin C. Moore, and Mohammed Z. Islam., Behavior mapping: A Method for Linking Preschool Physical Activity and Outdoor Design, Medicine & Science in Sports & Exercise 42, No. 3, 2010, pp.513-519.
- [8] Milke, Doris, Charles Beck, Stefani Danes, and James Leask., Behavioral Mapping of Residents' Activity in Five Residential Style Care Centers for Elderly Persons Diagnosed with Sementia: Small Differences in Sites can Affect Behaviors, Journal of Housing for the Elderly Vol. 23, No. 4, 2009, pp.335-367.
- [9] Larson, Jeffrey S., Eric T. Bradlow, and Peter S. Fader., An Exploratory Look at Supermarket Shopping Paths, International Journal of Research in Marketing Vol. 22, 2005, pp. 395-414.
- [10] Bernhardt, Julie, Helen Dewey, Amanda Thrift, and Geoffrey Donnan., Inactive and Alone: Physical Activity Within the First 14 Days of Acute Stroke Unit Care, Stroke Vol.35, 2004, pp. 1005-1009.
- [11] Ittelson, William H., Leanne G. Rivlin, and Harold M. Proshansky., The Use of Behavioral Maps in Environmental Psychology., Environmental Psychology: Man and His Physical Setting, ed. Harold M. Proshansky, William H. Ittelson, and Leanne G. Rivlin, New York Holt, Rinehart and Winston, 1976, pp. 340-351.
- [12] Sommer, Robert, and Barbara B. Sommer., A Practical Guide to Behavioral Research, New York, Oxford University Press, 2001.
- [13] Vidal, Luis., Urban Rail Transit Design Manual. Hong Kong Design Media Publishing Ltd., 2013.
- [14] SITA., Passenger Counting, and Tracking Technology: Comparison Fact Sheet, New York. PBD/ASL, 2016, pp. 1-12.
- [15] Miles, M.B and Huberman, A.M., Qualitative Data Analysis: A Source Book of New Methods, California, Sage Publication, 1984.

---

Copyright © Int. J. of GEOMATE. All rights reserved, including the making of copies unless permission is obtained from the copyright proprietors.

---