Research Article

The Influence of Shifting Media Displays on Visitor Circulation Patterns and Acoustic Environment

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Abstract.
Many exhibition spaces, such as museums, galleries, theme parks, and exhibitions, use audio-visual devices to enhance the presentation of their collections. These devices include display monitors and speakers that supplement the artifacts or content on display. The audio-visual devices can attract more visitors, but they also change visitor movement pattern and increase the ambient noise levels. How does this affect the design and experience of exhibition spaces with audio-visual elements compared to those without them? This research sought to examine the variations in visitor circulation patterns and acoustic environments across 16 museums and public exhibition spaces. The methodologies employed included photographic recording, sketches, and observational techniques for analyzing circulation patterns, alongside simple single-point acoustic measurements to assess background noise levels. The findings revealed that exhibition spaces incorporating audio-visual elements typically feature longer and more linear circulation paths to accommodate a greater number of visitors, as well as elevated background noise levels compared to spaces without such elements. This study offers valuable insights for the design of exhibition-type buildings, particularly those integrating audio-visual devices, which are anticipated to become increasingly prevalent in the future.

Keywords: exhibition hall, audio-visual, circulation, background noise levels

1. Introduction

The number of exhibition-type buildings, such as museums, galleries, theme parks, educational facilities, educational parks, planetarium, etc., are increasing, for the purpose of conservation, research, and exhibition. The collections artifacts are generally placed on pedestal or vitrine and equipped with collection identifier and visual label that contain description about the collection, with serial-linear circulation pattern for visitor [1,2]. To cope with the increasing demand for exhibition-type buildings, designers and

curators must consider various aspects of the space, such as the layout, the lighting, the signage, the accessibility, and the interactivity. The aim is to create a meaningful and engaging experience for the visitors, who can learn more about the collections and their contexts. One of the challenges is to balance the use of audio-visual content with the physical display of artifacts. Audio-visual content can enhance the understanding and appreciation of the collections, but it can also create distractions and congestion in the space. Therefore, the circulation pattern of visitors must be carefully planned and managed, to avoid overcrowding and confusion. Some possible strategies are to create multiple paths, to provide alternative modes of access [3-5].

Audio content has been used to enhance exhibitions since the 1940s, and radio-guided audio tours in galleries and museums have been experimented with since 1960 in America and Europe [6,4]. Audio content can provide more information and is easier to recall [7]. Visual content also emerged in the 1940s, especially in displaying science experiments through models. After 1970, digital technology and interactive screens enabled the combination of original artifacts, digital visuals, and audio. This combination marked the emergence of digital media that allowed visitors to interact and immerse themselves in the content [5]. Audio-visual content also made visitors stay longer in museums than traditional museums [5,8,4]. The time spent by visitors at each booth became more diverse. This diversity created the possibility of visitor queues accumulating at some booths. Therefore, exhibition planners revisited some visitor circulation patterns to supplement the linear circulation pattern. One of the circulation models that many space designers refer to is the 4 models that were proposed by Kathleen Mclean. They are radial plan, open plan, direct plan, and random plan [9]. Which circulation model between pavilions is more likely to be used in audio-visual exhibition spaces?

The acoustic and noise environment in an exhibition space with audiovisuals is a complex and dynamic phenomenon that depends on various factors, such as the design of the space, the type and number of audiovisual sources, the sound insulation and absorption properties of the materials, the background noise level, and the behaviour and preferences of the visitors. The acoustic and noise environment can affect the quality and effectiveness of the exhibition, as well as the comfort and satisfaction of the visitors. Compared to conventional exhibition spaces, exhibition spaces with audio visual elements certainly have more sources of sound. The audio-visual devices that are used for data processing visual graphics, audio, and interactive-immersive capabilities produce sound addition that are; the speaker who delivers the exhibition content,

mechanical sound of CPU. Another source of sound is the movement of visitors. All those together with the HVAC air conditioning device, have the potential to increase background noise in the interior. This can create a more immersive and engaging experience for the visitors, but it can also pose some challenges for the sound design and management. How is the acoustic and noise environment in an exhibition space with audiovisuals?

This study aims to explore the impact of audio-visual devices on the exhibition space of museums, focusing on the aspects of circulation plan and acoustic quality. The literature on this topic is scarce, so this study will contribute to the knowledge of how audio-visual devices affect the spatial configuration, visitor movement, and background noise of museums. The results of this study can provide useful insights for designing exhibition-type buildings that incorporate audio-visual facilities.

2. Methodology Research

The research method was descriptive qualitative that focusing on the field of interior design science. The data collection was done between 2016 and 2020 through field-study observations conducted in 16 exhibition facilities across various Asian Countries. These observations were conducted during the exhibition peak hours of 10:00 and 15:00 local time. In addition, the chosen exhibition facilities aimed to cover a range of topics including culture, history, science, art, and nationalities.

The researchers observed the interior elements of the exhibition booths, such as the size space, circulation model and the movement of the visitors through physical measurement, photographs, and video recordings. They also measured the background noise using a simple sound meter software application Kewlsoft instrument. The background noise in the room measured for 60 second noise levels were classified according to the NC range (Doelle, 1972) [10] as quiet (20dB-40dB), moderate (40dB-60dB), or noisy (above 60dB). The analysis of the data was based on the basic theory of interior elements [11]. The size of the exhibition spaces was categorized based on hall volume (small halls up to 200m^3, medium halls up to 900m^3, and large halls starting at 900m^3) [12] and circulation pattern or circulation model (direct plan, random plan, open plan, radial plan) [9].

TABLE 1: Sample of the study.

Conventional		Audio-visual technology (exist)	
Name of the Museum	**Location**	**Name of the Museum**	**Location**
Jakarta Museum National	Jakarta, Indonesia	Museum Listrik dan Energi Baru Taman Mini Indonesia Indah	Jakarta, Indonesia
Museum Sejarah Jakarta	Jakarta, Indonesia	Museum Pendidikan Dokter Surabaya	Surabaya, Indonesia
Museum Monumen Nasional Jakarta	Jakarta, Indonesia	Galery Indonesia Kaya Jakarta	Jakarta, Indonesia
House of Sampoerna Surabaya	Surabaya, Indonesia	Jatim Park 3 Dinopark Batu	Batu, Indonesia
Rumah Air Surabaya	Surabaya, Indonesia	National Singapore Museum	Singapore
Galery Nobel Prize Nagoya University	Nagoya, Japan	Nuwater Visitor Center Singapore	Singapore
Museum Folk Art Cen Clan Ancestral Hall Guangzhou	Guangzhou	Aichi Center for Industrial and Science Technology Japan	Japan
Macau Museum, Praceta do Museu de Macau	Macau	Sinfonia Otomation Industry Visitor Galery	Nagoya Japan

Source: (Author's Data)

3. Results and Discussion

3.1. Findings

The conventional exhibitions show the following characteristics: They are often permanent, although some of them use audio-visual elements to vary the displays. They usually occupy medium or large spaces with high ceilings. The walls serve as backgrounds for the exhibits, which are enclosed in glass cases for preservation, and accompanied by explanatory posters and labels. The lighting is bright and highlights the exhibits and posters with spotlights. The layout is mostly open plan, but the exhibits are organized in sequence. The noise level is low to moderate, as there are few sources of noise. The visitors tend to be quiet and less engaged, especially the younger ones.

Observation found different kinds of audio-visual technology in the exhibitions, such as video and interactive video displays, full theatre movies, virtual and augmented reality, mix media augmented reality, QR code content material, video 360, auditory storytellers, video mapping, games/digital simulators and mechanical games, robotic kinetic models. They found that these technologies were more common in newer museums or showrooms. Older showrooms had also added audio-visual elements, usually by changing the arrangement of interior elements. Most of the exhibitions were in medium and large hall spaces. The architectural walls were often covered

by the steering partition and vehicle boundaries. The visitor circulation patterns varied. There were fewer artifacts on display, and some of them were replaced by models. The auditory content was delivered through speakers that were placed in front of and above the visitors. The background noise was higher because of the multiple sources of sound and the diverse activities of the visitors.

The interior design reflected the change of concept. The visitors engaged in various activities such as reading, listening, playing with interactive audio-visuals, downloading content, and playing. The movement pattern was not consistent with the circulation guidelines. There were also "escape hatches" in both types of exhibited rooms. These were spaces that allowed for more relaxed activities but with a theme that matched the overall exhibition of the museum. Conventional exhibition room architecture could adapt to audio-visual exhibition rooms with adjustments to the configuration of interior elements.

TABLE 2: Observation Results at Conventional Exhibtion Facility.
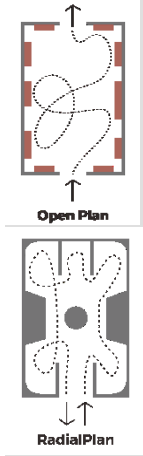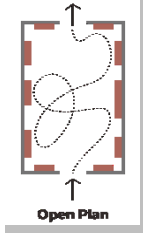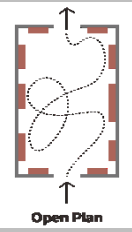
Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Jakarta Museum National	Conventional museums that are in the transformation to modern interior; Uses conventional formal display paradigm.	Large	Open Plan / RadialPlan	Low; Very quiet due to spacious area Medium; High reverberation further echoes	Carrying out the duties as a national museum of the Republic of Indonesia, a formal concept, officially implemented in a large amount of space and quality of the main material.
Museum Sejarah Jakarta	Conventional museum that uses conventional formal display paradigm; Minimum data added in collection; The number of visitors is quite a lot because of the attractive location and architecture.	Medium	Open Plan	Low and sometimes medium due to visitor steps on wood floor	Need to add lots of displays for collection information. The flow of visitors needs to be rearranged.

TABLE 2: Continued.

Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Museum Monumen Nasional Jakarta	Linear and formal layout; Display using successive dioramas; Proper interior with high quality finishing material.	Large	Open Plan	Low; Very quiet due to spacious area	A large space with the same repetitive display method does not succeed in attracting many visitors.
House of Sampoerna Surabaya	Classic modern formal interior configuration with the appropriate lighting.	Medium	Open Plan	Low and medium	The content in the material in the form of label stands is less telling much. Not equipped with ambient noise.
Rumah Air Surabaya	Fixed galleries that are relatively new, have few collections. Interior concept modern and the story model content on a large poster.	Medium	Direct Plan	Low to Medium noise depend on tour program.	Without audio-visual, noise from visitors is partially absorbed by the display partition.
Galery Nobel Prize Nagoya University	The gallery still has a modern minimalist style and focus only shows research on LED lights.	Medium	Open Plan	Low to Medium noise due to tour program and content theme.	Tranquility because without audio-visual and the arrival of visitors, many are interested in research.
Museum Folk Art Cen Clan Ancestral Hall Guangzhou	Preservation with an interior style and materially adjusting the original culture.	Medium	Open Plan	Medium noise due to semi outdoor space	Display content is displayed on a limited label.

TABLE 2: Continued.

Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Praceta do Museu de Macau	It is a National State Museum, using formal arrangement, good material.	Large	Open Plan	Low noise in low rever-beration due to medium spaces and many absorb material	Lots of collec-tions, labels and posters are proper.

Source: (Data processing)

TABLE 3: Observation Results at Audio-visual-Accompanied Exhibition Facility.
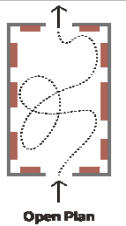
Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Museum Listrik dan Energi Baru Taman Mini Indonesia Indah	It has only just changed into a museum with lots of relying on audio-visual displays. Modern contemporary interior.	Large	Open Plan	Medium to high due to audio-visual sound and visitor density	Many audio-visual offers make visitors who most school students become interested in, but the circulation model becomes random open plan.
Museum Pen-didikan Dokter Surabaya	Modern contemporary interior. Have several display models.	Large	Direct Plan	Medium due to sound of audio-visual	Using 2 type audio-visual with high intensity noise due to high mounted space speaker.
Galery Indonesia Kaya Jakarta	Modern contemporary interior. Have several display models.	Medium	Direct Plan	Medium to high noise due to many audio-visuals used. Low rever-beration due to many absorb material used	Various audio-visual models make visitors very interested in trying and forgetting the minimal collection of objects.

TABLE 3: Continued.
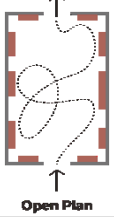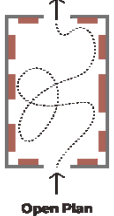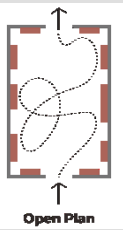
Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Jatim Park 3 Dinopark Batu	Full commercial gallery part of the tourist park. Has a variety of display and interior models.	Large	Direct Plan	Medium and mostly High noise due to many audio-visual devices used and visitor density.	High noise by audio-visual sounds, announcers, visitor movements and other mechanics, but visitors seem uninterrupted.
National Singapore Museum	The state-owned National Museum with a contemporary modern style, uses a variety of audio-visual.	Large	RadialPlan / Direct Plan	Medium to High noise due to many audio-visual devices used	The collection is not too much, but it is displayed in many stories in various ways. There is more than one model circulation based on room geometry.
Nuwater Visitor Center Singapore	Visitor center owned by a water company that focuses on educating visitors about water with a variety of display methods; Creative modern interior design.	Small and Medium	Open Plan / Direct Plan	Medium and mostly High noise due to many audio-visual devices used and visitor density. High noise in small hall.	The collection is not too much, but it is displayed in many stories in various ways. There is more than one model circulation based on room geometry.
Aichi Center for Industrial and Science Tech-nology Japan	The gallery belongs to the provincial government with many functional minimalist interior design styles in Japan.	Large	Open Plan	Medium noise due to audio-visual devices. Not too noisy because of the nature of the exhibition that focuses on science and physics.	Using many models and audio-visual to explain technology is helped by many of the original collections. Moderate noise because visitors tend to focus on studying collections.

TABLE 3: Continued.

Object	Photo & Highlight Interior Configuration	Hall Volume	Main Circulation Model	Noise level	Impression
Sinfonia Otoma-tion Industry Visitor Galery	Gallery owned by a Japanese company in technology. Modern functional minimalist interior.	Medium	Open Plan	Low and medium noise due to lack of visitor and limited use of audio-visual device.	Uses limited audio-visual and lots of original mechatronic items that is the company's products. Visitors that are invited guests tend to be calmer.

Source: (Data processing)

TABLE 4: Conclusion.

Characteristics	Conventional Exhibition	Exhibition With Audio-visual
Hall	Permanent or semi-permanent hall and partition booth. Medium or large spaces with high ceilings.	Medium or large hall spaces.Lower height ceiling.
Interior	Walls as backgrounds for exhibits in glass cases. Explanatory posters and labelsBright lighting with spotlights	Light and moveable partitions as walls.Fewer artifacts, some replaced by models.Variation of display meth-ods.Auditory content delivered through speakers.
Circulation Model	Open-plan layout with sequential organization.	Varied circulation patterns. Plus escape hatch.
Noise level	Low to moderate noise level.Quiet and less engaged visitors.	Higher noise level.More active and engaged visitors.

Source: Author (2023)

4. Conclusion

This article examines the differences between traditional and audio-visual exhibitions in terms of their features and effects. It argues that traditional exhibitions are more fixed and conservative, while audio-visual exhibitions are more flexible and innovative. It also indicates that audio-visual exhibitions can attract and engage visitors more effectively, as they provide more opportunities for sensory experience and participation. Have different patterns of visitor movement. As a result, having a higher sound level and could be a source of acoustic interference for visitor. However, this article does not assess the strengths and weaknesses of each exhibition mode, nor does it present any data or cases to support the arguments.

This article supports the opinion and development that audiovisual content can attract the audience's attention. This article also agrees with the acoustic theory about the decrease of audience focus due to the presence of multiple sound sources. Therefore, this article opens the opportunity for further research on the acoustic response of exhibition visitors due to the inevitable audiovisual content. This research also opens the opportunity for further research on the optimal exhibition space geometry to accommodate the audiovisual content.

References

[1] Farahat B, Osman KA. Towards a new vision to design a museum in historical place. HRBC Journal. Volume 14, 2018 ;66-78.

[2] Carvalho A, Garcia LM, Goncalves HJ. A multi-criteria method to assess the acoustic quality in museums. In: NOISE-CON 2014; Fort Lauderdale, Florida. 2014.

[3] Jones P, Macleod S. Museum architecture matters. Mus Soc. 2016;14(1):207–19.

[4] Tallon LW. Digital technologies and the museum experience: Handheld guides and other media. New York: Altamira Press; 2008.

[5] Smith JK, Tinio PP. Audibly engaged: Talking the walk. Digital technologies and the museum experience: Handheld guides and other media. Edited by Tallon L. and Kevin Walker K., New York: Altamira Press; 2008. pp. 63–78.

[6] Rich J. Sound, mobility and landscapes of exhibition: Radio-guided tours at the Science Museum, London, 1960–1964. Journal of Historical Geography, volume 52 April 2016. ;61-73. DOI: 10.1016/j.jhg.2016.02.010

[7] Cobussen M. Towards a "new sonic ecology". Leiden: Universiteit Leiden; 2016. Available from: https://scholarlypublications.universiteitleiden.nl/handle/1887/44578

[8] Falk JH. Identity and the museum visitor experience. New York: Routledge; 2016. DOI: 10.4324/9781315427058

[9] Mclean K. Planning for people in museum exhibition. Association of Science-Technology Centers; 1993.

[10] Doelle LL. Environmental acoustic. New York: McGraw-Hill; 1972.

[11] Ching FD. Architecture: Form, space and order. 3rd ed. Architecture John Wiley & Sons; 2007.

[12] Long M. Architectural acoustics. In Levy M, Stern R, editors. Elsevier Academic Press; 2006.