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学位論文題名	A Study on Model Framework of Pedestrian Level of Service Assessment for Traffic and Non-Traffic Functions on Streets in Tourism Sites - A Case in Melaka, Malaysia （観光地街路における交通および非交通機能を考慮した歩行者サービス水準評価モデルフレームに関する研究 ―マレーシア・マラッカを事例に）
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【論文の内容の要旨】

Pedestrian facilities are an important aspect in the design of traffic management systems because it also has implications on the overall traffic system, especially in the city centre. Assessment of pedestrian facilities is important to determine how well a facility is fulfilling its intended objectives. The issues with pedestrian planning are due to an absence of an objective method to assess the provision of pedestrian walkways, an inadequate planning, and design for pedestrian spaces as well as an inaccurate assessment of the needs of and requirements of a pedestrian especially in tourism destination or tourist site. Hence, there is a need to assess whether the facilities are pedestrians friendly. The conventional pedestrian level of service for traffic function express good street as low density, high speed and smoother traffic, and bad street as high density, low speed and congested. However, assessing pedestrian level of service for both traffic function and non-traffic function in tourism site is much more complicated. Dense pedestrian or congested/crowded condition would be worse in the viewpoint of traffic function, but might be attractive in the viewpoint of tourism function. Therefore, this study proposed a combined traffic- and tourism-related pedestrian level of service for a comprehensive assessment of street conditions in tourism site. The objectives of this study are (1) to develop a model framework of pedestrian level of service assessment for traffic and

non-traffic functions on streets in tourism sites, and (2) to compare psychological responses and physical parameters. The thesis organization are explained as follows: Chapter 2 compares existing evaluation methods that deal with the total model structure of pedestrian level of service found in the literature. It discusses the advantages and disadvantages of the existing method of *PLOS*.

The component of this study is structured like this; Chapter 3 proposed framework on traffic function based on counting physical condition on site. Pedestrian level of service are explained by traffic function includes Safety (SF), Mobility (MB), Facility (FC) and Accessibility (AC) indicators. Chapter 4 introduced model framework for traffic function and tourism function based on psychological response from tourist in site. There are two types of model assessment; Type 1 and Type 2. First part of Chapter 4 explains the proposed Type 1 method and introduced simple multiplier type. Satisfaction level for each function is expressed by level

of importance, recognition and satisfaction. The comprehensive overall traffic satisfaction is multiplication of importance, recognition and satisfaction for Safety (SF), Mobility (MB), Facility (FC), Accessibility (AC) and Security (SC), while overall tourism satisfaction is multiplication of importance, recognition and satisfaction for Attractiveness (AT), Enjoyment (EN), Convenience (CN) and Comfort (CM). Type 1 assessment is non-weight type of psychological aspect. It means all indicators have the same/equal weight. Then, the second part of Chapter 4 explained Type 2 assessment that check the weight (coefficient) of each factor through Structural Equation Model (SEM). SEM path analysis was used to understand the effects and relationship between the tourism-related factors, traffic-related factors and the satisfaction on three streets in the study area. The role of Type 2 assessment is to check the factor score and identify which factor may have impact and check which factor is not affected to each different types of street. Finally, chapter 5 compare and check the relationship between traffic and tourism function based on psychological response and physical condition.

This is detailed explanation on each chapter. Chapter 3 discusses the analytical assessment by star rating system. The role of chapter 3 is to propose rating system for traffic function based on physical condition. Traffic function includes Safety (*SF*), Mobility (*MB*), Facility (*FC*) and Accessibility (*AC*) indicators. The physical condition data can be observed directly on street. Eighteen selected streets in Melaka World Heritage Site had been evaluates as a case study to check the model application. The rating for pedestrian facilities in Melaka WHS can be interpreted as unfavorable to pedestrians. The pedestrian level of service for traffic function is expressed as inadequate mobility, very unsafe for walking, non-existence or negligible pedestrian facility, and good accessibility to land uses by walking. This reflected the poor walking environment of Melaka WHS and improvement strategy is necessary to create a pedestrian friendly environment in the heritage site.

Chapter 4 discusses the analytical assessment by star rating system for psychological components framework. The role of chapter 4 is to understand the relation among psychological responses to this

functions and to decide the final rating system. The data is on psychological responses from the questionnaire survey to tourists. Three (3) streets in Melaka World Heritage Site had been evaluates to check the model application. The selected streets have different characteristics, such as high number of pedestrian and have many tourism major attraction and activities. The selected streets are; Heeren Street (art/cultural street), Jonker Street (shopping street) and Temple Street (religious street). The purpose to conduct a questionnaire survey is to assess the selected factors using the tourists' psychological response toward the sidewalk condition of streets in the study site. There are two type of proposed model framework; Type 1 and Type 2 as mentioned above.

The assessment index for Type 1 is evaluated by three parts (1) level of recognition, (2) level of importance and (3) level of satisfaction for three streets in Melaka. The first part related to the level of recognition with several statements items on a point scale from 1 (strongly disagree) to 5 (strongly agree). The respondents' agreement with several performance/ statements items. In the second part, the respondents were asked to rate the important factors while walking, from 1 (very unimportant) to 5 (very important). Respondents were also asked about their satisfaction when walking on the streets based on several on a point scale from 1 (strongly dissatisfied) to 5 (strongly satisfied). The respondent was asked to reply the recognition of each function item, then secondly, we ask the respondent to identify how important this function is. For example, if this is very dangerous, highly recognize its dangerous situation, but they don't mind, not important for them, so we believe, this safety condition cannot be highly evaluated in the overall satisfaction on street. The questionnaire is 5 scales. The overall satisfaction can be achieved by multiplication of level of recognition, the level of importance and level of satisfaction. For example, if highly recognize, the condition is good, very satisfying, but not important, in this case, this is equal to 25, if we just multiply. The results show that the streets have high pedestrian satisfaction on both traffic-related and tourism-related street functions.

For Type 2 assessment, a Structural Equation Model (SEM) was used to understand the effects and relationship between the tourism-related factors, traffic-related factors and the satisfaction on three streets in the study area. For Heeren Street (art/cultural street), the SEM model show good fitness index with significant level of 0.000, ChiSq/df = 2.238 and RMSEA = 0.058, IFI = 0.961, CFI = 0.960, TLI = 0.936 and NFI = 0.932. It was found that (1) comfort and convenient factor significantly effect satisfaction to tourism and (2) mobility and facility factor significantly effect satisfaction to traffic. This study found out interesting point. There is high correlation between tourism factor and traffic factor (0.792). This means, those who satisfy with traffic functions also have high possibilities for satisfying to tourism functions. For Jonker Street (shopping street), the SEM model show good fitness index with significant level of 0.000, ChiSq/df = 2.440 and RMSEA = 0.062, IFI = 0.951, CFI = 0.950, TLI = 0.928 and NFI = 0.920. It was found that (1) comfort and convenient factor and (2) attractiveness and enjoyment factor significantly effect satisfaction to

tourism and (3) mobility and facility factor and (4) safety and security factor significantly effect satisfaction to traffic. There is high correlation of 0.807 between tourism factor (convenience and comfort) with traffic factor (mobility and facility). For Temple Street (religious street), the SEM model show good fitness index with significant level of 0.003, ChiSq/df = 1.591 and RMSEA = 0.040, IFI = 0.941, CFI = 0.969, TLI = 0.951 and NFI = 0.923. It was found that (1) attractiveness and enjoyment factor and (2) convenience and comfort factor significantly effect satisfaction to tourism and (3) mobility and facility factor and (4) safety and security factor significantly effect satisfaction to traffic. There is high correlation of 0.787 between tourism factor (convenience and comfort) with traffic factor (safety and security). To conclude Chapter 4, Type 1 assessment is better than Type 2 assessment. Type 1 is more simple and have better fitness as compared to Type 2 assessment because SEM is a little bit difficult, although it can provide specific coefficient.

The role of Chapter 5 is to compare the relationship between psychological responses and supported by physical condition data which is physical flow related data and the structure or street side environment on site. For traffic function, it was found out that: (1) safety satisfaction increases if traffic volume decreases, (2) security satisfaction increases if there is more monitoring cameras (CCTV) to make the tourists feel more secure while walking on streets, (3) accessibility satisfaction increases if the number of building use for tourism purposes increases (4) facility satisfaction increases if the number of street furniture including street lighting and signage (wayfinding) increases and (5) mobility satisfaction increases if pedestrian volume increases. This is interesting finding, in tourism site, even if the condition of streets is more crowded, tourist feel more satisfy to enjoy the situation. For tourism function, this study found that: (1) attractiveness satisfaction increases if the number of street vendors and number of interesting buildings increases, (2) enjoyment satisfaction increases if there are more cultural activities and more public space for social interaction on streets, (3) convenient satisfaction increases if the number of shops with visible window increases and the number of on-street parking decreases, and (4) comfort satisfaction increases if the number of amenities

such as benches, trees and shades increases on street, and if there is more crowding point for example people queuing to be serve outside the shops. This is interesting finding, in tourism site, even if there is more crowding point that obstructed the pedestrian way and less space for waiting space, but this situation makes tourist more satisfy.

The significance of study is the method can be use in both academic and practical. It gives primitive idea about how we rank pedestrian walkway. The proposed method can be use practically in the transportation and tourism field. It is important to understand the current PLOS for planner that manage a tourism site. In planning, we set the new target how much achievement to improve the current condition to achieve the minimum requirement of good pedestrian level of service. For example, what is the option or control parameters to change the PLOS to be better rating from the

current situation. There are several measures for example, redesign the street or operation such as traffic control or tourism control. For example, if we add more street vendors, what will happen? For traffic function, this will be the obstacle, but for tourism function, the satisfaction level will be increase and become more attractive. It has opposite effect, in the low-density situation, adding more street vendors may not have much impact but if this is in the congested crowded street, satisfaction level might be reduced. This is the meaning of this study, to understand the relation in the changes of some variables and its impact to satisfaction. Any kind of actions can change some psychological parameter and finally effect satisfaction level. By using this model, we can evaluate the effect of some change in some elements and know specifically which coefficient may have impact to achieve the satisfaction level. To increase the level of satisfaction, what is the strategy, how many physical parameters should we provide to achieve optimum value and manage the balance of traffic function and tourism function in site. If we try to change from 2 stars to 3 stars rating, what option can we have. If density increase, safety become reduce, but enjoyment level will become increase. If street become wider, density become lower, by changing the width, we can control the density for geometric change. If we change the shop composition on street, what will happen? So, this is the mechanism and significance of this study, to know the sensitivity and the impact in this system by understanding the relationship between psychological and physical, so that we can proposed better planning by considering the feeling of user perception.

As a conclusion, the final star rating system is based on psychological response and supported by physical. The computation of PLOS defines what an ideal pedestrian walkway should be. This method use common idea on assigning star rating, in the same way to how airlines and hotels are rated. The star rating provides a layman explanation of how good or how bad a pedestrian facility is. It can evaluate precisely and provides ideas which street should be improved in specific. It is also for allocating the budget to identify corrective actions to retrofit the facility to meet the criteria of an ideal walkway. The task is often challenging if the planner lacks a definitive measuring tool to objectively evaluate the pedestrian infrastructure to determine its conformance to the pre-set criteria. *PLOS* is proposed to assign numerical value to the facility being evaluated. In normal circumstances, planners should aim for having a minimum *PLOS* value of 40 which corresponds to a 3-star rating as such facility would be at least ‘walkable’ for pedestrians.