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Invited Paper

The Development of Walking Environment Measures for Indonesia Cities[ζ]

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Abstract. Walking is one of key points in assessing the quality of urban transport, as well as the quality of public transport services, accessibility, and land use connectivity. Currently, cities in Indonesia have not been entirely friendly to pedestrians. Beside the lack of walking infrastructure quality, there is a high reluctance of people to walk. Therefore, Indonesia cities might need good quality of walking environment to push more walking trip. Walking environment is a condition that includes pedestrian infrastructure that supported by the other facilities to encourage people to walk more often. This paper describes the development of walking environment measures for Indonesia cities. Previous related research has been carried out and to be continued as the standard and design guide of pedestrian-friendly environment for Indonesia cities.

1. Introduction

As transportation mode, walking has specific characteristics comparing with walking as an activity only. The transportation mode of walking has a role in urban development. The qualities of public transport and as well city accessibility and connectivity are measured based on the quality of walking. For walking facilities design in urban area, Indonesia have design standard under Ministry of Public Work Law of 2014. In that law, the facilities is consist of pedestrian network that linkage facilities among buildings; part of transport mode interchange; space for social interaction; city scenery; and as evacuate routes. It is understand that a good walking facilities is useless if it is built in the middle of nowhere, even in the part of city area. In other case, walking facilities surrounding city parks gave the good scenery but they are not good since they give longer walking distance to those who just want to pass through. Therefore, in the concept of walking environment, it is not enough to provide just wider and good scenery unless the facilities could encourage people to do more walking. In this paper, the walking environment is defined as the condition that includes pedestrian infrastructure that supported by the other facilities to encourage people to walk more often. The objective of the paper is to describe the development of walking environment measures for Indonesia cities. The previous research is already done as shown in [1] and being continued in the development of walking environment measures and will be carry on to be standard and design guide of pedestrian-friendly environment for Indonesia cities.

2. Related Research

Research on walking as transport mode is already carried out in the last decade for the case of Indonesia cities. Previously, it was believed that walking as the urban transportation mode is not too popular in the South Asia cities because of its tropical climate. However, as mentioned in [1], characteristic of walking distances to reach urban transport terminals (MRT stations) in Bangkok,

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Singapore, and Manila were quite similar with Sapporo, Japan. They also stated that providing of walking facilities had significant impact on walking distance rather than climate condition.

Pedestrian level of service is the well known method to assess the walking facilities. The Highway Capacity Manual (HCM), in [2], provided standardized of indexing with letter A to F (A for the best and F for the worse) to express the quality of service of the pedestrian facilities. The method is quite similar with model capacity for vehicle flow. The index was defined based on pedestrian flow rate which is the interaction result between providing facilities and actual pedestrian flow. More simple method was provided earlier by [3] with assessment parameter as follow.

Table 1 Category and Criteria of Pedestrian Level of Service [3]

Category	Criteria
Pedestrian Facilities	Related to sidewalk facilities such as continuity in both sides, sidewalk width, barriers free on the sidewalk
Conflicts	Related to crossing conflict
Amenities	Availability of benches, shading tree, lighting, and so on.
Vehicle level of service	Level of service of the traffic lanes
Facilities Maintenance	Provision of maintenance program or activities
Transport Demand Management/Multimodal System	Whether the facilities were part of TDM system

Other methods that have similarity can be summarized in the following table. Those methods were using similar index i.e. letter of A to F.

Table 2 Parameter of Level of Service for Pedestrian Facilities

In [4]	In [5]		In [6]	In [7]	In [8]	
• Sidewalk width • Road shoulder width • Availability of on-street parking • Buffer area • Average traffic flow	• Design Factor	◦ Path width ◦ Obstruction ◦ Crossing opportunity ◦ Support facilities	• Sidewalk width • Obstruction • Pedestrian flow rate • Opposing events (including bicycle passing)	• Distance between sidewalk and the adjacent road • Pedestrian and bikers volume • Vehicle volume • No. of driveway access	• Traffic Factor	• Distance from traffic • Outside traffic speed • Traffic Separation • Traffic Noise • Traffic volume • Road access
	• Location Factor	◦ Connectivity ◦ Path environ. ◦ Vehicular conflict			• Geometric Factor	• Sidewalk width • Obstruction • Guide for the blind • Pavement condition • Ramps • Trees
	• User Factor	◦ Pedestrian volume ◦ Mix users ◦ Personal security			• Pedestrian movement	• Ped. volume • Safety • Maneuver • Multimodal facilities

From the table above, it can be seen that the calculation is based on pedestrian flow and potential conflict with vehicle movement. On the other hand, the walkability index was the other walking assessment that focused on characteristics of walking infrastructure that related to how easy to walk.

Previous research was carried out in [9] and extended applying for the case of some Asia Cities in [10] and in [1] for some cities in Indonesia. Basically, the parameter assessment is shown in as follow.

Table 3 Assessment Components of Walkability Index [9]

Component	Variable
• Safety and Security	• Proportion of road accidents that resulted in pedestrian fatalities (most recent year avail.) • Walking path modal conflict • Crossing safety • Perception of security from crime • Quality of motorist behavior
• Convenience and Attractiveness	• Maintenance and cleanliness of walking paths • Existence and quality of facilities for blind and disabled persons • Amenities (e.g., coverage, benches, public toilets) • Permanent and temporary obstacles on walking paths • Availability of crossings along major roads
• Policy Support	• Funding and resources devoted to pedestrian planning • Presence of relevant urban design guidelines • Existence and enforcement of relevant pedestrian safety laws and regulations • Degree of public outreach for pedestrian and driving safety and etiquette

3. The Concept of Walking Environment

The concept of walking environment was derived mainly from the concept of walkability index and pedestrian level of service. Unlike walkability index, walking environment focus on how to fulfill pedestrian's need to walk. General concept, it can be illustrated in the following figure.

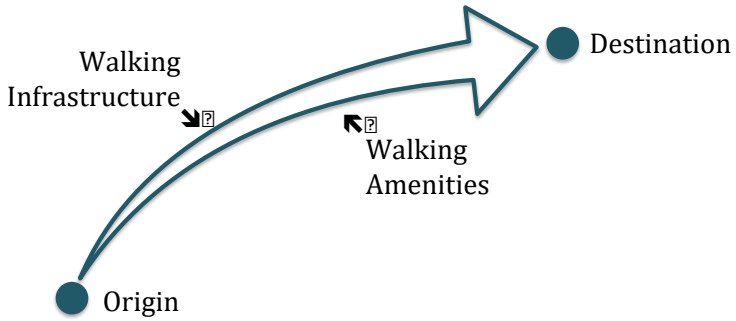

Fig. 1 Illustration of the Concept of Walking Environment

In this concept, walking is defined as a trip from an origin (e.g. home) to the desired destination (e.g. office or school). This definition term is important to make distinction with walking as the means of activity. On the way to reach desired, there were walking infrastructure and some amenities. The walking infrastructure was related to physical characteristic of the facilities such as sidewalk width, ramp provision, directness, and so on. On the other hand, the walking amenities was specific features to make the infrastructure having better environment to walk, in order to reach desired

destination. Moreover, the amenities should encourage people to walk more often. Therefore, the element of walking environment assessment can be seen in the following table.

Table 4 Parameter of Walking Environment Assessment

No.	Parameter	Criteria	Description
1	Infrastructure	Sidawalk width, etc	The assessmnet was based on whather elements of walking infrastucture had fullfil standard design* or not.
2	Connectivity	Integration sidewalk and walkway	Connectivity sidewalk and walkway among buildings, public services, and city parks within 2000 meters.
3	Accesibility	Directness	Division between actual walking distance and stright line distance from origin to destination
		Information dan Direction	Provision of enough information sign along the walking route
4	Attractiveness	Good sightseeing and very limited street vendor	Sightseeing and limited (or controlled) street vendor along the walking route
5	Comfort	Shelter (or tree), etc.	Provision shelter (tree if available); Chair and trash bin for every 10 meters.
6	Safety	Protection facilities along sidewalk and walkway	Sidewalk: protection from traffic flow; Walkway: protection from entering/exiting vehicle
7	Secure	Protection facilities from the crime	Provision of environment friendly street lighting
8	Equality	Facilities for disability, eldery, and children	Provision supporting facilities along the walking route

* refer to Ministry of Public Work Law No. 03/PRT/M/2014

4. Walking Environment Measures

In carried out the measures, the scoring system was applied. Each parameter was scored with value of 1 to 5, where the score of 1 was the worse condition, and 5 was the best one. Modified from already done in [1], the walking environment assessment consist of three main activities. The first one is identifying the study area. To have walking assessment for the whole city, one should breakdown the whole city into compact city areas with only one dominant center of activities, e.g. mall, compact office building, university, and so on. In case of a city area with more than one main activities, the assessment was carried out separately for each center. The second one, a radius of 800 meters was drawn from the center as the walking catchment area of the center. Since walking environment assessment based on specific pair of origin-destination, then, all possible walking routes to reach the center within the area were identified. Some of the routes then were selected randomly as the sample. Finally, walking environment assessment was carried out for the selected walking route.

The following table is an illustration of the assessment with the sample that taken from [1]. It was education area with a university as the central of activity. The university has main gate in the south and it was defined as the destination points. Within radius of 800 meter, there were about 5 main walking routes to reach the gate. The foremost route was taken as the sample with characteristic as follow. The total length was about 765 meter with less than 15% was a walkway. Sidewalk was provided in the both side of with good paving. The terrain is relatively flat and there were many trees along the route.

Table 5 Walking Environment Assessments

No.	Parameter	Criteria	Score	Weight	Value
1	Infrastructure	Average width less than 2.0 m; no ramp available; discountinus; some were slipery if wet. 80% fulfill the design standard	3.5	0.20	0.7
2	Connectivity	Itegration between walkway and sidewalk with mostly without ramp; good conectivity with main buildings;	3.5	0.15	0.525
3	Accesibility	Average directness: 1.7; almost no direction sign along the routes	3	0.15	0.45
4	Attractiveness	Good sightseeing and very limited street vendor	4	0.05	0.2
5	Comfort	Mostly covered by tree. No walking shelter provided; limited chair and trash bin along the route	3.5	0.10	0.35
6	Safety	more than 80% of the sidewalk has trees along the route; protection from vehicle movement.	3	0.15	0.45
7	Secure	Limited street lighting	2	0.10	0.2
8	Equality	Difficult for wheel chair	1	0.10	0.1
				Total	2.98

As result in the table, it was shown that the value of walking environment is 2.98 (for the maximum value of 5). This value indicated that the walking environment of the route was not too good. As seen in the table, the fulfillment of design standard was not enough to make the route more environments friendly. Some parameters need to upgrade in order to have better environment, such as accessibility, safety, secure, and equality.

Comparison with previous study in [1], in walkability index, the value was 77% while in walking environment it was 60% (2.98 of 5). This result indicates that the concept walkability index can be improved into the walking environment.

Note that some values in Table 5 was needed to be elaborated more, especially the weight. Recently, the weight was derived from the experts' judgments in the focus discussion group in the Institute of Road Engineering Agency for Research and Development, October 2016.

5. Conclusion

There are three methods that arise in this paper. The first one was the pedestrian level of service that developed based on pedestrian flow rate and potential conflict with vehicle flow. The second one was walkability index that focused on the ability to walk under the providing walking infrastructure. Finally, the method of walking environment that focuses on the fulfillment of design standard with additional features to encourage people does more walking.

Walking environment can be seen as the combination between walking infrastructure and its environment that encouraging people do more walking. Indonesia's standard for walking facilities is

not enough to capture the walking environment. Improvement on the environment might increase walking trip, especially in the city area, such as CBD area, and short distance trip. Extended methodology can be carried for crossing environment.

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References

[1] S.S. Wibowo, N. Tanan, N. Tunumbia, "Walkability Measures for City Area in Indonesia (Case Study of Bandung)", **Journal of the Eastern Asia Society for Transportation Studies**, Vol. 11, pp. 1507-1521, 2015.

[2] Highway Capacity Manual (HCM), **Transportation Research Board**, National Research Council, Washington D.C. 2000.

[3] L.B. Dixon, "Bicycle and Pedestrian Level of Service Performance Measures and Standards for Congestion Management Systems", **Transportation Research Record 1538**, pp. 1-9, 1996.

[4] B.W. Landis, V.R. Vattikuti, and R.M. Ottenberg, "Modelling the roadside walking environment: A Pedestrian Level of Service", **Transportation Research Record 1773**, pp. 82 – 88, 2001.

[5] N. Gallin, N., "Quantifying Pedestrian Friendliness- Guidelines for Assessing Pedestrian Level of Service", **Proceeding**, Walking the 21st century, 20 -22 February, Perth, Western Australia, 2001.

[6] T. Muraleetharan, T. Adachi, K. Uchida, T. Hagiwara, and S. Kagaya, "A Study on Evaluation of Pedestrian Level of Service Along Sidewalks and at Crosswalks Using Conjoint Analysis", **Journal of Infrastructure Planning**, Japan Society of Civil Engineers, Vol.21 No.3, pp. 727-735, 2004.

[7] D. Tan, W. Wang, L. Jian, and Bian, Y., 2007, "Research on Methods of assessing Pedestrian Level of Service for Sidewalk", **Journal of Transportation Systems Engineering and Information Technology**, Vol. 7, Issue 5, October 2007, pp. 74-79, 2007.

[8] P. Christopoulou, and L.M. Pitsiava, L.M., 2012, 'Development of a Model for the Estimation of Pedestrian Level of Service in Greek Urban Areas", **Procedia** – Social and Behavioral Sciences, Vol. 48, pp. 1691-1701, 2012.

[9] H.V. Krambeck, "The Global Walkability Index", **Master Thesis**, the Department of Urban Studies and Planning and the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Februaty, 2006

[10] J. Leather, S. Gota, H.G. Fabian, A.A. Mejia, and S.S. Punte, "Walkability and Pedestrian Facilities in Asian Cities", **ADB Sustainable Development Working Paper Series**, Metro Manila, Philippines, 2011.