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Research Article

Sustainability and friendly circulation path in Sangiran Museum Sragen Indonesia

Seruni Inas Hanendya[1] , Nur Rahmawati Syamsiyah[2,*]

[1,2] *Department of Architecture, Faculty of Engineering, Universitas Muhammadiyah Surakarta, Indonesia.*

[*]Corresponding author: nur_rahmawati@ums.ac.id

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ABSTRACT

Museums are windows into a country's past. Museums can tell stories about history and life. Sangiran museum is one of the world's heritages that tell the story of human evolution from prehistoric times to the present. The presence of historical or other information in the museum heavily relies on the zoning of space and circulation paths. The circulation of visitor movements between spaces and buildings significantly impacts the museum's function. Submission of historical information to visitors will be easier to understand if there is good circulation, which supports visitor movement activities. In the observations, the movement of visitors at the Sangiran museum has constructed an uncomfortable feeling for the users. This study aims to assess the circulation path's compliance with government standards. Due to the nature of this study, a descriptive qualitative approach is required. The study discovered three types of circulation paths that were not user-friendly, namely ram, stairs, and hallways. They did not meet Indonesian government and international data architecture standards. Hence, this study proposes an easy-to-implement design to ensure the long-term function and sustainability of the circulation pathway.

1. INTRODUCTION

A building is a place to accommodate user activities. Therefore, the convenience of circulation is an essential element that needs to be considered in the design of a building because it is an element that forms the environmental structure of a building. The circulation space within the building is divided into horizontal circulation spaces such as entrances, foyers (open areas), lobbies, and corridors, and vertical circulation spaces such as stairs, ramps, and elevators. Circulation space is a link between rooms or floors of a building that must meet user comfort standards.

The existence of an interconnected circulation between the functions of the room or building determines user convenience in a building. Furthermore, circulation must be following user requirements, such as the availability of special circulation lanes for people with

disabilities [1]. The separation of pedestrians and people with disabilities will provide comfort for both parties, and there will be no competing functions. Circulation must be a facility that provides visitors with comfort wherever they go, including in public spaces. The use of public facilities for shared and diverse activities will make these public facilities more congested, potentially interfering with the user's comfort [2], so people with disabilities must have a unique circulation path in public areas to avoid disturbing feelings [3].

There have been numerous studies on circulation in public buildings. These studies found that the key components were the general and evacuation circulation paths. Fachrurrozi & Astuti studied the model that integrates these two circulations in a textile market in Solo, Central Java, Indonesia [4]. They found that the circulation path is deliberately made open for evacuation circulation. Naibaho & Hanafiah proposed a circulation path as well as a movement space, which is more flexible in a library reading room so that visitors do not come into touch [2]. For the circulation of area for individuals with disabilities, Lase et al. proposed a circulation path with an efficient arrangement of elements [5]. According to this study, people with disabilities must be able to reach the locations they want to go with comfort and freedom without encountering any difficulties or feeling left out.

On the other hand, Irsyadi & Setiawan investigated how buildings circulate and how well public transportation works [6]. They stated that the location of the space in the building or the shape of the site where the building is located will influence the circulation pattern in the building. Furthermore, Pynkyawati et al. studied the effectiveness of circulation design in shopping malls and hotels [1]. Circulation paths in buildings and sites are inseparable and will take up quite a lot of space.

The integrated circulation between the outside and inside of the building creates a comfortable continuous space. According to ISO 18461:2016 on International Museum Statistics in Access and Facilities, providing circulation space is a requirement. Circulation comfort for people with disabilities and normal humans is critical in museums, including the ancient museum in Sangiran, Central Java, as a World Cultural Heritage Site. This museum's purpose is to convey historical information about the origins of humans so that if visitor circulation is good, information delivery to visitors will be easier to understand. The building in the Sangiran museum area follows the contours of the existing land, so there is only a minor cut-and-fill process, resulting in each building being a height difference, necessitating a vertical circulation space as well as a hallway to connect each building. In a nutshell, the circulation of the Sangiran Museum does not comply with the government regulation of the Minister of Public Works and Public Housing No.14/PRT/M/2017 regarding circulation. Therefore, there is a standard gap between visitors with disabilities and other visitors. This problem must be resolved so that there is integrated circulation both inside and outside the building. The continuity of circulation that forms comfort or user-friendliness/humanity is more important than the cohesivity of the circulation.

Museums exist to protect, develop, and use collections while also communicating their collections to the public [7], so museum evaluations should include three architectural elements [8]: 1) conceptual, which includes the underlying philosophy and ideas; 2) programmed, which includes functions and relationships between functions; and 3) formal, which includes spatial configurations and geometric shapes. Due to the museum's function as an information centre, it must be easily accessible, and the available facilities must be complete, safe [9], and in accordance with socio-technical needs [10]. Circulation facilities can be provided in the form of walkability, stairs, and ramps and are comfortable, particularly for users with disabilities. Walkability is an essential factor to consider when it comes to pedestrian accessibility, and users will feel more at ease with the appropriate provisions [11]. A building with an elevator will still require stairs in an emergency, so stairs must also be considered [12]. The use of an appropriate ramp will ensure the safety of visitors with disabilities, with a ramp that is not too steep and has appropriate width.

According to Ataoglu [13], the museum's circulation can be divided into new and multiple circulations, allowing visitors to choose their path as if they were in their labyrinth. Visitors are not required to read the information entirely if it is helpful and communicative. The museum needs not only to focus on the communicated content but the existing old building's shape must also be considered. Andhikaputra [14] proposed an elevator for the museum as an antique building. The use of vertical transportation in the form of an elevator is used for the tourists' convenience. Combining circulation, artificial lighting, and supporting installations for presenting items or space installations could help make the museum more user-friendly [15].

Furthermore, environmental factors and functional technology are highly recommended for museum design, given that the museum is no longer a closed space [16]. Since a museum is no longer a closed environment and only for conserving artefacts but has become a sociocultural centre with diverse educational, cultural, and social functions, it is necessary to organise several additional spaces for these activities. Museums are no longer static, and the architectural space is no longer just a case for collections of exhibits. Thus, the design of contemporary museums should be considered environmental and functional technology factors for fully

implementing modern requirements for the interactive nature of collaboration between the museum and its visitors.

Circulation in a museum is analogous to a "rope" connecting the spaces of a building or a series of indoor and outdoor spaces [17]. Circulation can act as a barrier or separator between indoor and outdoor spaces. The path's entrance is the first phase of the circulation system, allowing one to see, experience, and use the space. The door used to enter the circulation path varies depending on the circulation system used. The circulation system is a beneficial factor influencing user perception of building form and space [18]. Hallways, corridors, stairs, elevators, escalators, ramps, bridges, and other forms of circulation can be used. To make circulation a concern, spatial processing is required by creating geometric floors, space boundaries, irregular gaps, and colours [8].

Some functions of the circulation form must be accessible to all users or user-friendly. Circulation, in particular for people with disabilities, must provide convenience and independence in getting to where they want to go without creating obstacles or difficulties [5]. Architectural barriers associated with the three major types of disability are [19]: 1) physical disability, including wheelchair users; 2) sensory disability, including visual and hearing impairment; or 3) intellectual disability or progressive disability. Architectural obstacles can also be found in the Sangiran Museum, so it is essential to understand the circulation that is not following the rules and is not welcoming to visitors. It is necessary to propose a friendly design with a long-term function.

2. METHODS

The qualitative approach that used in this research is the object of the museum must be seen in terms of the museum space's suitability with technical ministry standards No. 14/PRT/M/2017 [19] and architect data [20], while conformity with ISO 18461:2016 [21] is seen in terms of the availability of space/facilities. The research stages follow the sequence as shown in Figure 1.

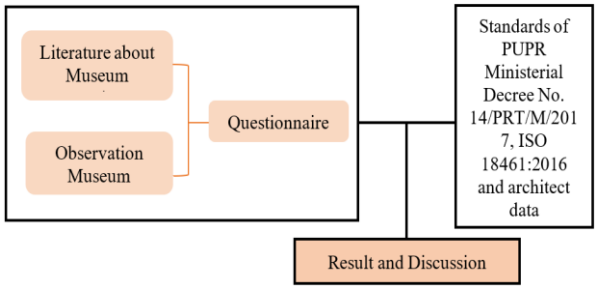


Figure 1. The research procedure.

2.1 Data collection methods such as observation, questionnaires, and literature

At the Sangiran Museum, data is being collected using the literature method to obtain information about floor plans and circulation patterns. Data on the size of the circulation space at the Sangiran museum, such as rams, stairs, and hallways, are collected through direct observations. Meanwhile, a questionnaire is distributed to visitors of the Sangiran museum to gather information about their perceptions of the Sangiran museum's circulation. The secondary data comes in the form of a museum working drawings or detailed engineering design drawings, which will be analysed as a whole, one of which is a floor plan, as shown in Figure 2.

2.2 Methods for data processing and analysis

Methods for analysing qualitative data used by categorising the level of conformity with government standards, such as PUPR Ministerial Regulation No. 14/PRT/M/2017 Articles 18 and 19 paragraph 1 and ISO 18461:2016.

2.2 Questionnaires

Respondents are given structured interviews with questionnaires. The questionnaire's goal is to determine the degree of agreement between objective observation analysis results and respondents' subjective evaluation data. The questionnaire is a measuring instrument that includes wayfinding, comfort walking through the hallway, disturbances when passing through the hallway, the height of stairs, steep ram, narrow path, and fatigue after passing stairs are among the questions asked. Questionnaire responses are only divided into yes and no, and the percentage of the number of yes and no answers is calculated.

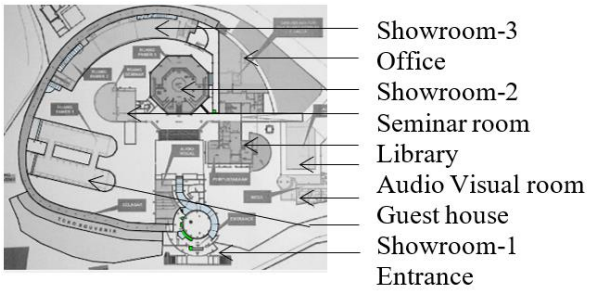


Figure 2. Floor plan of Sangiran museum.

3. RESULTS

The Sangiran museum is situated in the hills where early human fossils were discovered (Figure 3). This is a prehistoric human site in Indonesia. Currently, the Sangiran site is known internationally as a site capable of contributing important knowledge about the evidence of human evolution (physical change), fauna evolution,

cultural evolution, and environmental evolution that occurred two million years ago. Sangiran site was designated as World Cultural Heritage Number 593 by UNESCO in 1996 under The Sangiran Early Man Site [22]. The museum's facilities are in accordance with ISO international standards, and Sangiran is classified as a History Museum, which deals with the history of specific geographical areas or cultural groups of people over time. Sangiran museum complies with ISO standards in terms of the availability of space for permanent exhibitions, temporary exhibitions, storage rooms, visitor service rooms (including areas for recreation and communication, as well as shops and restaurants), museum management rooms and technical services, meeting rooms, cleaning storage, laboratories, museum archives and museum libraries, hallways, restrooms, and all spaces used for museum collections.

The Sangiran museum serves several purposes. There are both private and public areas. Public spaces include exhibition rooms 1, 2, and 3, as well as disabled rooms, whereas offices, seminar buildings, libraries, and audio-visual rooms require prior permission to enter the zone. A hallway connects showrooms 1, 2, and 3, and there are stairs at every exit or enter the showroom, as shown in Figure 4. Two circulation types connect spaces and buildings: vertical circulation (stairs and rams) and horizontal circulation (the hallway). Some parts of the circulation form are found to be in violation of the government's standards, as explained in the following analysis.

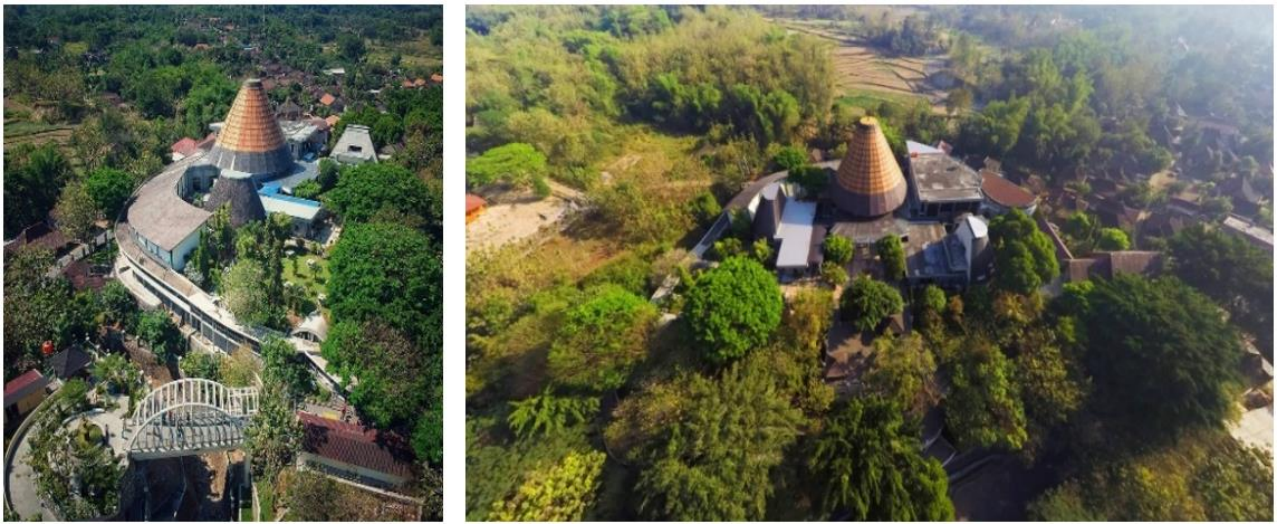


Figure 3. The existence of the Sangiran museum seen from the air [23].

3.1. Rams

PUPR Ministerial Decree NO. 14/PRT/M/2017, and the data architect explain the standard ram, which is:

1. The largest ram, or construction ram, must have a slope of 6° or a height-to-slope ratio of 1:10, and the outer ram of the building must have a slope of 5° or a height-to-slope ratio of 1:12.
2. The ram's effective width should be 95 cm or greater and 120 cm or greater if the curb is low.
3. The ram prefix/suffix is not recommended to be placed directly opposite the building's entrance/exit.
4. Ram with non-permanent construction can be used in preserved or cultural heritage buildings.

Ram data from field observation are shown in Figure 4. The ramp for access to the Sangiran museum is less friendly for people, especially disabled people. The inclination angle exceeds the standard 5°-6°, reaching an extreme angle of 55.5°. This is a very steep angle that is unsuitable for circulation.

3.2. Stairs

PUPR Ministerial Decree NO. 14/PRT/M/2017 and the data architect explain the standard ram, which is:

1. The height of the steps (optrade/riser) is not more than 18 cm and not less than 15 cm.
2. The width of the stairs (antrade/tread) is at least 30 cm.
3. The stairs use non-slip material and are provided with anti-slip material (step nosing).
4. The number of stairs up to the landing (landing) is a maximum of 12 steps.

The location of stairs is dispersed throughout the building, both inside and outside. Each optrade's height and antrade's wide can be divided into three categories:

1. Optrade's height is 10 cm, and antrade's wide is 30-60 cm. Stairs with a height < 15 cm are not according to the rules used at the entrance and exit of the showroom, as shown in Figure 6 (a).

2. Optrade's height 17-18 cm, and antrade's wide 30-35 cm. Stairs are used at the showroom entrance (Figure 6.b), and to ascend to the mosque. This mosque staircase there is a landing after 20 and 26 steps. A large number of steps and the length of the landing is long, some visitors become tired after passing through these stairs, as shown in Figure 6 (c).
3. Optrade's height 22 cm, and antrade's wide 30 cm. Stairs that have a height > 18 cm and are not according to the rules used at the showroom exit, as shown in Figure 6 (d)
specimens

3.3. Hallway

PUPR Ministerial Decree NO. 14/PRT/M/2017 and the data architect explain the standard ram, which is:

1. It is not allowed to use a slippery floor covering material.
2. The curtain must have an effective width sufficient for a wheelchair user or 2 people to pass by at least 140 cm.
3. For wheelchair users or two, the effective wingspan must be at least 140 cm.

The hallway around the showroom does not meet the requirements because it is too narrow and makes it difficult for visitors to pass through. Figure 8 (a) shows that the hallway is only about 90 cm wide, making it impossible for two people to walk together or pass each other. Furthermore, a barrier in the middle of the corridor (Figure 8 (b)) makes the passage narrower. Meanwhile, the hallway around the retail shop is 180 cm wide enough to pass through (Figure 8 (c)).

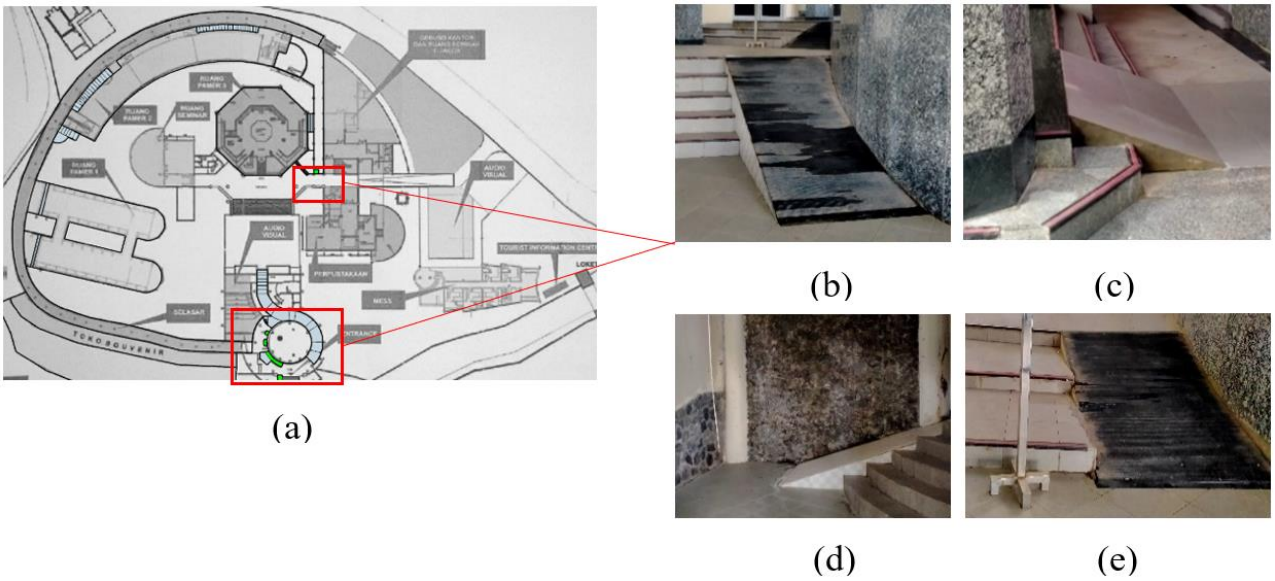


Figure 4. (a) Two points of ram location, with four kinds of shape (b) ram has a slope angle of 35° with a ratio of 1:2.8, (c) ram has a slope angle of 55.5° with a ratio of 1:1.8, (d) ram has a slope angle of 37° with a ratio of 1:2.7, and (e) ram has a slope angle of 37.5° with a ratio of 1:2.6.

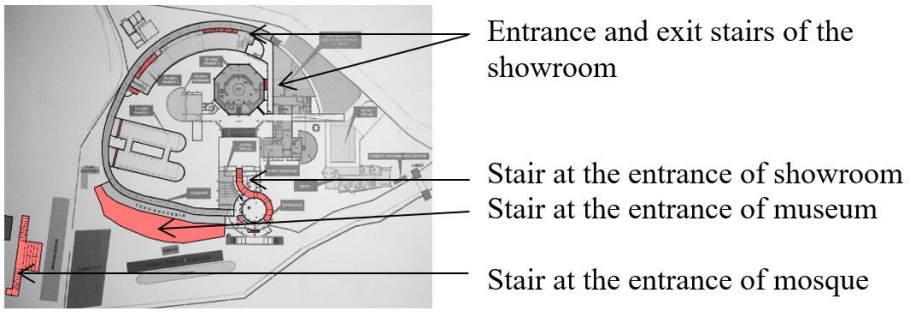


Figure 5. Several points of stairs.

Figure 6. The height and width of the stairs are used to categorise the shape of the stairs.

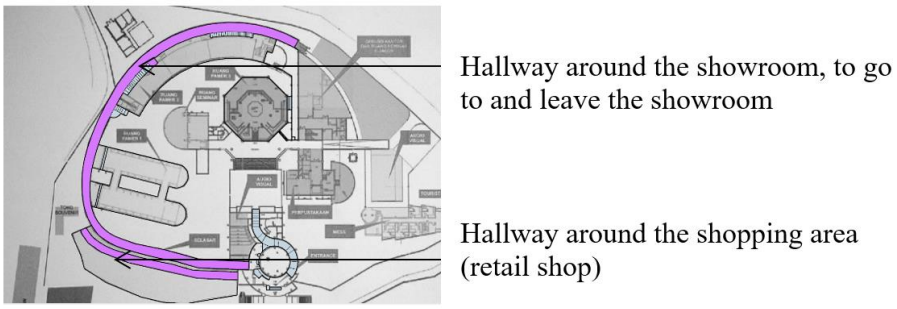


Figure 7. Hallway position in the Sangiran museum.

Figure 8. (a) and (b) The hallway looks narrow, and the pillar barrier in the middle of the hallway, and (c) The hallway around the shopping area (retail shop).

4. DISCUSSION

In the Sangiran museum area, the lobby is the only access from exhibition room 1 to the next exhibition room, which is also used as an evacuation route. The hallway is open to traffic from outside of the building, either without walls or only on one side of the wall. In the Sangiran museum, the link between the exhibition rooms is the lobby, where this lobby is the main access to enter the Sangiran museum building. Circulation paths inside and outside the building, such as hallways, corridors, ram components, and internal stairs, have non-standard shapes. This situation is also in violation of government regulations.

Article 18 paragraph 1 of PUPR government regulation No. 14/PRT/M/2017 describes stairs, namely manual vertical transportation for pedestrians, that are designed for comfortable and safe use by all users, considering the proper slope, foot size, and height of the stairs. Paragraph 1 of Article 19 states that a ram is a transportation route with a specific slope and width to allow people with disabilities, building users, and building visitors access between the floors. This regulation clearly states that visitors must be comfortable. Based on the questionnaire results, it is noticeable that several issues need to be addressed in the future because visitors have the following opinions:

1. The wayfinding is unclear, making it difficult to reach the desired location.
2. Being in the circulation path is uncomfortable because it is narrow, and there is a pole in the middle of the hallway.
3. Fear of going down the stairs because they are very steep.
4. Experience fatigue when using stairwells with steep angles

5. Feel afraid to go up the stairs because there's a puddle of water, and feel afraid to fall and slip.

The comfort of visitors appears to be overlooked in this museum. The building is only made to fulfil its technical function. Although spaces and a connecting corridor between rooms are needed, they do not fulfil other functions (i.e., comfortable function) such as comfortable stairs, sloping rams, and more open circulation paths. The presence of circulation is still less encouraging as a positive factor that will raise visitor perceptions of space [17]. There is still room for improvement in floor configuration and colour [8], so this ancient museum does not appear frightening.

On the other hand, the museum organiser is not educated that museum facilities must be self-sufficient for disabled people, as research by Lase et al. suggests [5], but disabled people are considered pitied people and in need of assistance. Furthermore, a separate room for people with disabilities is not created in conjunction with the other visitors, and people with disabilities feel excluded and unimportant in this situation and are not allowed to develop self-confidence.

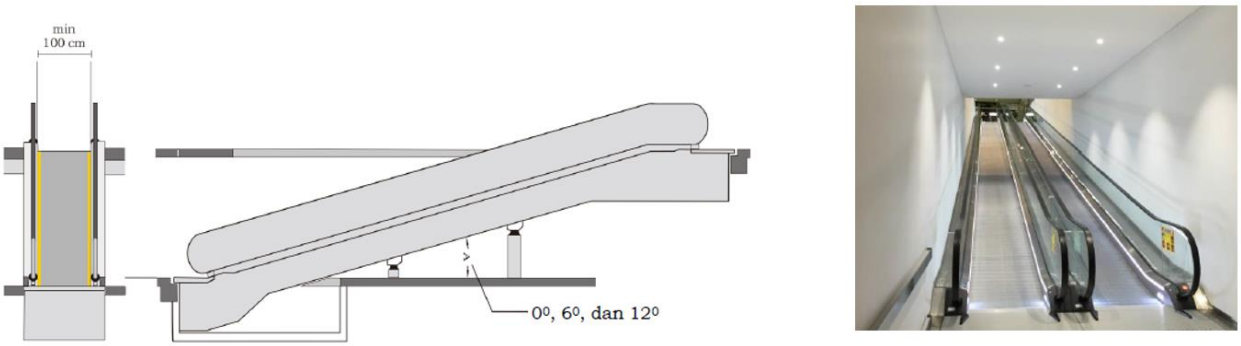
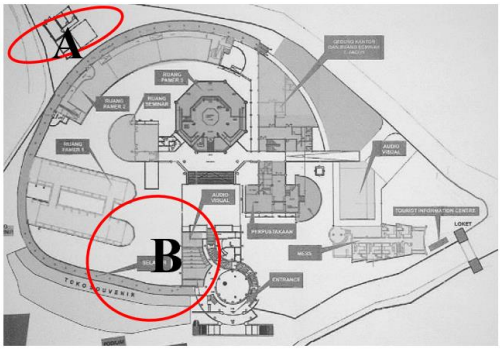
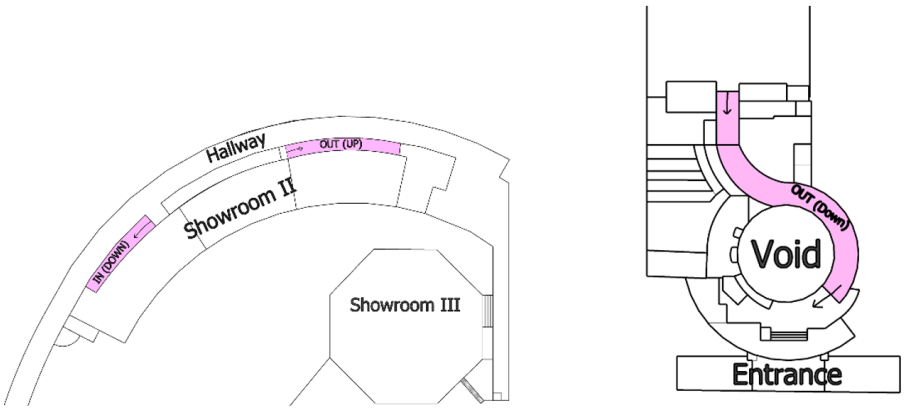


Figure 9. Circulation alternatives that can be developed at the Sangiran museum



(a)



(b) (c)

Figure 10. (a) Conveyor location plan at Sangiran museum in two locations: (b) detail of A location, and (c) detail of B location.

In contrast, the museum should also serve as a social gathering place [16]. Most respondents are concerned about unclear wayfinding. The building's twisting shape gives visitors the impression that they are in a maze [8]. This design was created to depict the historical journey, but it fell short of its goal. According to this study's observations, the curved shape causes visitors to be unsure of what they will find later, making directions less effective.

The Sangiran site, along with all its archaeological content, is an important cultural heritage that must be preserved. Efforts to preserve the Sangiran site must continue in various ways, including providing services for visitors in comfortable and friendly forms and circulation routes. A conveyor or moving walk is one type of vertical circulation that should be included. This form is similar to a regular hallway, but it is moved by machines, so visitors don't get tired of walking and can continue to their destination, as shown in Figure 9.

The moving walkway can be installed horizontally at 0° or with a 6° to 12° slope. On average, one moving walk unit can serve a floor area of 1500 m^2, but it is more appropriate for a floor area of 500 m^2 – 700 m^2. It is even more advantageous for wheelchair users because they can walk without the assistance of others. This walking floor is ideal for use as a link between rooms or buildings

5. CONCLUSION

Sangiran museum is a cultural heritage that needs to be maintained and protected in the present and preserved for future generations. Based on the results of the evaluation conducted at the Sangiran museum, it can be concluded that the circulation path is not friendly to visitors, with the following details:

1. Some of the circulation paths for visitors at the Sangiran museum do not comply with the PUPR Ministerial Regulation, so the circulation paths are uncomfortable for visitors.
2. There is less emphasis on the path for the disabled, both physically and mentally disabled. Several rams have been placed at various points, but all the available rams are so steep that the physically disabled cannot climb the ram on their own; they must be pushed.
3. Due to a lack of guiding blocks for the blind, the blind must be guided by the officer or family.
4. Stairs that are too high or too short make users uncomfortable.

Vertical circulation, such as stairs and ramps and horizontal circulation, such as hallways and corridors, must be prioritised in this museum building for both regular visitors and people with disabilities. Spaces should be designed specifically for people with disabilities, with configurations of shape, floor, and colour so that people with disabilities can grow their self-confidence and do things independently without needing assistance from others.

The best service largely determines the sustainability of the museum's function for visitors in the form of comfortable and friendly circulation facilities. One form of vertical circulation that does not yet exist is a conveyor, especially on the outside of the building, which connects rooms or buildings. This conveyor can take the visitors to the showroom that visitors want, so the visitors do not need to walk until they are tired

CONFLICTS OF INTEREST

The author declares that there is no conflict of interest affecting this publication.

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