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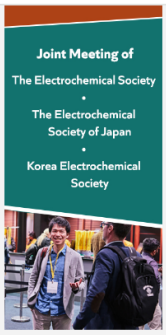

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The 6th International Symposium on Sustainable Urban Development (The 6th ISoSUD) 2023

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The 6th INTERNATIONAL SYMPOSIUM ON SUSTAINABLE URBAN DEVELOPMENT (The 6th ISoSUD) 2023

The International Symposium on Sustainable Urban Development (ISoSUD) is a series of international activities organized by the Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta. The event is held once every 3 (three) years with themes related to current issues regarding sustainable urban development, in particular related to urban environmental management and environmental technologies. The activity aims to facilitate academics to publish their research results in order to enhance their scientific expertise as researchers.

The 6th ISoSUD in 2023 carried the theme "**From Recovery To Resilience: Building A Sustainable Future For A Better Life"** which means this symposium will focus on how we can recover from the difficult times caused by the COVID-19 pandemic and build a better future and sustainable. This theme also shows the importance of building resilience in facing future challenges, whether related to climate change, economic policies, or other social problems.

The COVID-19 pandemic that swept the world in the last four years has had a significant impact on human health, the global economy, and the daily lives of people around the world. It will take the concerted efforts of all countries and peoples to overcome this pandemic and rebuild the world after it. This pandemic underscores the need for global efforts to strengthen health systems, enhance societal resilience, strengthen international cooperation, and accelerate action to achieve sustainable development goals and combat climate change. This crisis provides an opportunity to make significant changes in the way we view and manage our economic and social activities and to create a world that is more sustainable and fairer for all people and our planet. Now is the time to make a difference, to make a profound systemic shift towards a more sustainable economy for the benefit of our people and our planet. In other words, now is the right time to undertake significant transformations in existing economic and social systems, which can help sustainably achieve the SDGs and fight climate change to ensure a better future for people and our planet. Overall, post-pandemic recovery must be based on the principles of sustainable development contained in the SDGs. By integrating the SDG goals into our recovery policies and actions, we can create a more sustainable, inclusive, and resilient future for our people and the world.

The 6th ISoSUD was held in the hybrid conference:

a. Day 1, on Wednesday, August 2nd, 2023, at Building M, 12th floor, Universitas Trisakti, Jakarta, Indonesia. There were 130 participants offline and 170 participants on the Zoom platform in the plenary session.

b. On day 2, on Thursday, August 3rd, 2023, using the Zoom meeting facility, 270 participants attended virtually on Day 2.

In this two-day International Symposium, experts, researchers, and academician shared their valuable insights and research findings. These esteemed presenters hail from 58 universities and institutions in Filipina, India, Indonesia, Iraq, Japan, Malaysia, Netherlands, Singapura, and Taiwan, reflecting the symposium's diverse and inclusive nature. The call paper system that has been used since the first ISoSUD in 2008 succeeded in inviting 165 manuscripts (more than 400 authors) that were presented offline and virtually. Then, 136 from 165 papers were selected further to be published in IOP Proceedings Indexed by Scopus. After another review process, 106 manuscripts were published in IOP EES. To improve the quality of the manuscripts, the organizing committee held a Coaching Clinic for Scientific Paper Writing on June 24th, 2023. Prof. Mohamad Ali Fulazzaky, Ph.D, delivered the coaching clinic.

The 6th ISoSUD 2023 involved co-host universities consisting of five from within the country and four from abroad: Universitas Jember (UNEJ), Jember, Indonesia; Universitas Islam Indonesia (UII), Yogyakarta, Indonesia; Universitas Pasundan (UNPAS), Bandung, Indonesia; Institut Teknologi Sepuluh November (ITS), Surabaya, Indonesia; Universitas Indonesia (UI), Jakarta, Indonesia; Universiti Teknologi Malaysia (UTM), Malaysia; Universiti Tun Hussein Onn Malaysia (UTHM), Malaysia; The University of Kitakyushu, Japan; Chung Yuan Christian University (CYCU), Taiwan. During the class presentation session, a presentation from the participants representing the 6th ISoSUD co-host was carried out. Besides that, The 6th ISoSUD 2023 was supported as well by the Indonesian Society of Sanitary and Environment Engineers (IATPI), which has continuously supported our symposium since 2008. And sponsored by PT Enviro Cipta Lestari.

In the plenary session, some main speakers delivered more focused seminar themes; they were:

Welcoming Speech:

Prof. Dr. Kadarsah Suryadi DEA – Rector of Universitas Trisakti

Opening Speech:

Ir. Diana Kusumastuti, MT. - Director General of Human Settlements, Ministry of Public Works and Public Housing Indonesia

Plenary Speakers:

Day-1

1. Prof. Lin Chi Wang - Chung Yuan Christian University (CYCU), Taiwan
2. Prof. Ir. Joni Hermana M.Sc.ES., Ph.D – Institut Teknologi Sepuluh November (ITS), Indonesia

Day 2

3. Prof. Ts. Dr. Azmi Bin Aris - Universiti Teknologi Malaysia (UTM), Malaysia
4. Prof. Dr. Eng. Toru Matsumoto - University of Kitakyushu, Japan
5. Associate Prof. Victor R Savage – Nanyang Technological University (NTU), Singapore

We believe that this event will be able to facilitate good networking among researchers, scientists, engineers, and practitioners with common interests, especially in sharing the latest research results, ideas, development, and applications in Sustainable Urban Development. Hopefully, all participants enjoyed the seminar and found this experience inspiring and helpful in their professional field. Thank you for choosing the 6th ISoSUD as your symposium reference. Let us embrace the spirit of collaboration and innovation as we strive towards a sustainable future for a better life. We hope to have your pleasant support and participation in the next three years on The 7th ISoSUD 2026.

Sincerely,
Assoc. Prof. Ariani Dwi Astuti, ST., MT., PhD
Chairperson of The 6th International Symposium on Sustainable Urban Development (ISoSUD) 2023

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

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

L Dewi, R Situmorang* and M C Adriana

Department of Urban and Regional Planning, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta, Indonesia

*rahelsitumorang@trisakti.ac.id

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.

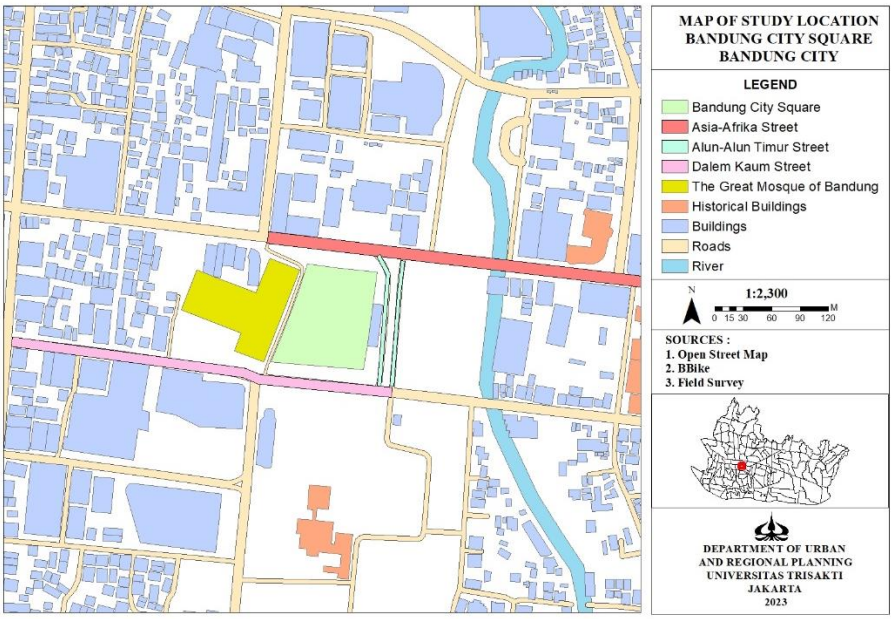

Figure 1. Study area.

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 characteristics

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 Square 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.)

Characteristic	Components	Total	Percentage (%)
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 City 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 Square 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].

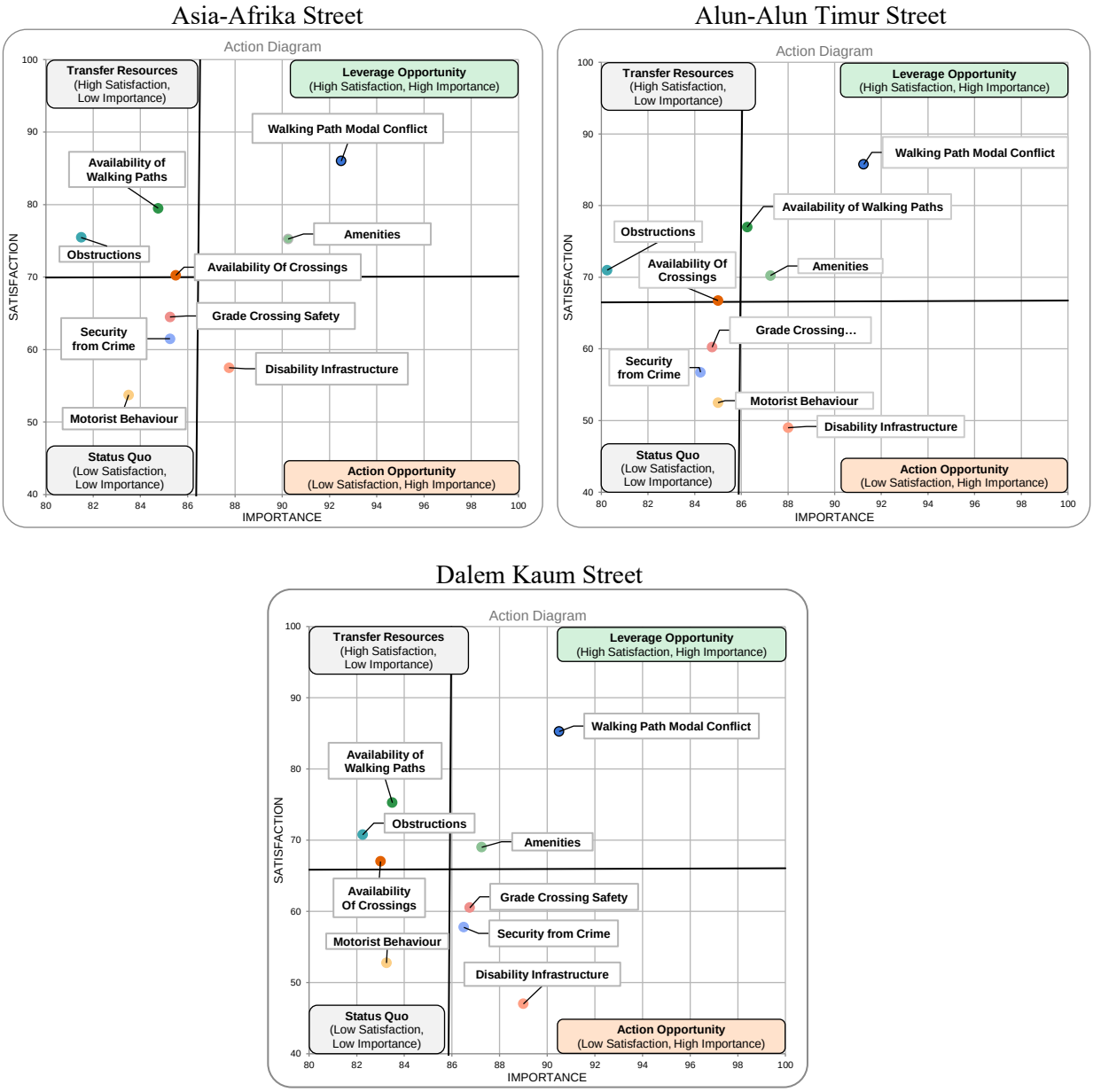

Figure 2. Bandung City Square Area action diagram.

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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Isosud

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The Walkability Concept in Bandung City Square Area: based on Pedestrian Perceptions

L Dewi[1], R Situmorang[1], M C Adriana[1]
[1]Department of Urban and Regional Planning, Universitas Trisakti, Jakarta, Indonesia

rahelsitumorang@trisakti.ac.id

Abstract. The concept of Walkability is a pedestrian-friendly environmental condition that provides security, comfort, safety and offers visuals for pedestrians. The Bandung City Square Area has various attractions, especially historical tourism, photography, pedestrian malls, and places of worship (Great Mosque) spread across some streets: Asia-Afrika, Alun-Alun Timur, and Dalem Kaum, which leads to walking activities. However, problems such as the existence of street vendors (PKL); lack of: disabled facilities, vegetation, crossings, and supporting facilities; and also illegal parking has not fulfilled the pedestrian-friendly environmental aspects. This study aims to assess pedestrian paths condition 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 show that existing condition of pedestrian path in Bandung City Square Area is Waiting to Walk which adequate for walking. However, result also showed that five parameters such as availability of crossings, security against crime, disability infrastructure, grade safety of crossing, and motorist behaviour are below average. It can also be concluded that three parameters such as crossing safety, security against crime, and disability infrastructure requires attention. This result suggest pedestrian paths improvement is needed by focusing on parameters that are below-average and requires attention. Further research is needed to find effective improvements for pedestrian paths walkability based on pedestrian perception, to ensure a pedestrian-friendly environment in Bandung City Square Area.

Keywords: global walkability index, multicriteria satisfaction analysis, pedestrian, walkability

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 attraction in the Cultural Heritage Tourism Area which is one of Regional Tourism Strategic Area [4], which serves the western region of the city as center for economic, social and/or administrative services [5].

Alun-Alun is open space concept that can be found in Javanese city center. Alun-Alun (formerly written aloen-aloen or aloon-aloon) is a wide-open field with grass surrounded by roads and can be used for various community activities, as for Bandung City Square, previously (1967) was a government center used by people to fulfill calls or listen to announcements or see demonstrations

underwent several changes until lately become the Great Mosque of Bandung Plaza (2017) while maintaining and enhancing socializing function of the square as a public open space [6,7].

For Bandung City, Bandung City Square has strategic and important location, as one of the city icons of the city. It is also surrounded by various attractions [6] dominated by historical tourism, such as 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 the attraction spread along pedestrian way around location near some street namely: Asia-Afrika, Alun-Alun Timur and Dalem Kaum, which lead to walking activities [8] in the area around Bandung City Square.

Problems in Bandung City Square Area related to pedestrian paths as infrastructure that is closely related to walking activities, such as the presence of street vendors disturbing the pedestrian way [9], a lack of disability infrastructure [6,9,10], a lack of vegetation for pedestrian shading [6,9], safe crossings and illegal parking [9] that does not meet pedestrian-friendly environmental aspects (security, comfort, and safety). Therefore, this study aims to assess pedestrian paths condition 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 by questionnaire from March 23 to March 26, 2023 (the beginning of Ramadhan month) with 33 responses collected to strengthen selected location boundaries. The study area (Figure 1) is in the administrative areas of several districts, including Lengkong, Sumur Bandung, and Regol [5], and the road segments to be studied include Asia-Afrika, Alun-Alun Timur, and Dalem Kaum.

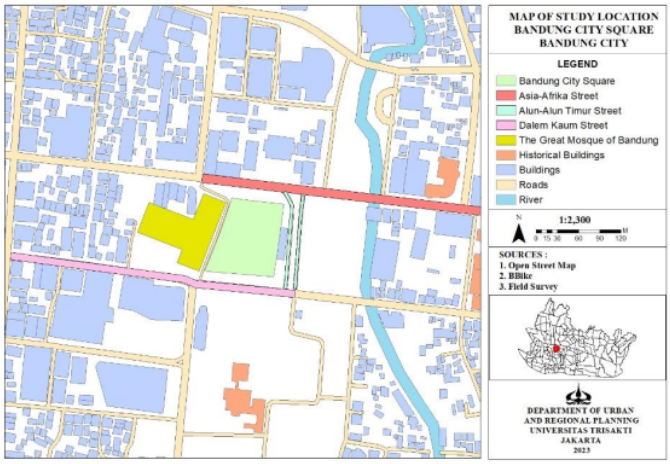

Figure 1. Study Area

Data collection and study area observation were carried out from April 6 to 10, 2023 during Ramadhan month, using questionnaires distributed directly to pedestrians as respondents. According to the Lemeshow formula [11], 100 respondents are required. Although 110 questionnaire responses were collected, 10 were invalid (missing or blank answers, ambiguous, etc.). The final data used was 100 respondents to determine pedestrian perceptions of: characteristics, walkability level based on nine parameters in the Global Walkability Index [2,11,12] and satisfaction and importance level of pedestrian pathways [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 pedestrian paths and parameters in the Action Opportunity (low level of interest and satisfaction). Before performing the analysis, the 1-5 rating data is converted to 0 -100 using a positive tone from the System Usability Scale (SUS) [14]. Furthermore, descriptive analysis is used to explain both GWI and MUSA analysis results as well as pedestrian characteristics data.

3. Result and Discussion

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 then pedestrian passes Asia-Afrika, Alun-Alun Timur and Dalem Kaum street, through to destination : 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 pedestrian walked more than average person (500 meters) [15] as pedestrian tend to walk around and to several destination. Since the data was collected during Ramadan, pedestrians walked the most at night (after breaking their fast) (>18.00). Pedestrian rarely visit the study area (once or twice in the last two months), and when they do, they use a private vehicle such as a motorcycle to access the area before continuing to walk around the study area. As this research was done on Ramadhan month, additional research on pedestrian characteristics in the Bandung City Area 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**
Only one answer	> 45	9	9.00
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Only one answer	Female	36	36.00
Activity	**Walking**	**78**	**35.45**
	Sitting	74	33.64
	Shopping	36	16.36
Pedestrians can choose multiple answers	Travelling	21	9.55
	Working	11	5.00
Starting point	**Bandung City Square Bus Stop**	**41**	**44.57**
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Pedestrians can choose multiple answers	Asia-Afrika Street Parking Lot	19	20.65
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Pedestrians can choose multiple answers	Dalem Kaum Street	65	30.95
	Alun-Alun Timur Street	49	23.33
Destination	**Bandung City Square**	**57**	**29.38**
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	Asia-Afrika Monument	18	9.28
Pedestrians can choose multiple answers	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
Only one answer	**Very Far (>500 m)**	**41**	**41.00**
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

Only one answer	**Night (>18.00)**	**34**	**34.00**
Walking frequency (in the past two months) Only one answer	**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 Only one answer	**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
Only one answer	Walking	6	6.00

3.2 Analysis of the Global Walkability Index

Table 2 displays the value from pedestrian ratings. The initial value (IV) from the 1-5 rating based on field walkability survey scoring guide [2] is then converted to a 0-100 value (CV). Based on the results of the Global Walkability Index analysis (Table 3), 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, disability infrastructure, grade safety of crossing and motorist behavior which need to be a concern for pedestrian paths.

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

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, disability infrastructure, grade safety of crossing, and motorist behavior as concerns for the condition of pedestrian paths on Bandung City

Square Area revealed a relationship to the existing condition of pedestrian paths such as a lack of disability infrastructure [6,9,10] and safe crossings [9] which 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.

Previous research also identified security against crime, disability 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, despite the fact that crossings are available and can provide an option for pedestrians to cross in term of its quantity. The quality of the crossing is not in good condition, so pedestrians face hardship if they want to cross; the same finding regarding availability of crossing is not met in terms of quality can be found in previous research as well. Since there is a difference in result of this finding, this study suggests that more walkability assessments be performed to see 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 have 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 disability infrastructure on 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 Pedestrian Pathways

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 Behaviour	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 met but it is not the main priority, at the lower-left quadrant it has not met pedestrian expectations but is not the main priority for pedestrian pathway improvement. In the upper-right quadrant, indicates that the parameter has met pedestrian expectations and can become an area of strength. Meanwhile, the lower-right quadrant indicates parameters that need attention [13].

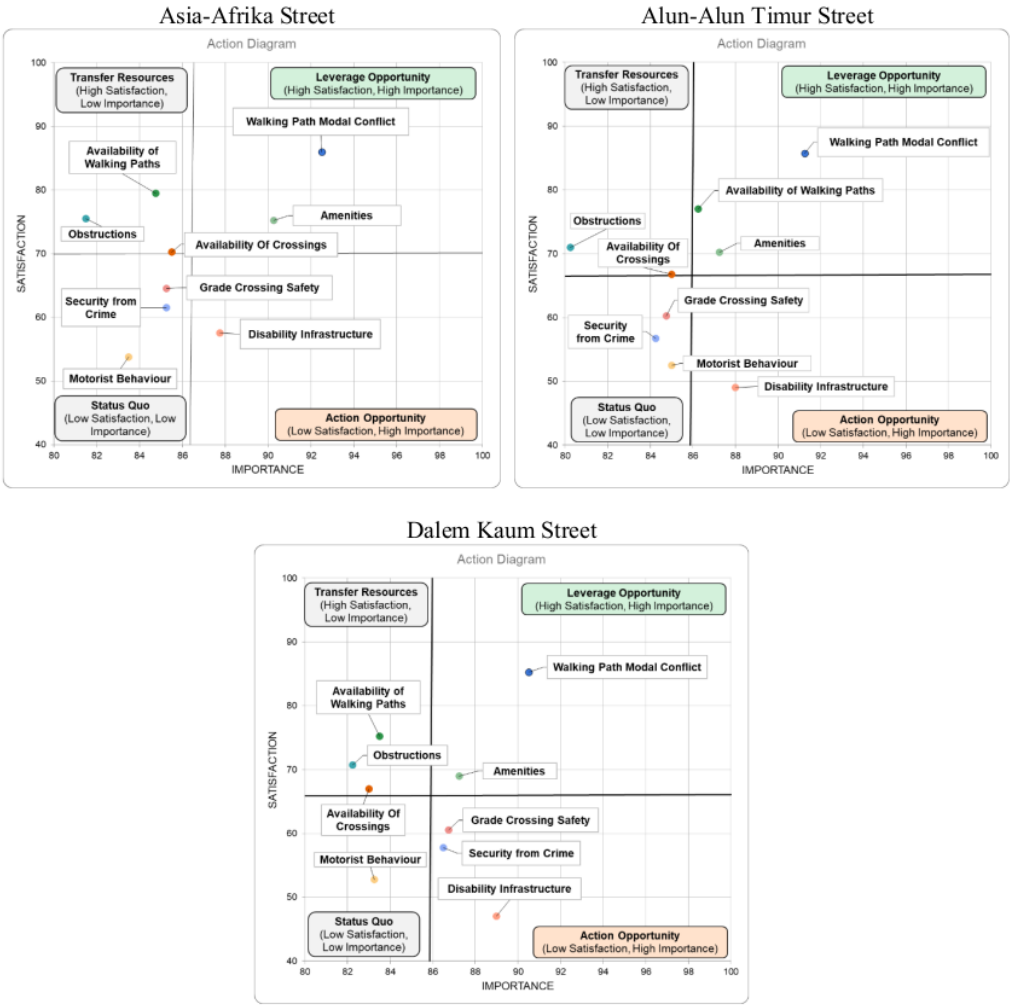

Figure 2. Bandung Square Area Action Diagram

Figure 2 shows that disability infrastructure falls into action opportunity (lower-right), indicating that this parameter requires attention, particularly in the development of pedestrian paths on both Asia-Afrika and Alun-Alun Timur streets. Three parameters fall into action opportunity (lower-right) on Dalem Kaum street: grade crossing safety, crime security, and disability infrastructure. This result for pedestrian satisfaction demonstrated that, while motorist behavior was the least satisfied parameter, particularly on Asia-Africa streets, disability 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 disability infrastructure, which aligned with the parameter that requires the most attention; however, Dalem Kaum street demonstrated that the existing condition requires further attention in other two parameters such as security against crime and grade crossing safety, making this street the most attention to be improved to be pedestrian-friendly.

Previous research using Multicriteria Satisfaction Analysis [11] on different streets revealed that parameters that requires 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 disability infrastructure is not. However, there is a similar result regarding crossing that is inadequate, particularly in terms of providing pedestrian-safe crossing related to quality of crossing that is insufficient leading to pedestrians facing hardship if they want to cross. More research is needed on the parameters that requires attention in the Bandung City Square Area to see if there is a difference and find effective improvements on pedestrian condition based on certain Global Walkability Index parameters.

4. Conclusion

Result showed that Bandung City Square Area is Waiting to Walk, which is adequate for walking. However, parameters such as availability of crossings especially on Asia-Afrika and Alun-Alun Timur Streets, security against crime, disability infrastructure, grade safety of crossing, and motorist behavior are below average based on Global Walkability Index. Three parameters such as: crossing safety (Dalem Kaum street), security against crime (Dalem Kaum Street), and disability infrastructure that needs attention according to Multicriteria Satisfaction Analysis based on existing condition. Based on the result of this study, pedestrian paths improvements are needed. This improvement should be based on parameters that are below average and requires attention in order to achieve a pedestrian-friendly environment, particularly on Dalem Kaum street. Further research is needed regarding the effective improvements on pedestrian paths based on walkability aspects and pedestrian perception as users, so that walkability in Bandung City Square Area can be highly walkable and giving pedestrian a good environment to be walked on.

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