Sustainability and friendly circulation path in Sangiran museum, Sragen Indonesia

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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 is heavily reliant on the zoning of space and the presence of 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 not been comfortable for users. This study aimed to assess the circulation path’s compliance with government standards. The research method not only used the literature review, observation, and questionnaires but also applied a descriptive qualitative approach. The study discovered three types of circulation paths that were not user-friendly, namely ram, stairs, and hallways, and did not meet Indonesian government and international data architecture standards. This study proposes an easy-to-implement design to ensure the long-term function and sustainability of the circulation pathway.

Keywords: accessible, friendly circulation, Sangiran Museum, sustainability
INTRODUCTION

The building is a place to accommodate user activities, so the convenience of circulation is something that needs to be considered in the design of a building, because circulation 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, as well as vertical circulation spaces such as stairs, ramps, elevators, and so on. 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 in accordance with 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 public spaces. The use of public facilities for shared and diverse activities will become more congested, potentially interfering with user comfort [2], so people with disabilities must have a special circulation path when in public areas to avoid feeling disturbed [3].

There have been numerous studies on circulation in public buildings. The key components are the general circulation path and the evacuation circulation path, and Fachrurozi & Astuti studied the model of integrating these two circulations [4]. At a textile market in Solo, Central Java, Indonesia, the circulation path is deliberately made open for evacuation circulation. Naibaho & Hanafiah propose 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 space for individuals with disabilities, Lase et al. propose a circulation path with an efficient arrangement of elements [5]. According to the 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. Irsyadi & Setiawan looked at how buildings circulate and how well public transportation works [6]. 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. Pnkyawati et al. investigated the effectiveness of circulation design in shopping malls and hotels [1]. Circulation paths in buildings and sites are an inseparable part, and will take up quite a lot of space.
The integrated circulation between the outside and inside of the building creates a continuous space that is comfortable. Providing circulation space is standard in a museum according to ISO 18461:2016 on International Museum Statistics in Access and Facilities. Circulation comfort for both 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 different height, necessitating a vertical circulation space as well as a hallway to connect each building. In a nutshell, the circulation at 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, so there is a normal 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. It is not enough to be cohesive; it is the continuity of circulation that forms comfort or user-friendliness/humanity that is more important.

Museums exist to protect, develop, and use collections while also communicating them 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. Because the museum is an information center, it must be easily accessible, and the facilities available 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 important factor to consider when it comes to pedestrian accessibility. Users will feel more at ease with the appropriate provisions [11]. A building with an elevator will still require stairs in the event of 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 of appropriate width.

According to Ataoglu [13], the museum’s circulation can be divided into new and multiple circulations, allowing visitors to choose their own path as if they were in their own labyrinth. Visitors are not required to read the information in its entirety as long as it is helpful and
communicative. The museum not only stresses the appearance of the content to be communicated, but the existing old building’s shape has also been called into a museum. As an antique building, Andhikaputra [14] proposed an elevator for the museum. The use of vertical transportation in the form of an elevator is maintained for the tourists' convenience. Combining circulation, artificial lighting, and supporting installations for presenting items or space installations can help make the museum more user-friendly [15]. Furthermore, the 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, intended only for the conservation of artifacts, but becomes a sociocultural center with diverse educational, cultural, and social functions, it is necessary to organize a number of 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 performed taking into account environmental and functional technology factors for the full implementation of modern requirements for the interactive nature of collaboration of 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, on the other hand, 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. Depending on the circulation system used, the door used to enter the circulation path varies. The circulation system is a beneficial factor that influences our perception of building form and space [18]. Hallways, corridors, stairs, elevators, escalators, ramps, bridge 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 be able to 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 important to understand the circulation that is not
following the rules and is not welcoming to visitors. Following that, it is necessary to propose a friendly design with a long-term function.

RESEARCH METHODOLOGY

The qualitative approach was used in this research, where 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 procedure uses the sequence as shown in Figure 1:

![Figure 1. The research procedure](image)

1. Data collection methods such as observation, questionnaires, and literature. At the Sangiran Museum, data is being collected using literature in order 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, were collected through observations directly. Meanwhile, a questionnaire was distributed to visitors to the Sangiran Museum to gather information about their perceptions of circulation. The secondary data comes in the form of museum working drawings or detail engineering design drawing, which will be analysed as a whole, one of them is a floor plan as look at Figure 2.
Figure 2. Floor plan of Sangiran Museum

2. Methods for data processing and analysis: Methods for analysing qualitative data used categorise. Meanwhile, one method of analysis qualitative data is to categorize 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.

3. Respondents were given structured interviews with questionnaires. The questionnaire’s goal is to determine the degree of agreement between the results of objective observation analysis and subjective evaluation data from respondents. 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.

RESULTS AND DISCUSSION

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 not only in Indonesia, but also internationally as a site capable of contributing important knowledge about the evidence of human evolution (physical change), fauna evolution, culture evolution, and environmental evolution that occurred two million years ago. UNESCO has designated the Sangiran Site as a World Cultural Heritage Site because of its values. Sangiran Site was designated as World Cultural Heritage Number 593 by UNESCO in 1996 under the name 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.

![Image of Sangiran Museum from above]

**Figure 3.** The existing of Sangiran Museum seen from the air [23]

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 for Enter the zone. A hallway connects showrooms 1, 2, and 3, and there are stairs every exit and enter the showroom as shown in Figure 4. There are three types of circulation that connect spaces and buildings, namely: vertical circulation (stairs and rams) and horizontal circulation (the hallway). Some parts of the circulation form were found to be in violation of the government's standards, as explained in the following analysis:
Rams

Figure 4. (a) There are 2 points of ram location, with 4 kinds of shape (b), (c), (d), (e)

PUPR Ministerial Decree NO. 14/PRT/M/2017 and 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. It is not recommended that the ram prefix/suffix be placed directly opposite the building’s entrance/exit.
4. Ram with non-permanent construction can be used in preserved buildings or cultural heritage buildings.

Field observations obtained ram data were shown in Figure 4: (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. The ramp for access to Sangiran is somewhat less friendly for people, especially for disabilities
people. The angle of inclination exceeds the standard 5°-6°, reaching an extreme angle of 55.5°. This is a very steep angle that is unsuitable for circulation.

**Stairs**

PUPR Ministerial Decree NO. 14/PRT/M/2017 and 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.

![Diagram of stair locations](image)

**Figure 5.** Several points of stairs

The location of the 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 10 cm, and antrade's wide 30-60 cm. Stairs that have a height < 15 cm, and 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 used at the entrance of the showroom (Figure 6.b), and to ascend to the mosque. This mosque staircase there is a landing after 20 and 26 steps. The 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).
Figure 6. The height and width of the stairs are used to categorize the shape of the stairs.

Hallway

PUPR Ministerial Decree NO. 14/PRT/M/2017 and 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.

Figure 7. Hallway position in the Sangiran Museum

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 a few 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 so it can be passed through (Figure 8.c).
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 outside 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 enter the Sangiran Museum building. Circulation paths both inside and outside the building, such as hallways, corridors, and ram components, as well as 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, taking into account the proper slope, foot size, and height of the stairs. Continued in Paragraph 1 of Article 19 explaining ram, ram is a transportation route with a specific slope and width to allow people with disabilities, building users, and building visitors access between floors. This regulation clearly states that visitors must be comfortable. If you pay attention to the questionnaire results, you will notice that there are several issues that 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 too steep. Not only do the stairs have a steep angle, but so does the ram for the disabled.

4. Experience fatigue when using stairwells with steep angles

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

The comfort of visitors appears to be overlooked in this museum. The building is only made to fulfill a technical function, where there are spaces that are needed, and there is a connecting corridor between rooms, but it does not fulfill functions in a comfortable way, 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 terms of floor configuration and colour [8], so that this ancient museum does not appear frightening. On the other hand, the museum is not educated to be self-sufficient for disabled people, as research Lase et.al. suggests [5], but rather to be pitied and in need of assistance. Even a separate room for people with disabilities is not created in conjunction with the other visitors. People with disabilities are increasingly feeling excluded and unimportant in this situation, and they are not given the opportunity to develop their self-confidence. In contrast, the museum should also serve as a social gathering place [16].

The majority of 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 with the intention of depicting the historical journey, but it fell short of its goal. According to 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 of its archaeological content, is an important cultural heritage that must be preserved. The Sangiran Site must be preserved so that all of the important values contained within it can be studied, utilized, and passed down to future generations. Efforts to preserve the Sangiran Site must continue in a variety of 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, that is the moving walk or conveyor.
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 m², but it is more appropriate for a floor area of 500 m² – 700 m². 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.

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

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

Sangiran Museum is cultural heritage that 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 not comfortable for visitors at some points.
2. There is less emphasis on the path for the disabled, both physically and mentally disabled. Several ramps have been placed at various points, but all of the available ramps are so steep that the physically disabled cannot climb the ramp on their own; they must be pushed.
3. Because the Sangiran Museum lacks a guiding block 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, as well as horizontal circulation such as hallways and corridors, must be prioritized 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 color so that people with disabilities can grow self-confidence and do things independently without needing to be assisted by others.

The sustainability of the museum’s function is largely determined by the best service for visitors, namely 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 between room or buildings, where visitors do not need to walk until they are tired, but the moving walkway or conveyor will take them to the showroom that visitors want.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest.

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