The walkability concept based on pedestrian perceptions in Bandung City Square, Indonesia

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Abstract. The concept of walkability is about the provision of a pedestrian-friendly environmental condition that provides security, comfort and safety, and offers visuals for pedestrians. The Bandung City Square Area has various attractions which all promote walking activities. However, the presence of street vendors, the lack of facilities for the disabled, inadequate vegetation, crossings, and supporting facilities, and also illegal parking have caused problems, which have rendered the pedestrian-friendly environmental aspects not being able to be fulfilled. This study aims to assess the walkability of streets in Bandung City Square Area, using aspect of walkability based on pedestrian perception as users. The research was conducted using the Global Walkability Index and Multicriteria Satisfaction Analysis, based on pedestrian perception surveys. The results showed that, the existing conditions of streets' walkability in Bandung City Square Area is Waiting to Walk, which is adequate for walking. For example, five parameters, namely the availability of crossings, security against crime, disabled infrastructure, grade safety of crossing, and motorist behavior were found to be below average. It can also be concluded that, three parameters, namely crossing safety, security against crime, and disabled infrastructure require immediate attentions. The overall results of the study suggested that, improvement of streets' walkability is needed by focusing on parameters that are below-average, thus requiring immediate attentions. Further research is recommended to find effective improvements for streets' walkability, based on the pedestrian perception to have a pedestrian-friendly environment in Bandung City Square Area.

1. Introduction

The concept of walkability can be defined as the extent, to which, the built environment supports and encourages walking by providing security [1], comfort and safety for pedestrians, connecting pedestrians with various destinations within reasonable time and effort, and offering visual interest in walking along pedestrian paths [2,3]. Bandung City Square (Alun-Alun Kota Bandung) is included in the primary tourist attractions in the Cultural Heritage Tourism Area, one of the Regional Tourism Strategic Areas [4], which serves the western region of the city as the center for economic, social and/or administrative services [5].

Alun-Alun (formerly written as aloen-aloen or aloon-aloon) is an open-space concept, located in the Javanese city center. It is a wide-open field with grass, surrounded by roads and can be used for various community activities, since Bandung City Square, previously (1967) was a government center used by the public to fulfill calls, listen to announcements or to see demonstrations. It underwent several changes, until it finally became the Great Mosque of Bandung Plaza (2017), with the socializing function of the square as a public open space being maintained and further enhanced [6,7].

For Bandung City, Bandung City Square has a strategic and important location, making it one of the city icons. It is also surrounded by various attractions [6] dominated by historical tourism, with the presence of the Savoy Homan Hotel and the Grand Preanger Hotel, the Asian-Afrika Conference Museum, the Regent's House, some instagrammable selfie spots, pedestrian malls, and also the Great Mosque of Bandung. All of these attractions spread along the pedestrian way around the locations of nearby streets, namely Asia-Afrika, Alun-Alun Timur and Dalem Kaum Streets, which promote walking activities [8] in the area around Bandung City Square.

Problems in Bandung City Square Area are closely related to walking activities, such as the presence of street vendors disturbing the pedestrian way [9], the lack of infrastructures for the disabled [6,9,10], the lack of vegetation for pedestrian shading [6,9], inadequate safe crossings and illegal parking [9], which all render pedestrian-friendly environmental aspects (security, comfort, and safety) not being able to be fulfilled. Therefore, this study aimed to assess the walkability of streets in Bandung City Square Area, using the aspects of walkability concept based on the perception of pedestrians as users.

2. Methods

A preliminary study was conducted from 23rd to 26th March, 2023 (the beginning of Ramadhan), using a questionnaire as the research instrument. A total of 33 responses were received, to strengthen selected location boundaries. The study area (Figure 1) is in the administrative zones of several districts, including Lengkong, Sumur Bandung, and Regol [5], and the street segments to be studied include Asia-Afrika, Alun-Alun Timur, and Dalem Kaum.

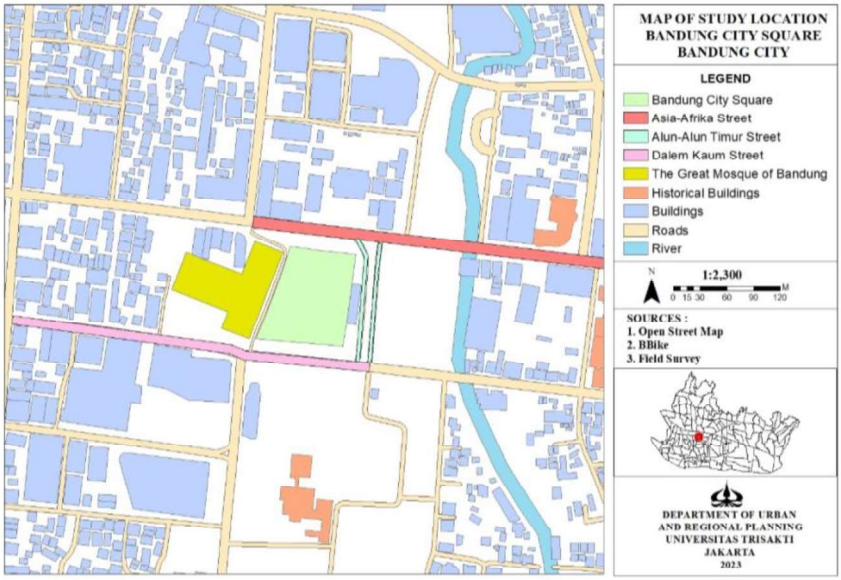

Figure 1. Study Area

Data collection and study area observation were carried out from 6th to 10th April, 2023 during Ramadhan, using questionnaires distributed directly to the respondents, all of whom were pedestrians. According to the Lemeshow formula [11], 100 respondents are required. Although 110 questionnaire responses were collected, 10 of them were found to be invalid (ambiguous and missing or blank answers, etc.). The final data provided by the remaining 100 respondents was used to determine pedestrian perceptions of: required characteristics, walkability level based on nine parameters in the Global Walkability Index [2,11,12] and satisfaction and importance level of streets' walkability based on nine parameters in the Global Walkability Index [13].

In this study, the following methods were used: Global Walkability Index (GWI)[2,12] to determine the level of walkability, and Multicriteria Satisfaction Analysis (MUSA)[13] in the final form of an

Action Diagram to determine the level of importance and satisfaction of streets' walkability and parameters in the Action Opportunity (low level of interest and satisfaction). Prior to performing the analysis, the 1-5 rating data was converted to 0 -100 using a positive tone from the System Usability Scale (SUS) [14]. Furthermore, a descriptive analysis was used to explain both the GWI and MUSA analysis results, as well as the pedestrian characteristics data.

3. Results and Discussions

3.1. Pedestrian Characteristic

The characteristics of pedestrians in the study area (Table 1) are dominated by men, aged 18-45 years, with walking being the most common activity. Starting from Bandung City Square Bus stop, pedestrians then pass Asia-Afrika, Alun-Alun Timur and Dalem Kaum streets, through to their destinations; Bandung City Square, Pedestrian Mall, and Great Mosque of Bandung. As previously stated, the most common activity is walking, which corresponds to a walking distance of more than 500 meters. This result showed that, the pedestrians walked more than the average person (500 meters) [15] as they tend to walk around and to go to several destinations. Since the data was collected during Ramadhan, the pedestrians walked the most at night, after 18.00 hours (after breaking their fast). Pedestrians rarely visited the study area (once or twice in the last two months), and when they did it, they used private vehicles, such as motorcycles, to access the area before continuing to walk around the study area. As this research was done in Ramadhan, additional research on pedestrian characteristics in the Bandung City Area, outside the fasting month, can be conducted, to see if there are any differences in pedestrian characteristics.

Table 1. Pedestrian Characteristics

Characteristic	Components	Total	Percentage (%)
Age	< 18	12	12.00
	18 - 45	**79**	**79.00**
	> 45	9	9.00
Gender	**Male**	**64**	**64.00**
	Female	36	36.00
Activity Pedestrians can choose multiple answers	**Walking**	**78**	**35.45**
	Sitting	74	33.64
	Shopping	36	16.36
	Travelling	21	9.55
	Working	11	5.00
Starting point Pedestrians can choose multiple answers	**Bandung City Square Bus Stop**	**41**	**44.57**
	Bandung City Square Basement Parking Lot	26	28.26
	Asia-Afrika Street Parking Lot	19	20.65
	The Kings Parking Lot	6	6.52
Street passed Pedestrians can choose multiple answers	**Asia-Afrika Street**	**96**	**45.71**
	Dalem Kaum Street	65	30.95
	Alun-Alun Timur Street	49	23.33
Destination Pedestrians can choose multiple answers	**Bandung City Square**	**57**	**29.38**
	Pedestrian Mall	47	24.23
	The Great Mosque of Bandung	30	15.46
	Asia-Afrika Mural (Pedestrian Bridge)	21	10.82
	Asia-Afrika Monument	18	9.28
	Otto Iskandar Dinata Street (Shops)	11	5.67
	Asia-Afrika Museum	10	5.15
Length of walking distance	Near (<100 m)	22	22.00
	Quite Far (100-300 m)	12	12.00
	Far (300-500 m)	25	25.00
	Very Far (>500 m)	**41**	**41.00**

Table 1. Pedestrian Characteristics (cont.)

Walking time	Morning (09.00-12.00)	17	17.00
	Afternoon (12.01-15.00)	18	18.00
	Evening (15.01-18.00)	31	31.00
	Night (>18.00)	**34**	**34.00**
Walking frequency	**Very Rarely (1-2 times)**	**63**	**63.00**
	Rarely (3-5 times)	14	14.00
	Often (6-8 times)	7	7.00
	Very Often (>8 times)	16	16.00
Type of transportation	**Private Vehicle**	**54**	**54.00**
	Public Vehicle	40	40.00
	Walking	6	6.00
Type of vehicle	**Motorcycle**	**32**	**32.00**
	Car	22	22.00
	Bus (Damri)	17	17.00
	Online Taxi	13	13.00
	Walking	6	6.00

3.2 Analysis of the Global Walkability Index

Table 2 displays the scores from pedestrian ratings. The initial value (IV) from the 1-5 rating, based on the field walkability survey scoring guide [2] is then converted to a 0-100 value (CV). The results of the Global Walkability Index analysis (Table 3) show that, the walkability level of the Bandung City Square Area is Waiting to Walk, which is adequate for walking. However, there are parameters with a value (CV) below the average, such as the availability of crossings, security against crime, disabled infrastructure, grade safety of crossing and motorist behavior, which need to be a concern for streets' walkability.

Table 2. Walkability Score in Bandung City Square Area

P	Asia-Afrika Street			Alun-Alun Timur Street			Dalem Kaum Street		
	IV	CV	CV x PW	IV	CV	CV x PW	IV	CV	CV x PW
					Security				
1	4.32	83.00	1245.00	4.44	86.00	1290.00	4.41	85.25	1278.75
2	3.83	70.75	1768.75	3.66	66.50	1662.50	3.74	68.50	1712.50
3	3.38	**59.50**	595.00	3.52	**63.00**	630.00	3.54	63.50	635.00
4	3.89	72.25	722.50	3.88	72.00	720.00	3.62	65.50	655.00
5	3.26	**56.50**	282.50	3.15	**53.75**	268.75	3.10	**52.50**	262.50
					Comfort				
6	4.08	77.00	770.00	4.00	75.00	750.00	4.00	75.00	750.00
7	3.21	**55.25**	552.50	2.98	**49.50**	495.00	3.05	**51.25**	512.50
					Safety				
8	3.34	**58.50**	585.00	3.37	**59.25**	592.50	3.45	**61.25**	612.50
9	2.82	**45.50**	227.50	2.87	**46.75**	233.75	2.92	**48.00**	240.00
					Average Conversion Value				
		64.25			**63.53**			**63.42**	

Note : P: Parameters; IV: Initial Value; CV: Conversion Value; PW: Parameters Weight

Table 3. Bandung Square Area Walkability Score

Asia-Afrika	Alun-Alun Timur	Dalem Kaum
67.49	**66.43**	**66.59**
Waiting to Walk	Waiting to Walk	Waiting to Walk

The availability of crossings, security against crime, disabled infrastructure, grade safety of crossing, and motorist behavior as concerns for the walkability of streets in Bandung City Square Area revealed a relationship to the existing conditions, such as the lack of disabled infrastructure [6,9,10] and safe crossings [9] which are also related to the availability of crossings and motorist behavior. Security against crime is also strongly related to pedestrian characteristics, such as walking at night (>18.00), which necessitates that pedestrian paths be well lit in order to prevent crime to individuals, as much as possible.

A previous research also identified security against crime, disabled infrastructure, grade safety of crossings, and motorist behavior as below-average parameters [11,12]. However, this study found that, amenities in the Bandung City Square Area are already above average, indicating that the area provides adequate amenities for pedestrians. However, contrary to previous findings, the availability of crossings in the Bandung City Area is below average. Furthermore, the quality of the crossing is not good enough, causing inconveniences to pedestrians to safely cross roads, a finding which was also revealed in a previous research. Since there is a difference in the result of this finding, this study suggests that, more walkability assessments be performed, to examine if there is a difference in the results, particularly in the availability of crossing parameters in the Bandung City Square Area.

3.3 Multicriteria Satisfaction Analysis

According to the analysis results (Table 4), walking path modal conflict has the highest level of satisfaction and interest on all streets. The least satisfied parameter on the Asia-Afrika Street is motorist behavior (53.75%), followed by disabled infrastructure in Alun-Alun Timur (49%), and Dalem Kaum (47%). Meanwhile, the parameters of all street obstacles have the lowest level of importance.

Table 4. Level of Satisfaction and Interest of Streets' Walkability

No	Parameters	Level of Satisfaction (%)			Level of Importance (%)		
		Asia-Afrika	Alun-Alun Timur	Dalem Kaum	Asia-Afrika	Alun-Alun Timur	Dalem Kaum
1	Walking Path Modal Conflict	**86.00**	**85.75**	**85.25**	**92.50**	**91.25**	**90.50**
2	Availability of Walking Paths	79.50	77.00	75.25	84.75	86.25	83.50
3	Availability Of Crossings	70.25	66.75	67.00	85.50	85.00	83.00
4	Obstructions	75.50	71.00	70.75	**81.50**	**80.25**	**82.25**
5	Security from Crime	61.50	56.75	57.75	85.25	84.25	86.50
6	Amenities	75.25	70.25	69.00	90.25	87.25	87.25
7	Disability Infrastructure	57.50	**49.00**	**47.00**	87.75	88.00	89.00
8	Grade Crossing Safety	64.50	60.25	60.50	85.25	84.75	86.75
9	Motorist Behavior	**53.75**	52.50	52.75	83.50	85.00	83.25
	Average (Quadrant Limit)	**69.31**	**65.47**	**65.03**	**86.25**	**85.78**	**85.78**

In the upper-left quadrant (Figure 2), pedestrian expectations are fulfilled, but it is not the main priority, while in the lower-left quadrant, it has not fulfilled pedestrian expectations, but this is not the main priority for improvement of streets' walkability. In the upper-right quadrant, it indicates that, the parameter has fulfilled pedestrian expectations and it can become an area of strength. Meanwhile, the lower-right quadrant indicates parameters that need attention [13].

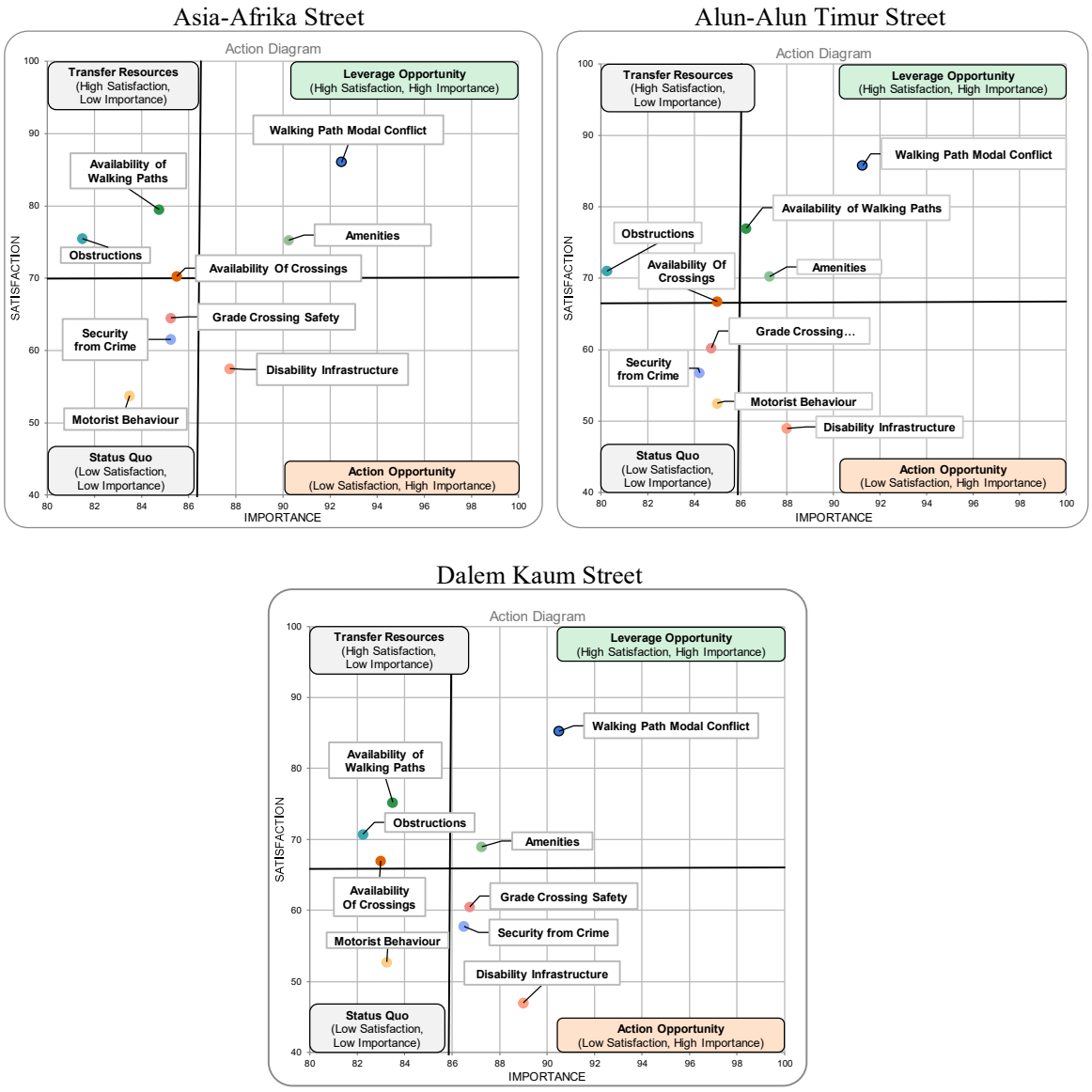

Figure 2. Bandung Square Area Action Diagram

Figure 2 shows that, the disabled infrastructure falls into action opportunity (lower-right), indicating that this parameter requires attention, particularly in the development of pedestrian paths in both Asia-Afrika and Alun-Alun Timur streets. Three parameters fall into action opportunity (lower-right) in Dalem Kaum street: grade crossing safety, crime security, and disabled infrastructure. This result for pedestrian satisfaction demonstrated that, while motorist behavior was the least satisfied parameter, particularly on Asia-Africa streets, disabled infrastructure is the parameter that requires the most attention, based on current conditions. However, there is a similarity, in that, the least satisfied parameter in Alun-Alun Timur and Dalem Kaum streets is disabled infrastructure, aligned with the parameter that requires the most attention. However, Dalem Kaum street demonstrated that, the existing condition requires further attention in two other parameters, security against crime and grade crossing safety, making it the highest priority for improvements to be carried out to make it pedestrian-friendly.

A previous research, using Multicriteria Satisfaction Analysis [11] on different streets, revealed that, parameters that require attention are comfort related to amenities and safety related to motorist behavior, as well as inadequate crossing. This made a difference, because the amenities in the Bandung City Square Area are adequate, but the disabled infrastructure is not. However, there is a similar result regarding crossing, that is inadequate, particularly in terms of providing pedestrian-safe crossing related to the quality of crossing that is insufficient, causing inconveniences to pedestrians to safely cross roads. More research is needed on the parameters that require attention in the Bandung City Square Area, to see if there is a difference and find effective improvements on streets' walkability, based on certain Global Walkability Index parameters.

4. Conclusion

The overall results showed that, Bandung City Square Area is Waiting to Walk, which is adequate for walking. Particularly, in Asia-Afrika and Alun-Alun Timur Streets, five parameters, namely the availability of crossings, security against crime, disabled infrastructure, grade safety of crossing, and motorist behavior were found to be below average based on Global Walkability Index. Three parameters, crossing safety (Dalem Kaum street), security against crime (Dalem Kaum Street), and disabled infrastructure all require immediate attentions, according to the Multicriteria Satisfaction Analysis based on existing conditions. The results of this study also showed that, the walkability of streets require improvements based on parameters that are below average. Meanwhile, immediate attentions and remedial actions are required to achieve a pedestrian-friendly environment, particularly in Dalem Kaum street. Further research is recommended, regarding the effective improvements to be done on streets' walkability based on walkability aspects and pedestrian perception as users, so that, better walkability in Bandung City Square Area can be achieved, providing pedestrians a good environment to be walked in.

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