Index of Walkability to and from Public Transport Stops or Terminals in Greater Jakarta to Enhance Walking Environment

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Index of Walkability to and from Public Transport Stops or Terminals in Greater Jakarta to Enhance Walking Environment

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Abstract. Almost all travel between an origin to a destination requires walking as first-mile and last-mile transport mode. Walking can be conducted either in the sidewalks, zebra-crosses, and pedestrian bridges. This paper adopts the index of walkability developed by D'orso dan Migliore in 2020 to be used for 150 respondents in Greater Jakarta. This index consists of three constructs (factors), i.e., practicability, safety and, pleasantness. A confirmatory factor analysis was used using principal component analysis in SPSS 27 and rotated using varimax with Kaizer Normalization. Instead of three factors in the original index, in this Indonesian adaptation, only two factors were extracted. Based on the discussion on this paper, it was recommended to increase the number of respondents to get a more valid result.

1. Introduction

Walkability can be generally defined as the extent to which the built environment, allows walking [1] and is pedestrian-friendly [2-3]. However, walkable is multi-dimensional [4], with studies stressing different environmental features or means of creating walkable environments, which are traversable, compact, physically attractive, and safe, creating vibrant locations, adding sustainable travel choices, and supporting outdoor physical activities and recreation [5-7].

Index of walkability developed by D'orso & Migliore (2020) [8] consist of three factors, i.e., practicability, safety and, pleasantness. Practicability consists of the condition and cleanliness of the sidewalks, architectural obstacles, and other elements limiting accessibility. Safety defines as protection from various risks during the walking experience such as sidewalk fences, sidewalk lightings and safety, and perception of security against crime. Pleasantness relates to sidewalk attractiveness and the presence of attributes along the sidewalks elevating the degree of walking quality.

According to the Minister of Public Work Regulation No. 03/PRT/M/2014 [9], pedestrian facilities include green belts, lightings, benches, sidewalk fences, trash bins, markings, signs, information boards, bus stops, and public phones. The width of green belts should be at least 150cm and to be planted by shading trees. The lightings should be mounted in 4m height with spacing 10m between each light pole. The dimension of benches is 0,4-0,5m in width dan 1.5m in length with a spacing of 10m between benches. The height of the sidewalk fence should be 90cm. Spacing between trash bins is 20m.

2. Literature Review

According to D'orso & Migliore (2020) [8], the following was the description of each item in the index of walkability:

Practicability:

- Sidewalk slope: manageable (<5%) vs too steep for elderly and/ or wheelchair users (>=5%).
- Pedestrian level of service: high pedestrian flow/ limited sidewalk width/ some obstacles vs low pedestrian flow/ sufficient sidewalk width/ no obstacles.
- Surface degradation: some holes or dips/ degraded sidewalk vs no holes or dips/ adequate sidewalk

Pleasantness:
- Street furniture: no trash bins/ benches/ other street furniture vs some trash bins/ benches/ other street furniture.
- Shelter for rain and sun: not available vs available.
- Green areas: not available vs available.
- Shops: not available vs available.
- Building context/ land use mix/ urban design: degraded urban landscape (damage urban furniture, dirty, some graffiti, some abusive posters, some buildings with degraded facades) vs nice urban landscape (perfect functionality of urban furniture, adequate cleaning, some well-maintained buildings.

Safety:
- Lighting: poor or lack of lighting vs proper and efficient lighting.
- Traffic volume and vehicle speed: high traffic volume/ high speed vs low traffic volume/ low speed.
- Pedestrian protection from vehicles: not available vs were available.
- The traffic control signal at the intersection: not available vs available.
- Driveways: some driveways vs no driveways

According to Lee et al (2020) [10], the audit-based school walkability index can be used as a complementary tool for measuring walkability near low-income elementary schools along with the existing GIS-based school walkability index. The audit-based school walkability index consists of three variables and several items as follows:
- Land use (density of multi-family housing, the density of park, density of vacant land).
- Street characteristics (density of sidewalk, sidewalk completeness rate, flat sidewalk rate, wide sidewalk rate, sidewalk buffer rate, sidewalk connectivity rate, density of uneven surface, density of trashes on the street, density of graffiti, density of drainage deficiencies, streetlight density, density of traffic calming equipment, noise from factories/ pets, and density of zebra cross).
- Neighborhood perception (easiness to observe sidewalk from home, no cracks/ holes/ overgrown grass, cleanliness from trash, pedestrian/ cyclist safety, pedestrian/ cyclist comfort, and scenery surrounding the street).

Christiansen et al (2014) [11], combining school site, perceived environment, and social environment to model active school travel. Perceived environments include perceived safe route, many paths, safe crossing, traffic flow, and traffic speed. Social environments include parents cycle weekly, friends cycle daily, and parents support cycling.

Koohsari et al (2021) [12] conducted data collection between July and December 2013 and April 2014 to February 2015 from a randomly chosen sample of residents in 2 Japanese cities, Koto Ward and Matsuyama City. They found that walkability correlated with population density, access to shops, access to public transport, availability of sidewalks, availability of cycle lanes, access to recreational facilities, aesthetics, traffic safety, and security from crime.

Conderino et al (2021) [13] analysed the 2019 Walk Score across 500 large cities in the U.S. They found that high-income and majority White geographic units had the lowest walkability overall. However, this association was reversed within the majority of Black neighbourhoods, where tracts in lower-income tertiles had the lowest walkability

3. Method

The respondents were 150 pedestrians who use public transport frequently in Greater Jakarta. The general data includes gender, age, residence address (just to indicate the residence location within the Greater Jakarta; full address not required), travel objective, monthly personal expenses, frequency of using public transport, walking distance. The perception data was an adaptation to 13 items of the index of walkability (D'orso & Migliore, 2020) [8] as follow:

Practicability:
- PR1: I prefer to walk on a sidewalk that can be easily accessed by everybody.
- PR2: I prefer to walk on a wide sidewalk.
- PR3: I prefer to walk on a sidewalk without obstacles.
- PR4: I prefer to walk on a well-maintained sidewalk.

Pleasantness:
- PL1: I prefer to walk on a sidewalk equipped with street furniture such as trash bins and benches.
- PL2: I prefer to walk on a sidewalk equipped with shelter for rain and sun.
- PL3: I prefer to walk on a sidewalk equipped with minimarkets.
- PL4: I prefer to walk on a sidewalk surrounded by well-maintained and clean buildings.
- PL5: I prefer to walk on a sidewalk surrounded by greeneries.

Safety:
- S1: I prefer to walk on a sidewalk with proper lighting.
- S2: I prefer to walk on a sidewalk when road traffic is heavy.
- S3: I prefer to walk on a sidewalk equipped with a fence.
- S4: I prefer to walk on a sidewalk with the signalized pedestrian crossing.

Likert scale was used as responses of the perceptional part of the questionnaire, i.e. (1) strongly disagree (2) disagree (3) agree, and (4) strongly agree.

A confirmatory factor analysis (CFA) was conducted using principal component analysis in SPSS 27 and rotated using varimax with Kaizer Normalization. The extraction was based on eigenvalues greater than 1. There were two criteria related to sampling adequacy, i.e., Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, and Measures of Sampling Adequacy (MSA). KMO should be at least 0.6 and MSA's in the main diagonal of the anti-image correlation matrix should be at least 0.5. The other criterion is Bartlett's test of sphericity tests, i.e., the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and therefore unsuitable for structure detection. Therefore, the significance of the test should be less than 0.05. A variable's communality ranges from 0 to 1. In general, one way to think of communality is as the proportion of common variance found in a particular variable. A variable that does not have any unique variance at all (i.e., one with an explained variance that is 100% a result of other variables) has a communality of 1. An average value between 0.5 and 0.6 is acceptable for sample sizes between 100 and 200 (Samuel, 2017) [14].

4. Respondent Profiles

Of 150 respondents, most of them (73%) came from the younger-adult age group. The respondent's mean age of 36 years old and a standard deviation of 11 years old. Most of the respondents (61%) lived in Jakarta. Most of the respondents (67%) monthly expenses were less than the minimum regional wage of 4.5 million rupiahs (USD 314) with mean monthly expenses of USD 390 and a standard deviation of monthly expenses of USD 674. Most of the respondents (81%) did not use public transport daily but were frequent enough to be eligible to be the respondent. Most of the respondents (46%) were willing to walk 1000 m or more a day with a mean willingness to walk 2,945m with a standard deviation of 5,073m. Most of the respondents (43%) travel for work

5. Results

To be able to fulfill all the requirements stated in Data Analysis Method, the CFA should be conducted more than once. In the first trial, the KMO Measure of Sampling Adequacy was 0.677 (more than 0.5) and Bartlett's Test of Sphericity <0.001 (far under 0.05) and therefore the requirement was fulfilled. Table 1., shows the MSA in the first trial. MSA for PR4 (0.490), S1 (0.318), and S2 (0.274) were less than 0.5, and therefore the requirement was not fulfilled, and consequently, PR4, S1, and S2 were removed before further trial was conducted. Table 2., shows the communalities in the first trial. Communalities extraction of PL3 (0.280) was less than 0.5 and therefore the requirement was not fulfilled and consequently, PL3 was removed before further trial was conducted.

Table 1. MSA from the first CFA trial

Item	MSA
PR1	0.765
PR2	0.573
PR3	0.792
PR4	0.490
PL1	0.832
PL2	0.814
PL3	0.756
PL4	0.850
PL5	0.790
S1	0.318
S2	0.274
S3	0.591
S4	0.798

Table 2. Communalities from the first CFA trial

Item	Communalities
PR1	0.723
PR2	0.858
PR3	0.762
PR4	0.835
PL1	0.543
PL2	0.770
PL3	0.280
PL4	0.766
PL5	0.802
S1	0.879
S2	0.805
S3	0.842
S4	0.757

In the second trial, the KMO Measure of Sampling Adequacy was 0.794 (>0.6) and the significant level of Bartlett's Test of Sphericity was less than 0.001 (<0.05). Therefore, the requirement was fulfilled. Table 3., shows the MSA in the second trial. All MSA's were more than 0.5 and therefore the requirement was fulfilled. Table 4., shows the communalities in the second trial. All communalities were more than 0.5 and therefore the requirement was fulfilled. Table 5. describes the number of factors that can be formed based on eigenvalue > 1,0 and the total variance explained. Table 6. shows the rotated component matrix consists of 2 components (factors). The original walkability index (D'orso & Migliore, 2020) [8] consists of 3 factors. Therefore, our findings were 2 new combined factors called Pleasantness-Practicability (component 1) and Safety-Practicability (component 2).

6. Conclusion and Recommendation

Our findings were 2 new combined factors in the Indonesian Walkability Index called:

- Pleasantness-Practicability (component 1) consists of PL1 (I prefer to walk on a sidewalk equipped with street furniture such as trash bins and benches), PL2 (I prefer to walk on a sidewalk equipped with shelter for rain and sun), PL4 (I prefer to walk in a sidewalk surrounded by well-maintained and clean buildings), PL5 (I prefer to walk in a sidewalk surrounded by greeneries) and PR1 (I prefer to walk in a sidewalk which can be easily accessed by everybody).
- Safety-Practicability (component 2) consists of S3 (I prefer to walk in a sidewalk equipped with a fence), S4 (I prefer to walk in a sidewalk with signalized pedestrian crossing), PR2 (I prefer to walk in a wide sidewalk), and PR3 (I prefer to walk in a sidewalk without obstacle).

Based on the discussion on this paper, it was recommended to increase the number of respondents to get a more valid result.

Table 3. MSA from the second CFA trial

Item	MSA
PR1	0.794
PR2	0.748
PR3	0.778
PL1	0.877
PL2	0.817
PL4	0.846
PL5	0.792
S3	0.735
S4	0.781

Table 4. Communalities from the second CFA trial

Item	Communalities
PR1	0.721
PR2	0.845
PR3	0.626
PL1	0.877
PL2	0.817
PL4	0.846
PL5	0.792
S3	0.829
S4	0.694

Table 5. Total variance explained

Com-ponent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.751	41.678	41.678	3.751	41.678	41.678	3.571	39.682	39.682
2	2.829	31.435	73.113	2.829	31.435	73.113	3.009	33.430	73.113
3	0.639	7.095	80.208						
4	0.561	6.233	86.441						
5	0.382	4.245	90.686						
6	0.291	3.237	93.923						
7	0.223	2.480	96.403						
8	0.167	1.855	98.259						
9	0.157	1.741	100.000						

Table 6. Rotated component matrix

Items	Components	
	1	2
PL1	0.735	
PL2	0.862	
PL4	0.885	
PL5	0.880	
PR1	0.848	
PR2		0.917
PR3		0.787
S3		0.910
S4		0.832

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