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EXECUTIVE CARRIAGES TOILET OF JOGLOSEMARKERTO INDONESIAN`S TRAIN USING UNIVERSAL DESIGN APPROACH

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ABSTRACT
This study aims to assess the accessibility of toilets on the Joglosemarkerto executive train for people with disabilities, especially wheelchair users, using the Universal Design approach. The research method is a mixed method, through direct measurement of toilet dimensions, accessibility checklists based on universal design principles, and online user perception surveys involving 64 respondents, including disabled groups. The Accessibility Index is calculated based on weighting the door, sink, and main toilet room. The study results indicate that the accessibility index category is low, with a score of 22 for the toilet door, 17.5 for the sink, and 24.4 for the main toilet room. The main obstacles are narrow circulation space, insufficient door width, information in Braille, and emergency buttons not being available. Practically, this study encourages operators and policymakers to improve the design of accessible train toilets by involving disabled groups in the design. Theoretically, this study enriches the literature on evaluating public transportation accessibility in Indonesia through the presentation of a replicable universal design evaluation model. The contribution of this study is to map the infrastructure gaps and develop recommendations to improve the inclusiveness of railways in Indonesia and promote equality of access.
Keywords: *Accessibility Accessment, People with Disabilities, Toilet, Universal Design.*

1. Introduction

Accessibility is a primary requirement for persons with disabilities to be able to live independently and participate fully and equally in community life. Without adequate access to the physical environment, transportation, information and communication—including information and communication technology and systems—and other public facilities and services, persons with disabilities will be deprived of equal opportunities to be actively involved in their communities (ESCAP, 2019). This idea was first introduced by Hansen in the 1950s in the context of transportation planning and has continued to develop thanks to advances in technology and computing capabilities that allow for increasingly complex analysis (Ravensbergen et al., 2022). In the realm of transportation, accessibility not only focuses on spatial efficiency, but also emphasizes the fulfillment of the basic rights of all individuals—including people with disabilities—to reach their destinations fairly and equally (Olsson et al., 2021).

Public transportation is crucial in providing Accessibility to workplaces, completing daily activities, and fostering social interaction. Easy access to public transportation can ensure equitable access to all users' work, education, healthcare, social, and recreational facilities. Accessible public transport can also reduce social inequality, promote fairness, and eliminate discrimination against users. Improving public transportation accessibility significantly improves public health by increasing physical activity levels, reducing obesity, and decreasing transportation-related injuries. It is important to integrate health benefits into transportation planning and policy decisions (Brown et al., 2019). One of the critical factors in choosing a type of public transport (bus, taxi, train) is Accessibility.

In recent years, transport accessibility assessment has evolved from simple spatial approaches to more multidimensional and participatory approaches, with qualitative approaches using walk-along interviews, participant observation, and co-design workshops (Cao et al, 2019); (Rosa et al., 2025), while quantitative approaches utilize GIS technologies such as ArcGIS and QGIS for spatial mapping and identification of vulnerable areas (Cho et al., 2021), audit access (Bęczkowska et al, 2024). Recent trends involve big data, machine learning (Chen et al., 2021); (Choi et al., 2023), spatial interaction models (Zhao et al., 2023), and multi-criteria approaches based on user perception such as M-MACBETH (da Silva et al., 2022), focusing on vulnerable groups and the integration of new mobility services to create inclusive transport systems. The main challenge of assessing accessibility in public transportation in developing countries lies in the data gap. Solutions can use open sources such as QGIS, OpenStreetMap, and application-based crowdsourcing as important alternatives (Liu et al., 2022). In the future, the primary key to creating an inclusive and sustainable transportation system by universal design principles is the synergy between spatial analysis, big data, and user participation.

Among these various modes of transportation, trains are the preferred choice and have advantages in Accessibility, easy access to stations, fast routes, affordable costs, and safety. This is highly relevant in transit-oriented development, which focuses on promoting sustainable transportation. The safety of train travel is a crucial consideration, with measures in place to ensure the well-being of all passengers. Other considerations for choosing trains as a mode of transport include ease of ticket purchase, punctuality, service, and safety (Vojtek et al., 2019).

In Indonesia, the principle of accessibility in public transportation services also emphasizes the importance of safety and comfort aspects, as stated in the Regulation of the Minister of Transportation of the Republic of Indonesia Number 98 of 2017 concerning the provision of accessibility for service users with special needs (Regulation of the Indonesian Minister of Transportation Number 98, 2017). One of the public transportation that is the choice of the Indonesian people compared to other modes of transportation is the train. Therefore, the provision of accessible and appropriate facilities for all passengers, including people with disabilities, is a crucial part of efforts to improve the quality of railway services in Indonesia.

However, the progress of train services in Indonesia still leaves a number of accessibility problems, especially in sanitation facilities on the train. Based on a customer satisfaction survey by PT Kereta Api Indonesia (2022), it was found that toilet facilities in executive class trains are still a source of complaints. As many as 27.3% of respondents complained about unclean toilets, 18.2% mentioned unpleasant odors, and other complaints included doors that could not be closed, water not flowing, and cramped spaces. (PT. Kereta Api Indonesia, 2022).

One interesting case to study is the toilet on the Joglosemarkerto executive train. Because this train uses a new image type carriage which has the largest toilet dimensions among other regular executive trains that use new generation type carriages. The route of this train crosses major cities in Central Java and Yogyakarta such as Purwokerto, Semarang, Solo, and Yogyakarta (Gapeka, 2023). Although this train is classified as a regular executive service, the toilet facilities in it still do not meet universal accessibility standards, especially for wheelchair users.

Observations were conducted by directly measuring the dimensions of the toilets on the Joglosemarkerto executive train. The data collection process was conducted through a field visit to the Solo Balapan Train Depot, where researchers accessed the executive class toilets to conduct in-situ measurements using a measuring instrument in the form of a rolling meter. Each main element in the toilet room—such as doors, equipment, and facilities—was measured three times to ensure data consistency, then the average value was recorded. The observation results showed the following dimensions: toilet room length = 145 cm; toilet room width = 125 cm; toilet room height = 190 cm; toilet door width = 55 cm; sink height = 95 cm; mirror height = 110 cm; tissue holder height = 110 cm; soap holder height = 95 cm; toilet seat height = 40 cm; clothes or bag hanger height = 180 cm; and grab bar height = 50 cm.

Referring to the Regulation of the Minister of Public Works and Public Housing Number 14 of 2017, the dimensions of the toilets of the Joglosemarketo executive train are a very significant accessibility problem because the toilet is one of the basic elements in ensuring comfort and safety during the trip, especially for elderly passengers and people with disabilities.

The dimensions of the toilet room, the width of the door, and the height of equipment such as sinks and handrails still do not meet the requirements. Figure 1 shows the condition of the toilet in the executive carriage of the Joglosemarkerto train.

Fig. 1. Toilet Door, Wastafel and Water Closed

To answer this problem, this study proposes a barrier-free approach or barrier-free design needs to be applied. This approach then developed into the concept of universal design was first introduced in the 1970s by Ronald Mace, an architect and product designer who focused on special needs in the United States. He defined UD as a design approach to products and environments that allow use by as many people as possible without the need for special adaptations or designs. Between 1994 and 1997, the National Institute on Disability and Rehabilitation Research (NIDRR)—a US government agency that deals with disability and rehabilitation issues—funded massive research on universal design (Aarhaug, 2019). Universal design also aims to reduce environmental barriers and increase the usability of buildings for everyone, especially those with disabilities (Watchorn et al., 2023). Universal Design (UD) principles can improve accessibility for people with disabilities and can also benefit everyone (Marisa De Picker, 2020).

Design for all and inclusive design are related terms and concepts. A standardization guide states that ‘terms such as universal design, accessible design, design for all, barrier-free design, inclusive design and cross-generational design are often used interchangeably with the same meaning’ (ISO/IEC 2014: Note 2 to Entry). A European standard for UD from 2019 translates ‘design for all’ into the Swedish ‘universell utformning’ (Nielsen, 2024a). Universal Design principles can contribute to creating economic benefits. To obtain these benefits, both companies and public administrations can develop their activities – albeit using different approaches – to increase accessibility and create economic benefits (Arenghi et al., 2021)

Previous studies have evaluated toilet accessibility in terminals (Reddy et al., 2019), commercial aircraft (Evans et al., 2024), and train stations using a universal design approach (Muhammad Rizki, 2024); (Nielsen, 2024c). Yang (2019) explored the effect of barrier-free certification policies on user satisfaction, including toilet facilities in various transportation modes (Yang, 2019a). Mizuno et al. (2020) highlighted accessibility barriers at airports for the elderly and people with disabilities (Mizuno et al., 2020), while Nielsen (2023) revealed new challenges in toilet use by people with psychosocial disabilities post-Covid-19 pandemic from a universal design perspective (Nielsen, 2023). Meanwhile, research assesses that public transportation at train stations in Indonesia, including toilet facilities, has not fully adopted universal design principles (Muhammad Rizki, 2024). However, research that specifically highlights toilet accessibility in passenger trains in Indonesia, especially using a universal design approach, is still very limited. Here is the main difference of this study: This study fills the gap by assessing the accessibility of the toilets of the Joglosemarkerto executive train based on universal design principles, and integrating the perspectives of users with special needs. This study aims to assess toilet accessibility on the Joglosemarkerto executive train based on

universal design principles, identify existing design gaps, and provide recommendations for improvements to increase the inclusiveness of public transportation services in Indonesia.

The novelty of this study lies in the application of the universal design approach specifically to the case study of the Joglosemarkerto executive train toilet, by measuring the gap between actual conditions and accessibility standards. In addition, this study highlights the importance of implementing inclusive principles in transportation design to improve the quality of life of the community, especially vulnerable groups. Meanwhile, the research question tries to answer the question: Do the toilets in the Joglosemarkerto executive train meet the principles of universal design in terms of accessibility for disabled users, especially wheelchair users?

2. Literature Review

2.1 Accessibility

The concept of accessibility was first introduced by Hansen (1959) and has undergone significant development until now. Initially defined as the ease of reaching a location with available transportation modes, accessibility is now understood in a broader dimension, including land use, user diversity, and mobility equity (Jonathan Levine, 2020) (Yuji Shi, Simon Blainey, Chao Sun, 2020). In this context, accessibility is seen physically or spatially and as a human right, especially for vulnerable groups such as people with disabilities and the elderly (Che Had et al., 2023).

In Indonesia, the Regulation of the Minister of Transportation No. 98 of 2017 defines accessibility as the convenience provided for service users with special needs to realize equal rights. This regulation establishes four basic principles: safety, convenience, functionality, and independence, which align with the universal design framework.

However, implementing these principles still faces challenges, especially in public transportation infrastructure. Several recent studies have shown a gap between regulations and field conditions, especially in train toilet facilities, which still do not fully accommodate users with mobility limitations (Unsworth et al., 2021).

2.2 Accessibility assessment

Various methods have been developed and used to assess the accessibility of public transportation facilities, including physical, spatial, social, and user perception aspects. One of the most common approaches are (1) a GIS (Geographic Information System)-based spatial method that aims to measure the distance and travel time to transportation facilities (Yhee et al., 2021), (2) the Accessibility Index method that provides a quantitative value for ease of access to facilities that generally use input in the form of distance, number of facilities, population density, or even user perception scores (Mitropoulos et al., 2023), (3) a checklist method based on regulations or universal design principles that aims to evaluate the physical conformity of facilities such as toilets, ramps, doors, and signage to accessibility standards applicable in the local country, (4) user perception survey method that assesses accessibility based on the comfort and experience of vulnerable groups such as people with disabilities and the elderly (Watchorn et al., 2022), (5) multi-criteria analysis method (Multi-Criteria Decision Analysis - MCDA) is also often used to evaluate various aspects of accessibility simultaneously and determine improvement priorities (Erica Isa Mosca, 2020), and (6) Accessibility audit methods (access audit) can be qualitative or quantitative and are usually conducted by professionals with systematic guidance. This audit can be a holistic audit involving actual users, expert review by accessibility engineers or architects, and post-occupancy evaluation after the facility is used (Omi, 2024).

Each method has its advantages and disadvantages. For example, the checklist method is efficient but tends to ignore users' subjective experience. In contrast, the holistic and value-based approach involves users directly but requires more time and money (Cao et.al, 2019).

It is important to note that universal design-based accessibility audits in the context of train toilets are still very limited in the literature. Countries such as Japan and the UK have implemented a mixed evaluation model (checklist and post-occupancy evaluation/POE) to assess the accessibility of facilities in public transport (Fathipour et.al, 2024), (Cassi et al.,

2021). However, this practice has not been widely adopted in Southeast Asia in general and in Indonesia in particular.

2.3 Universal Design: Principles and Practical Challenges

Ronald Mace developed universal design in the 1970s, aiming to create products and environments that everyone can use without needing special modifications. The concept of universal design has evolved from simply removing physical barriers to emphasizing social values and equity. This reflects a shift from focusing on the end product to an inclusive and human-centered design process (Dolph, 2021). The application of universal design cannot be separated from the seven principles of universal design, including equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for approach and use which can create a more inclusive and accessible environment for all individuals, including those with different abilities and needs, for example in wayfinding systems (Fogli et al., 2020).

Although these principles have been widely adopted, their implementation remains uneven, especially in the transport sector. Countries like Norway and Germany have integrated universal design into national policies (Nielsen, 2024b). However, many other countries do not yet have a strong implementation framework for universal design, including inclusive public area design on trains (Carnemolla et al., 2024).

A study by (Yang, 2019b) showed that Universal design is a mediator in the relationship between barrier-free certification and passenger satisfaction and can have implications. Universal design can improve user perceptions of accessibility and comfort, increasing overall satisfaction. (Mizuno et al., 2020) Recommend improving service management based on universal design to ensure an equal experience for all users. (Nielsen, 2023) found that it is necessary to expand the scope of universal design, not only to physical disabilities but also to mental and psychosocial aspects.

The current trend in universal design research is towards a co-design approach, where end users are actively involved in the design process (Watchorn et al., 2024). This approach is more adaptive and contextual, especially in diverse social environments.

2.4 Theoretical Framework and Literature Selection Methods

This study refers to Universal Design Theory as a basic framework for evaluating the built environment and inclusive access based on seven principles (Aarhaug, 2019). Universal Design has evolved into a multidisciplinary field integrating formal knowledge from various disciplines to create contextually specific solutions. UD is no longer merely a design philosophy but an applied science combining anthropometry, medicine, and design to address user needs in specific social, economic, and urban contexts (Bianco, 2020).

To ensure the study's relevance, a literature review was conducted from 2019 to 2025 through the Scopus database using the keywords accessibility audit, universal design, public toilets, transportation accessibility, and trains. The selected literature is the result of empirical research, policy reviews, and international practices relevant to the context of this study.

3. Research Methods

This study uses a universal design approach to evaluate toilet accessibility on the Joglosemarkerto executive train. This approach was chosen because it emphasizes equality of use of facilities by all user groups, including people with disabilities, the elderly, pregnant women, and temporary users such as passengers with injuries. Unlike specific special needs-based approaches, universal design is comprehensive and proactive in creating an environment that can be used by anyone by default without the need for further modification. Therefore, this approach is most relevant to evaluating public toilets in public transportation facilities (Aarhaug, 2019). Figure 2: Research Stages is a visual flow of the entire research process, from initial observations to the final results of the index calculation. This image helps visualize the integration between technical data collection, user assessment, and processing scores into actionable accessibility categories.

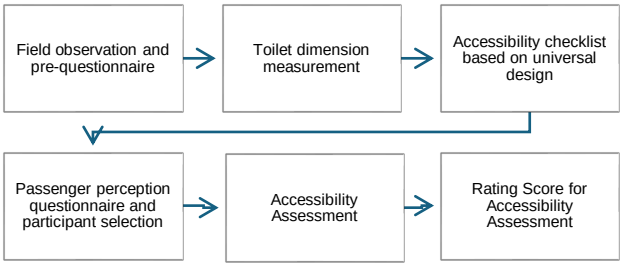

Fig. 2. Research Steps

a. Field observation and pre-questionnaire
   Direct observation was conducted in the executive train toilets to record physical design features and potential accessibility barriers. In addition, a preliminary questionnaire was distributed to 12 passengers who had used the executive train toilets to identify initial complaints and perceptions of the facility's comfort and safety.
b. Toilet dimension measurement
   Measurements were made for Door width and opening space, Sink and faucet dimensions, Mirror height, Toilet size, Wheel space and wheelchair turning space, and Handrail position and size. They were made using a rolling meter and compared to the standards: Regulation of the Indonesian Minister of Public Works and Housing Regulation No. 14 of 2017.
c. Accessibility checklist based on universal design
   The data collection for the accessibility assessment of the Joglosemarkerto executive train toilets used a checklist method based on the seven principles of universal design and technical requirement criteria contained in the local country's accessibility regulations (Isa Mosca & Capolongo, 2018). The regulations used were the Regulation of the Minister of Public Works and Public Housing of Indonesia Number 14/PRT/M/2017 of concerning Building Construction Facility Requirements and the Regulation of the Indonesian Minister of Transportation Number 41 of 2010 concerning Technical Specification Standards for Locomotive-Pulled Trains (Regulation of the Minister of Public Works and Public Housing of Indonesia, 2017), (Regulation of the Indonesian Minister of Transportation, 2010)
   Each indicator is scored as follows: 3 = Available and Suitable, 2 = Available and Less Suitable, 1 = Not Available and Not Suitable.
d. Passenger perception questionnaire and participant selection
   The questionnaire was distributed online to 64 respondents. Purposive sampling was chosen to determine respondents, with the following provisions:, with the following criteria: they used the Joglosemarkerto executive train toilet and were willing to fill out the survey voluntarily. Characteristics of respondents: 25% (16 people) are users with special needs (people with mobility disabilities, elderly, or those experiencing temporary disorders such as injuries), 75% (48 people) are users without disabilities, Respondents' ages ranged from 18–60 years, consisting of men and women. This method was chosen because it allows the collection of perceptions from the most relevant user groups to the study object.
e. Accessibility Assessment
   Quantitative evaluation was conducted by calculating the Accessibility Index (IA) using the formula from (Mitropoulos et al., 2023), which is based on a weighted sum model:

$$\text{Accessibility Index} = \sum_{i=1}^{n} (Ii\ x\ Wi) \quad (1)$$

$$\text{Wi} = \frac{(n - ri + 1)}{\sum_{i=1}^{n}(n - ri + 1)} \quad (2)$$

   Where:
   IA (Accessibility Index)
   n (Number of criteria)
   Wi (Weight for the ith criterion)

Ii (Score for the i-th criterion)
ri (Ranking for the i-th criterion)

f. The reason for choosing this formula is because the weighted sum model provides flexibility in combining objective scores (checklist) with priority criteria, which is important in toilet accessibility studies that have various components with different importance weights. commonly used in similar studies for public space and built environment assessments. The criteria are ranked based on input from inclusive design experts. For example, minimum turning space and the presence of handrails are considered more important than mirror placement and are ranked higher (r=1–3).
g. Rating Score for Accessibility Assessment
The final IA value is interpreted using the categorization table. (Mitropoulos et al., 2023):

Table 2 - Accessibility Index Categories

Accessibility Index Score	Accessibility Index Category
0	Not accessible
1-25	Poor Accessibility
26-50	Moderate Accessibility
51-75	Satisfactory Accessibility
76-100	Excellent Accessibility
0	Not accessible

4. Results and Discussions

This research uses a universal design approach to assess the Accessibility of train executive carriage toilets. There are five stages carried out in this research, including:

4.1 Joglosemarterto Train Executive Carriage Toilet Layout Data

Joglosemarterto Train Executive Car Toilet Layout consists of three different dimensions, namely (1) 140 x 120 x 190 cm, (2) 150 x 125 x 190 cm, and (3) 150 x 100 x 190 cm. The image of the Joglosemarkerto train executive carriage toilet layout is as follows:

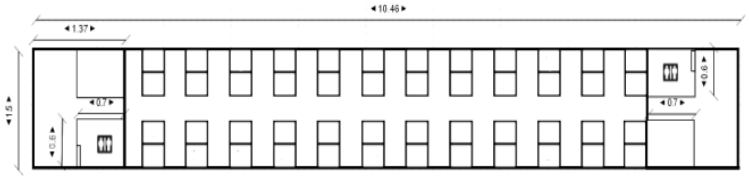

Fig. 3. The Layout of The First Executive Carriage Toilets for Joglosemarkerto Train

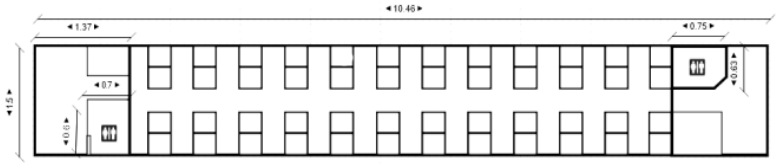

Fig. 4. The Layout of The Second Executive Carriage Toilets for Joglosemarkerto *Train*

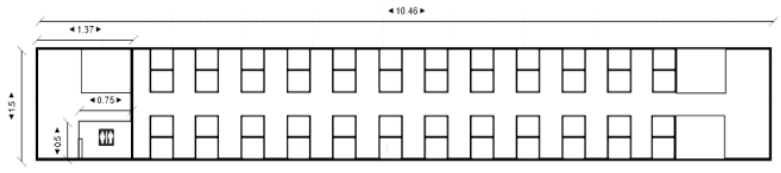

Fig. 5. The Layout of The Third Executive Carriage Toilets for Joglosemarkerto Train

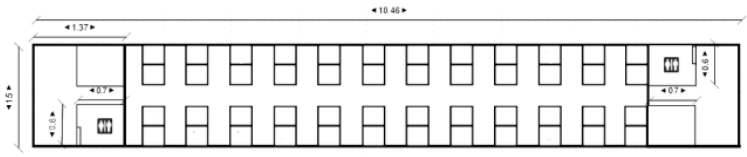

Fig. 6. The Layout of The Fourth Executive Carriage Toilets for Joglosemarkerto Train

4.2 Checklist Data Accessibility Assessment in Joglosemarkerto Train Executive Carriage Toilets Using a Universal Design Approach

The checklist data collected for assessing passenger accessibility in the Joglosemarketo train executive carriage toilets consists of three item areas. Table 2 shows the areas of accessibility assessment with a universal design approach

Table 3 - Accessibility Assessment Area with a Universal Design Approach

Item *Checklist*	Number of Checklist Items
Toilet door	13
Wastafel	7
Main toilet	25

The results of the passenger accessibility checklist data in the Joglosemarkerto train executive carriage toilets are in the appendix.

4.3 Data on Passenger Accessibility Perceptions in Joglosemarketo Train Executive Car Toilets

Accessibility perception data was collected by distributing online questionnaires to toilet users of Jogloemarketo train executive carriages.

1) Respondent Demographics

The number of respondents was 64 people, consisting of 3 people with disabilities who use independent wheelchairs, two people with disabilities who use crutches, six people with disabilities with visual impairments, two people with disabilities who are deaf, one person with physical disabilities, four elderly, one pregnant woman, and 45 adults. Respondent demographics can be seen in the following picture:

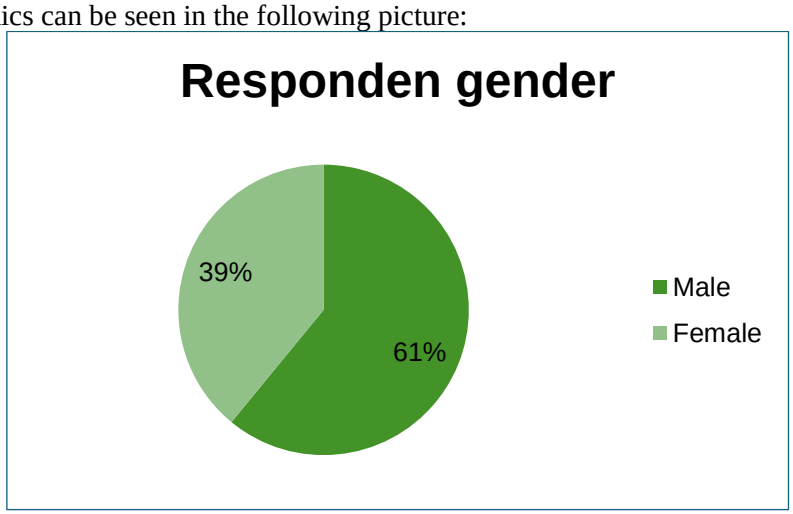

Fig. 7. Percentage of Respondent Gender

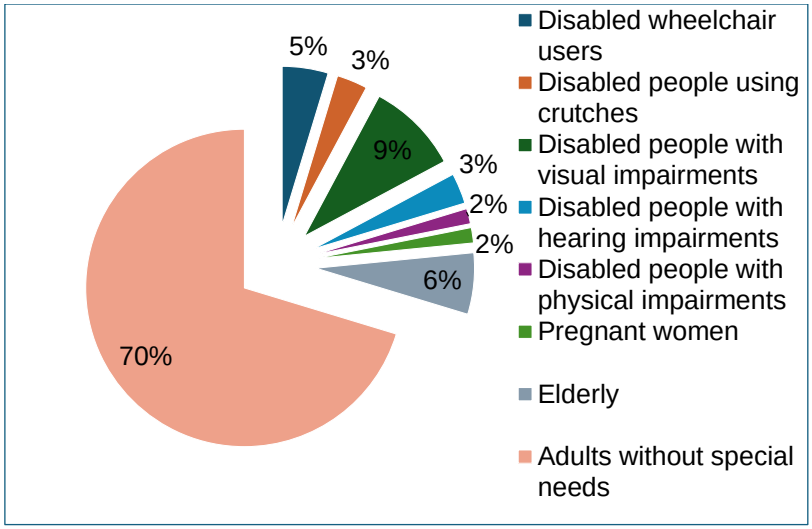

Fig. 8. Percentage of Respondent

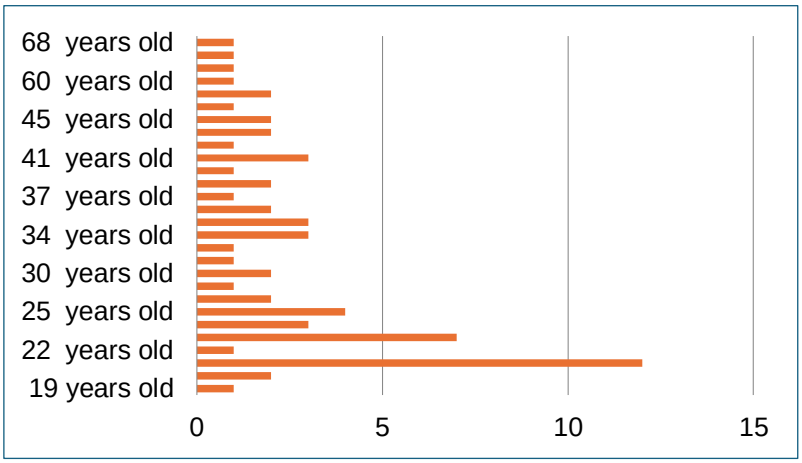

Fig. 9. Respondent`s Age

2) Respondents Questionnaire data

Data on accessibility perceptions of toilet users in Joglosemarketo train executive carriages can be seen in the following table:

Table 4 - Results of The Accessibility Perception Questionnaire

Question	Accessible	Less accessible	Not accessible
Access toilet door dimensions	8	36	20
Access Opens the toilet door	10	35	19
Access to toilet space	7	18	39
Access directional information (images) of toilets	35	17	12
Sink Access	15	37	12
Access to open the sink faucet	48	13	3
Access to Toilet bag hook	7	30	27
Flexible access to toilet equipment (right and left hand)	19	34	11
Toilet grab handle access	28	32	4
Access the water closet button	46	10	8
Access to toilet water availability	24	33	7
Toilet floor access	19	37	8
Access information (braille) toilet	8	8	48
Access the toilet emergency button	8	8	48

3) Validity Test

The validity test of passenger accessibility perception data in the toilets of Joglosemarkereto train executive carriages was carried out to determine the validity of data on elements of

local wisdom in toileting. Data is valid if the correlation coefficient value of the item score with the total score is r > 0.3. Conversely, it is invalid if the correlation coefficient value of the item score with the total score is r < 0.3. Validity testing was carried out with the help of SPSS software. Table 4 shows the results of the validity test.

Table 5 - Results of the validity test

Question	r count	r table	Result
1	0,441	0,408	Valid
2	0,406	0,316	Valid
3	0,437	0,408	Valid
4	0,641	0,408	Valid
5	0,471	0,408	Valid
6	0,570	0,408	Valid
7	0,546	0,408	Valid
8	0,541	0,408	Valid
9	0,465	0,408	Valid
10	0,628	0,408	Valid
11	0,550	0,408	Valid
12	0,535	0,408	Valid
13	0,544	0,408	Valid
14	0,545	0,408	Valid

4) Reliability Test

The reliability test of passenger accessibility perception data in the Joglosemarkereto train executive car toilet was carried out to determine the consistency of the data with the help of SPSS statistical software version 24. Data is reliable if the Cronbach alpha (α) value is > 0.6. The results of the reliability test can be seen as follows:

Table 6 - Results of the validity test

N	*Cronbach alpha (α)*	*Cut off*	Result
10	0,723	0,60	Valid

4.4 Accessibility Index Assessment Data

The assessment of the passenger accessibility index in the toilets of Joglosemarketo train executive carriages can be seen in the following table:

Table 7 - Assessment of Accessibility Index for the Toilet Door of the Joglosemarketo Train Executive Carriage

Criteria	r	W	I	IA (Accessibility Index)
The clear width of the toilet door is at least 70 cm, except for accessible toilets, which are 90 cm	10	0,652	2	1,30
Accessible toilet doors are equipped with self-closing hinges.	4	0,68	3	2,04
The door width is designed to make it easier to get in and out of a wheelchair	5	0,67	2	1,34
Avoid manual sliding door types.	4	0,68	2	1,36
Disabled toilet doors must have a kick plate at the bottom, a critical feature that helps wheelchair users and blind people identify the door and prevent damage from wheelchairs.				
Ramps must adhere to a 6-degree slope or a 1:10 height-to-slope ratio, a critical requirement for safe and accessible navigation	8	0,66	2	1,32
The effective width of the ram must be at least 95 cm without the safety edge/kanstin (low curb) and 120 cm with the safety edge/kanstin (low curb).	10	0,65	2	1,3
Accessible toilet with toilet door dimensions that match the width of the wheelchair	4	0,68	3	2,04
Avoid manual sliding toilet doors that	4	0,68	3	2,04

are heavy and difficult to open/close, doors with two small doors, doors that open in two directions ("push" and "pull"), and doors with handles that are difficult to operate, especially for people with physical disabilities and people with disabilities who are blind.				
Swing-style toilet door design toilet symbol/logo on toilet door/brail	10	0,65	2	1,3
The door handle must be non-slip and not a rotary lever	8	0,66	2	1,32
At the top, outside the door to the accessible toilet, there is an alarm light (panic lamp), which the toilet user will activate by pressing the emergency sound button or pulling the lever available in the accessible toilet when an emergency occurs.	10	0,65	2	1,3
The door is not that heavy and challenging to open/close	8	0,66	2	1,32
If the door to an accessible toilet opens towards the inside of the toilet, it must provide sufficient free space for the wheelchair user to maneuver 180 degrees and open/close the door.	5	0,67	2	1,34
The door in the room is at least 152.5 cm x 152.5 cm.	5	06,7	2	1,34
The swing door design must be able to open 90◦, and the maximum door pull load is 5 kg.	5	0,67	2	1,34
Total				22

Table 8 - Assessment of Accessibility Index for the Wastafel of the Joglosemarketo Train Executive Carriage

Criteria	r	W	I	IA (Accessibility Index))
The recommended height of the hand washing basin for wheelchair users is 75 cm.	16	1,4	3	4,2
The design has a handwashing basin size of at least 45 cm x 60 cm.	12	1,5	2	03
The location of the hand washing basin must be easily accessible for wheelchair users.	16	1,4	2	2,8
There is soap available in the handwashing tub	12	1,5	3	4,5
Installation of hand washing tubs must be able to avoid water splashing around the hand washing tub, users, and the floor.	12	1,5	2	0,3
For your convenience, we recommend using a faucet with a sensor system.	16	1,4	0	0
The free space for handwashing tub users is at least 60 cm from the edge of the tub, which has a circulation of 60 cm	16	1,4	0	0
			Total	17,5

Table 9 - Assessment of Accessibility Index for the Main Toilet of the Joglosemarketo Train Executive Carriage

Criteria	r	W	I	IA (Accessibility Index))
Toilets for disabled people must be equipped with handrails to make it easier for wheelchair users to move from the wheelchair to the toilet or vice versa.	6	0,396	3	1,191
The vine handle, with a length of 95 cm, is a critical component in the design of accessible toilets for disabled individuals	1	0,404	2	0,809

There are three creeping handles (vertical next to the mirror, vertical and horizontal next to the toilet)	1	0,404	2	0,809
The height of the horizontal creeper handle from the floor is 70 cm	4,5	0,399	2	0,798
The height of the vertical creeper handle from the floor is 80 cm	4,5	0,399	2	0,798
The height of the toilet is 45 cm from the floor	6	0,396	3	1,191
Minimum mirror width 40 cm	6	0,396	3	1,191
The diameter of the creeper handle is 3.5 cm	1	0,404	2	0,809
At the top, outside the toilet door for disabled people, there is an alarm light (panic lamp), which is activated by pressing the emergency sound button.	1	0,404	2	0,809
There is an emergency sound button in the toilet	1	0,404	2	0,809
Toilets are accessible to access.	4,5	0,399	2	0,798
The toilet placement should be an integral part of the main room.	6	0,396	3	1,190
The lever in the toilet must be placed in a place that is easily accessible to people with disabilities	6	0,396	3	1,190
The space equipment that needs to be provided in the toilet is: (a) hand washing basin; (b) mirror; (c) trash can; (d) hand dryer; (e) tissue; (f) sanitizer; (g) soap; (h) clothes hanger; (i) urinals; (j) toilet; (k) jet shower; (l) bidet; (m) air freshener; (n) exhaust fan; and (o) water tap	4,5	0,399	2	0,798
Toilets are equipped with clear and informative markings.	5	0,398	3	1,195
Embossed/braille signs for people with disabilities	1	0,404	2	0,809
Equipped with empty or empty instructions on the toilet	1	0,404	2	0,809
The floor covering for the toilet is chosen from a textured and non-slip material.	4,5	0,399	2	0,798
The toilet floor must be lower than the room's outside the adequate toilet.	6	0,396	3	1,191
The toilet floor has a slope of at least 1% of the length or width of the floor.	6	0,396	3	1,191
The walls and floor of the toilet are given a waterproof layer (waterproofing).	6	0,396	3	1,191
The handrails and joints, crucial components of the toilet's safety features, are meticulously crafted from corrosion-resistant materials, ensuring the safety and comfort of the users.	6	0,396	3	1,191
The toilet room is a module made of corrosion-resistant material	6	0,396	3	1,191
The lever in the accessible toilet must be placed in a place that is easily accessible to disabled people.	4,5	0,399	2	0,798
The minimum dimensions of space in an accessible toilet are 152.5 cm x 227.5 cm.	1	0,404	2	0,809
Total				24,4

4.5 Recap of Accessibility Index Assessment Results

A summary of the results of the passenger accessibility index assessment in the toilets of Joglosemarketo train executive carriages can be seen in the following table:

Table 9 - Accessibility Index Results

Item *Checklist*	accessibility index score	Accessibility Index Category
Toilet door	22	Poor Accessibility
Wastafel	17,5	Poor Accessibility
Main toilet	24,4	Poor Accessibility
Average	13,5	Poor Accessibility

4.6 Discussion

Comparison with Previous Studies and Novelty of Findings

This study provides an empirical assessment of toilet accessibility in executive trains using a universal design approach, which is still relatively rare in the context of railway systems in Southeast Asia, especially in Indonesia. Unlike previous studies that have mostly assessed accessibility in static building environments (e.g., airports and public buildings), this study highlights spatial challenges and access barriers in mobile transportation environments, especially in the Indonesian railway system. This is more or less the same as the findings (Zainol et al., 2018), who reported the lack of accessibility of toilet facilities in LTR and Komuter Line Malaysia, thus becoming an accessibility barrier. The results of this study showed low accessibility scores for all areas assessed—toilet doors (22), sinks (17.5), and main toilet rooms (24.4), which means that they are very much an accessibility barrier for disabled wheelchair users. Similar low accessibility was also found in the metro system in China (K. Zhang et al., 2018); in Indian metro stations there are still toilet facilities that are less friendly for people with disabilities and several respondents stated that toilets in some stations are not accessible for people with disabilities using wheelchairs (Mandhani et al., 2023), in public transportation facilities for trains and buses in Australia are also still incompletely accessible for people with (Kelsey Chapman, Carolyn Ehrlich, 2023). However, compared to the accessibility of train toilets in Norway (Nielsen, 2024d) and Poland (Lewandowski, 2020), there is a significant gap regarding inclusive infrastructure compared to Indonesia, especially accessible toilets on trains.

Compared to Similar Standards and Facilities

Based on international standards such as the ADA (Americans with Disabilities Act) guidelines, EN 16585-3:2017 (European standard entitled Railway applications), and Regulation of the Indonesian Minister of Public Works and Housing Regulation No. 14 of 2017 states that a minimum turning radius of 150 cm or 360 degrees and a minimum door width of 90 cm are the basic requirements for accessible toilets. However, the toilets on the Joglosemarkerto executive train do not meet these standards, especially regarding important elements such as circulation space and door dimensions. In addition, Braille signs and emergency systems are either not available or not installed properly, which is in stark contrast to the level of accessibility on European train systems. (Antony Swift, Long Cheng, Becky P.Y. Loo, Mengqiu Cao, 2021).

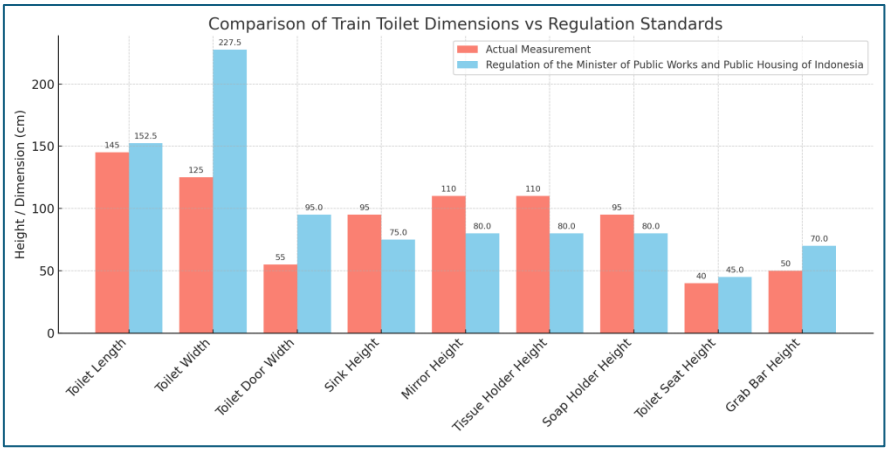

Fig. 10. Comparison of Toilet Facilities Dimensions of Joglosemarkerto Executive Train with Standard Regulations in Indonesia

Overall, this condition is very detrimental to wheelchair users, elderly passengers, and people with sensory disabilities, in line with the findings of (Izzy Yi Jian, Edwin H.W. Chan, Yang Xu, 2021), and (Gordon Waitt dan Theresa Harada, 2023) which highlight the vulnerability of these groups in non-inclusive transportation systems.

Score Interpretation

The accessibility score for the Joglosemarkerto executive train toilet is 13.5, indicating a systemic design error in the train toilet. Score 22: The toilet door is narrow, no emergency lights, and the door is heavy, making it difficult for wheelchair users and the elderly to access. The sink area scored 17.5 due to poor room circulation, the absence of automatic taps, and adequate clearance, making it very difficult for wheelchair users. Meanwhile, although the main toilet area was equipped with several handrails, it only scored 24.4 because the number and placement of handrails were less than optimal. The low accessibility index value is also in line with research conducted by (Z. Zhang et al., 2024) who assessed the accessibility index in Xinzhuang and Xujiahui stations with AHP, and (Rizki et al., 2024) who assessed the accessibility index in Yogyakarta Station with a checklist. Figure 3 shows a heatmap graph of the accessibility index score.

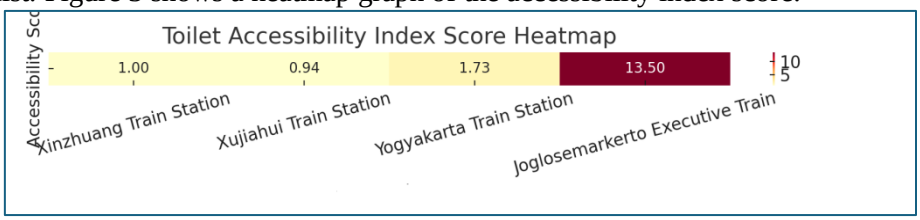

Fig. 11. Comparison of Toilet Accessibility Index Scores

Practical Implications

These findings have several significant practical implications. For train operators such as PT Kereta API Indonesia, it is important to review toilet design standards to comply with universal design principles, involve disabled users in the co-design process *design* (Neves et al., 2025), and consider retrofitting existing trains with modular and prefabricated accessible toilet units. For policymakers, it is necessary to develop enforceable railway accessibility regulations aligned with the SDGs on sustainable cities and communities and provide incentives to encourage inclusive innovation in public transport, such as subsidies or grants. Meanwhile, for passengers with disabilities, the current condition of facilities can threaten their dignity—for example, due to the need for personal assistance in private spaces—so it is necessary to provide an accessibility hotline or digital platform for reporting and requesting assistance during the journey.

Generalizations and Implications for the Wider Transportation System

Although this study focuses on the accessibility of the Joglosemarkerto executive train toilets, the findings reflect a broader infrastructure pattern in developing countries, where accessibility is still considered a secondary issue. This aligns with the findings of (Zallio & Clarkson, 2021), and (Lamirande, 2022) that poor design issues generally arise from a lack of standardization, minimal inclusive consultation, and a lack of funding priorities. Therefore, further research can replicate this approach in other modes of transportation or areas, such as buses or ferries, to build a national accessibility index database that can serve as a benchmarking tool and monitor future improvements.

5. Conclusion

The toilet accessibility assessment in the executive carriage of the Joglosemarkerto train using the universal design approach resulted in a score of 22 for the toilet door area, 17.5 for the sink area, and 24.4 for the main toilet area. Based on these scores, the three areas were declared to be in the poor accessibility category. These findings indicate that the toilets in the jogjlosemarkerto executive train are not accessible to wheelchair users and have not fully accommodated the principles of universal design. Theoretically, these findings emphasize the urgency of implementing a universal design approach in designing toilets on trains to ensure equal access for all users without exception. These findings also enrich the literature related to the evaluation of public transportation accessibility based on universal design, especially in the context of developing countries such as Indonesia. Practically, this study provides strategic input for train operators in Indonesia, especially in planning and renovating toilet facilities in executive carriages to make them more inclusive and disability-friendly. By applying universal design principles from the design stage, operators can improve the comfort, safety, and satisfaction of all passengers, including people with disabilities. The low toilet accessibility score in the Joglosemarkerto executive train toilet strongly indicates that inclusion-based design improvements are urgently needed based on the universal design principles approach to improve service quality and commitment to human rights in the context of public mobility and accessibility in Indonesia.

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