Evaluation of Pedestrian Pathway Design for Accessibility for Disabilities to Support SDGs and Reduce Carbon Emissions

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ABSTRACT (9 pt)

People with disabilities have the same right to access public spaces as the public in general. One of the crucial elements of the design of urban public spaces is pedestrian paths. This research was conducted on designing pedestrian paths for people with disabilities in the socio-cultural strategic area of Yogyakarta City. The sample taken was from the Kota Baru area along Jalan Suroto. This research uses an observational quantitative descriptive method through field surveys and literature studies with the stages a) segment determination, b) data collection, c) data evaluation, and d) recommendations. This study has divided the pedestrian pathway into 4 segments. The final results were obtained for segment 1 to receive quality II (High), segment 2 to receive quality I (Very High), segment 3 to receive quality II (High), and segment 4 to receive quality I (Very High). From the results of this research, it is hoped that the quality and accessibility of pedestrian pathways can be improved, creating a safer, more comfortable, and inclusive environment for all users. Eventually, this can also reduce the use of private vehicles, thereby decreasing traffic congestion, air pollution, and carbon emissions.

INTRODUCTION

The high density due to the many existing activity centers also increases mobility, so it needs to be supported by adequate city facilities and infrastructure to facilitate accessibility (Fatimah & Fadhilah, 2021; Fitriana, 2016). Accessibility concerns society in general and, in particular, people with disabilities. People with disabilities are individuals who face physical, mental, or sensory limitations over a long period. They face challenges interacting with the surrounding environment and experience difficulties fully participating due to impaired physical movement functions (Dewang, 2010; Maftuhin, 2016).

Yogyakarta is one of the cities with a very high population density. The Central Statistics Agency projects that the population of Yogyakarta in 2023 will be 455,535 people with an area of 32.5 KM2 so that the population density will be 14,016 people/KM2 (Badan Pusat Statistik, 2023). As for the number of people with disabilities, the Yogyakarta City Government recorded the number of people with disabilities in Yogyakarta City as many as 3,447 people (Warta Jogja Kota, 2022). Although the percentage of people with disabilities in Yogyakarta City is relatively low, the existence of unique communities like theirs still needs special attention to provide comprehensive protection and fulfillment of disability rights by applicable regulations nationally and globally, one of which is with adequate public space facilities. Public space is a space for mobility and economic activities and must be accessible to all (Pineda, 2022).

Persons with disabilities have the same right to access public spaces as the public in general to realize equal opportunities in life and livelihood (Perda Kota Yogyakarta No.4, 2019; Pujianti, 2018; Qur'ana & Priyono Purnomo, 2020). This is in line with the programs launched by the United Nations through the Sustainable Development Goals (SDGs) program. It is crucial to carry out infrastructure development by considering quality,

reliable, sustainable, and resilient infrastructure, including regional and cross-border infrastructure, to support economic development and human welfare, focusing on affordable and equitable access for all (United Nations, 2015). This includes ensuring that facilities for the general public, such as city and city streets, are available equally for persons with disabilities and responsive to their needs (United Nations Committee on the Rights of Persons with Disabilities, 2014). Local and regional governments and other key urban stakeholders face immense pressure to adapt urban planning and design strategies, policies, and practices to fully respond to the rights and needs of all persons with disabilities and intersecting social groups (Lagrelius & Bravo, 2022). Although Indonesia guarantees disability rights through various government regulations, it does not have clear sanctions if disability rights are not implemented in the field (Puspita Sari & Soeskandi, 2022). This is a serious problem because the regulations have become vague. The level of accessibility of an urban area can be measured based on several variables, namely the availability of road networks, the number of means of transportation, the length and width of roads, and the quality of roads (Fatimah & Fadhilah, 2021). The design of road network planning and good implementation can create complete streets. The term complete streets refers to roads that can accommodate various road users of various ages and with various abilities. In addition, the road in question must be safe, comfortable, and designed according to the needs of the various groups (ITDP Indonesia, 2019). According to Hamid Shirvani, an urban design expert in Mukti (2015), one of the important elements that are part of urban design is pedestrian paths. The basis for pedestrian path planning in Indonesia, especially adequate for people with disabilities, has been regulated in laws such as the Minister of PUPR No. 03/PRT/M/2014 (2014) and PUPR No. 14 PRT/M/2017 (2017). Globally, there is a Global Street Design Guide (2016) and other related research, such as Ergonomic Standards For Pedestrian Areas For Disabled People. (Berrett et al., 1998)

Looking at these problems, especially related to accessibility for people with disabilities, one of which is through pedestrian design, it is important to evaluate the design of existing pedestrian paths. Whether the pedestrian path is adequate and friendly for people with disabilities in accordance with the applicable laws and regulations and what solutions can be offered are the main points to be researched. Good pedestrian planning is also linked to sustainable infrastructure development. Research shows that pedestrian paths that are integrated with public transportation systems can improve accessibility and reduce the need for private vehicles (Arifin & Yusuf, 2021). By facilitating better access to public transportation, cities can reduce traffic congestion and emissions resulting from vehicles. In addition, planning that considers environmental aspects, such as the use of environmentally friendly materials and designs that pay attention to airflow, can also contribute to the reduction of carbon emissions (Lestari & Muazir, 2021)

RESEARCH METHOD

This research was conducted on designing pedestrian paths for people with disabilities in the socio-cultural strategic area of Yogyakarta City. The sample taken is the Kota Baru area along Jalan Suroto, which is included in the strategic socio-cultural area of Yogyakarta City and is listed in Yogyakarta City Regional Regulation No. 2 of 2021. The pedestrian on Jalan Suroto is new due to revitalization completed in 2018. Head of the

Jogja City Housing and Residential Areas Public Works Office (DPUPKP) Umi Akshanti said the pedestrian path on Jalan Suroto is conceptualized as disability-friendly. Therefore, the location is interesting for evaluating the pedestrian design and whether it is in accordance with the initial planning and is friendly to disabilities. This research method uses an observational quantitative descriptive method through field surveys and literature studies with the stages a) segment determination, b) data collection, c) data evaluation, and d) recommendations.

Segment

Segment division facilitates the research process based on road location. It involves dividing the road that is cut off by another road or at the intersection meeting into subdivisions. The results of the segment division in this study are depicted in Figure 1.

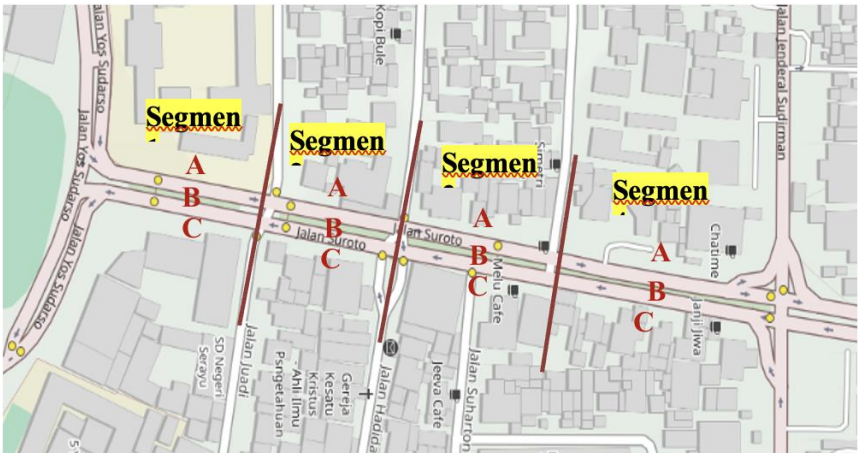

Figure 1. Segmentation

Data Collection

The method of data collection by conducting observations is mapping pedestrian elements, dimensional measurements, and documentation along the Suroto road. Observations focus on design and structural aspects in view of ease of access for people with disabilities, using instruments that have been made and compared with the theory and standards of applicable design regulations.

Data Evaluation

The primary data that has been obtained is then processed or evaluated in the form of digital images, mapping, and descriptive images in the form of narratives or tables based on the instruments that have been used. The research instrument developed refers to the pedestrian design standards of the Minister of PUPR No. 03/PRT/M/2014, the Minister of PUPR No. 14 of 2017 and adopts the Ergonomic Standards For Pedestrian Areas For Disabled People by Berrett et al. (1998). The assessment instruments can be seen in Table 1.

Table 1. Research Instrument

N	Design Features	Values for each Disability Group (Berret et all, 1998)			Condition Category	V
		Walking problem	Wheelchair Users	Blind		
A	**Access to an Area**					
1	Parking	M	V	M	Parking area available	1
					No parking	0
2	Public Transport	M/V	V	V/L	Any public transport	1
					No public transport	0
B	**Movement into area**					
1	Crossing the Road	V	V	V	Exist	1
					None	0
2	Movement Distance	V	V	M	> 3 m	4
					2.1 - 3 m	3
					1.5 - 2 m	2
					<1.5 m	1
					no sidewalk	0
3	Surface type and condition	V	V	V	no impediments in the surface	3
					few impediments in the surface	2
					significant impediments in surface	1
					no sidewalk	0
C	**Mobility within area**					
1	Furniture					
	a. Chairs	L	M	V	Exist	1
					None	0
	b. Distance				< 9 m	3
					9 m	2
					> 9 m	1
					None	0
	c. Tall				< 0.45 m	3
					0.45 m	2
					> 0.45 m	1
					None	0
3	Ramps and Curbs	V	V	V/M		
	a. Existence				Exist	1
					None	0
	b. Simplicity				< 8%	3
					8%	2

N	Design Features	Values for each Disability Group (Berret et all, 1998)			Condition Category	V
		Walking problem	Wheelchair Users	Blind		
					> 8%	1
					None	0
	c. Wide				> 1.2 m	3
					1.2 m	2
					< 1.2 m	1
					None	0
D	**Interface with services and facilities**					
1	Toilet	L	L	V	Exist	1
					None	0
	Information provision					
	Guiding block				Guide tiles along the strip	2
					Partial lane guide tiles	1
					None	0
2		L	L	V	Warning tile of each intersection	2
	Warning block				Warning tile only part of the intersection	1
					None	0

Keterangan:
V = Very Important
M = Medium Important
L = Low Important
M/V = Medium/Very Important
L/V = Low/Very Important

$$\text{Feasibility Percentage}(\%) = \frac{\text{Observed Score}}{\text{Expected Score}} \times 100\%$$

Table 2. Assessment Indicators

Class	Value	Category
I	81-100	Very High Quality
II	61-80	High Quality
III	41-60	Average quality
IV	21-40	Minimal Quality
V	1 - 20	Poor Quality

Recommendation

The final stage is to make recommendations on aspects of design assessment that do not meet the standards. Recommendations are suggestions and criticisms of the overall design concept.

RESULTS AND DISCUSSION

The results of direct observation in the field found that each segment consisting of sub-segments received a quality class score in the lowest range of level II (High) and the highest level I (Very High). This means that the Suroto road section has good pedestrian quality and provides easy access for people with disabilities. However, some parts still have shortcomings and need to be improved (Rose et al., 2020).

Evaluation of Pedestrian Design Aspects

Almost all indicators get a high maximum score from segments 1 - 4 on Jalan Suroto. While some indicators have inconsistent score results, this can be seen from the results of different scores in each sub-segment. Among them are the distance of the seats, the existence of toilets, the condition of the pedestrian surface, and the width of the pedestrian. The score data for each sub-segment is then made into a score distribution graph, which can be seen in Figure 2 below. This distribution data is used to facilitate the analysis of the decline and increase in the score of each sub-segment. It can be seen that the difference in the results of each sub-segment is quite significant. Only segments 2C-3A and 4B-4C have the same score. From the distribution results, it can be concluded that even though the pedestrian work process is at the same time, it turns out that the results obtained have differences or gaps.

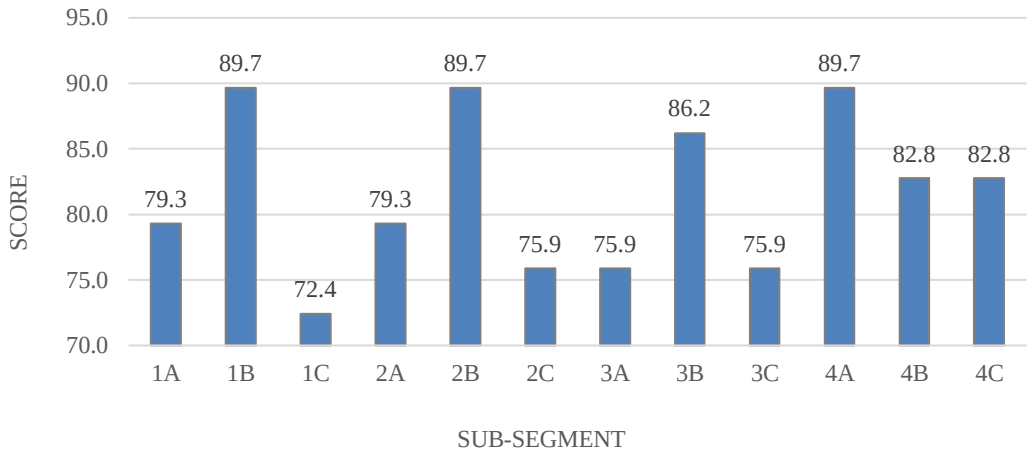

Figure 2. Sub-segment scoring score distribution graph

Based on field results data and referring to the standards according to the Minister of PUPR (2014 and 2017), further analysis was carried out on indicators that had low-value results. The first indicator is the distance between the seats along the pedestrian. The regulations have provided a rule that the distance of the seats must not be more than 9 meters. Meanwhile, the locations in sub-segments 1B, 2B, 3A, 3C, and 4B do not meet the standards where the distance between seats is more than 9 meters. The biggest factor is the existence of shophouses along the pedestrian path, so the seating area is reduced due

to being used as access to the shophouse. This results in a longer distance between the seats.

The second indicator is the condition of the pedestrian surface. In segments 1C, 2C, 3A, 3C and 4C there are road facilities that reduce the width of pedestrian lanes and damage to pedestrian surfaces. So that this becomes an obstacle for pedestrian users and reduces the assessment results. The surface characteristics of pedestrian paths significantly impact disabled users, especially wheelchair users, affecting their overall comfort, safety, and mobility (Darko et al., 2022; Pearlman et al., 2013)

Third, related to the width of the pedestrian, the factor that affects the difference in value is the width of the pedestrian body that is different. Some sub-segments have an average width of between 1.5 – 2 m, while some other sub-segments are found to be 2.1 – 3 m wide. However, the value of the pedestrian width is still appropriate and meets the existing standards, where the minimum width for pedestrians is 1.5 meters.

From the score results of each sub-segment, an average value is then made, and an assessment of the segment's quality is obtained, as seen in Table 5. The final results were obtained for Segment 1, which received quality II (High), Segment 2, which received quality I (Very High), Segment 3, which received quality II (High), and Segment 4, which received quality I (Very High).

Table 5. Final assessment results for each segment

Segment	Average score	Category
1	80.46	High Quality (II)
2	81.61	Very High Quality (I)
3	79.31	High Quality (II)
4	85.06	Very High Quality (I)

(Source: Research Data)

Good pedestrian paths are essential for urban planners aiming to enhance walkability and reduce carbon emissions in urban environments. Comfortable and safe pedestrian paths also contribute to improved quality of life. Research shows that pedestrian paths that have adequate facilities, such as seating, good lighting, and accessibility, can improve user comfort (Safira et al., 2023; Wulanningrum, 2021). When pedestrians feel safe and comfortable, they are more likely to choose walking as the primary mode of transportation, leading to a reduction in the use of private vehicles (Kusmalinda et al., 2019). By designing an environment that supports walkability, urban planners can create more efficient areas and reduce the need for motorized vehicle-based transportation (Guo et al., 2023).

In this context, good pedestrian paths not only improve mobility but also reduce congestion and air pollution, which are important factors in reducing carbon emissions (Opeoluwa Oluwanifemi Akomolafe et al., 2024). Additionally, by creating a pedestrian-friendly environment, cities can attract more visitors and increase local economic activity (Sari et al., 2020).

This shift not only reduces greenhouse gas emissions but also promotes a healthier lifestyle, as walking is associated with many health benefits (Jabbari et al., 2021). The psychological aspects of walkability cannot be overlooked. Research shows that

pedestrian-friendly environments can reduce stress and enhance the overall quality of life for residents (Nissanka & Jayasinghe, 2023). By designing urban spaces that prioritize pedestrian comfort and safety, planners can create environments that encourage walking, thus leading to a reduction in vehicle use and associated emissions (Yosifof & Fisher-Gewirtzman, 2024)

Recommendation

This evaluation looks at the extent to which pedestrian paths can make accessibility easier for people with disabilities. Referring to the results that have been obtained, it can be concluded that the pedestrian path on Jalan Suroto is very feasible and meets the needs of street space for people with disabilities. The results are considered appropriate and can be used considering that the instrument made refers to the problems experienced by those with disabilities who use wheelchairs, have difficulty walking, and are blind, according to Berret et al. (1998). The L (Low important), M (Medium important), and V (Very important) indicators are used to see how important the presence of these indicators is in the pedestrian for people with disabilities.

Based on the instruments developed, features such as road crossings, surface conditions, and ramp or curb design are very important features and must be owned by each disability group. There are still several sectors that have not been fulfilled and can be evaluated for better improvement. Disabilities, especially for the visually impaired, certainly really need a guide path or guiding block. Berret et al. (1998) categorized the entrance guide path as a very important need. Although there are already guide lanes along the pedestrian, it turns out that other problems arise from the large number of guide lanes that have begun to be damaged (see Figure 3).

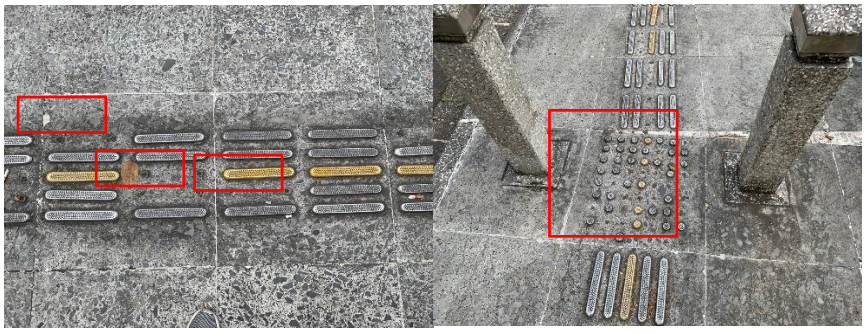

Figure 3. Damaged or missing guidelines

The next problem is that there are still road facilities that interfere with pedestrians, namely electric poles, which reduce the width of pedestrians. Some locations that are obstructed by the pole will be quite disturbing to pedestrians, especially those who use wheelchairs, if they cross paths with foot crossings in the opposite direction. Of course, a situation like this can be considered in future planning, considering that the regulations have been explained regarding the choice of pedestrian design form if a disturbance occurs due to facilities such as bus stops. A picture of the pedestrian condition obstructed by the pole can be seen in Figure 4.

Figure 4. Road facilities such as electric poles that reduce the width of pedestrians

CONCLUSION

Based on the data collected and analyzed, this chapter will provide possible implications, limitations, and recommendations for future research.

Implication

Evaluation of pedestrian design is essential for people with disabilities to ensure inclusivity and accessibility in urban environments (Adi et al., 2024). The study results showed that the condition of the pedestrian path for disability accessibility on Jalan Suroto got good results. This study has divided the pedestrian path into 4 segments. The final results were obtained for segment 1 to receive quality II (High), segment 2 to receive quality I (Very High), segment 3 to receive quality II (High), and segment 4 to receive quality I (Very High). Although the results are very good on average, some indicators lack value. Governments and infrastructure project organizers must ensure that all elements that support accessibility for persons with disabilities, such as guide lanes and adequate lane widths, are maintained and repaired regularly. The difference in quality in sub-segments worked on simultaneously indicates the need for more careful and sustainable planning. By paying attention to these implications, it is hoped that the quality and accessibility of pedestrians can be improved, creating a safer, more comfortable, and inclusive environment for all users. Adequate facilities on pedestrian paths, such as seating, good lighting, and accessibility, can enhance user comfort and encourage them to choose walking as their primary mode of transportation. This can reduce the use of private vehicles, thereby decreasing traffic congestion, air pollution, and carbon emissions. Additionally, a pedestrian-friendly environment can boost local economic activity and support a healthier lifestyle while reducing stress.

Limitation

This research only covers certain segments of Jalan Suroto. The results and findings may not fully represent pedestrian conditions in other areas of the city that have different characteristics and challenges. The data collected comes mostly from field observations and visual assessments, which can be subjective. These limitations can affect the accuracy of the assessment results and data interpretation.

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