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Smart Building Application in Revitalization of Historic Buildings Case Study: The Museum Bahari, Jakarta

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KEYWORDS
Smart Building; Revitalization; Historic Building; Smart Technology; Museum Bahari

ABSTRACT
Historical buildings are cultural heritages that require preservation while adapting to modern demands. The Museum Bahari in Jakarta faces challenges in revitalizing its historical architectural elements while integrating adaptive technologies. This research examines the application of smart building systems in revitalizing the museum with minimal intervention to maintain historical integrity. A descriptive qualitative method is used, involving condition analysis, identification of smart technologies, and strategy development. Data collection includes observation, literature review, and case study analysis. Findings indicate that technologies such as humidity sensors, adaptive lighting, and environmental monitoring can enhance building performance and visitor experience without compromising heritage values. This study recommends placing devices in non-structural areas, integrating energy management with conservation needs, and using real-time monitoring systems. These strategies align with heritage conservation principles. The study concludes that smart building technology with minimal intervention offers a sustainable solution for revitalizing historic buildings like the Museum Bahari while enhancing functionality and relevance in the modern era.

Introduction

Historical buildings are an important part of cultural heritage that has high historical and symbolic value. One of the biggest challenges in the management of historic buildings is how to combine the need for preservation with ever-evolving technological advancements. One of the concepts that has developed in the field of architecture is the application of smart building systems to increase efficiency and comfort, without sacrificing the historical value and architectural character of the building (ICOMOS, 2013). Smart building refers to the application of smart technology for automatic management and control of various systems in the building, such as

lighting, temperature, humidity, and more efficient energy management (Karimi et al., 2021; Kumar et al., 2021).

The Jakarta Bahari Museum, as one of the class I historical buildings (main classification) that has centuries of age and high architectural historical value , faces great challenges in presenting modern technology without disturbing the authenticity of the existing space and architectural elements (Hildayanti, 2020; Polkinghorne et al., 2024). As a historical building located in the Jakarta port area, the Bahari Museum has an important role as a center for education and conservation of Indonesia's Bahari history (Danang, 2019; Malik, 2023). However, this building that has been hundreds of years old needs revitalization efforts so that it can continue to function properly, accommodating the needs of the times.

The revitalization of historic buildings involves not only the physical and structural maintenance of the building, but also the application of technology that can increase the value of the building itself in modern times. One of the proposed solutions is the implementation of a smart building technology system that can optimize energy management, lighting, and environmental control in buildings, while maintaining its architectural integrity. Technologies such as automatic lighting, sensor-based energy management systems, and adaptive temperature and humidity control can improve energy comfort and efficiency, and support the preservation of museum collections by regulating more stable space conditions.

However, the application of this technology must be done carefully so as not to damage the elements that have historical and aesthetic value, which is the identity of the historic building. Therefore, it is important to find the right approach so that smart building systems can be integrated into historic buildings without causing unwanted physical or aesthetic damage.

The formulation of the problem proposed in this study is how to apply the smart building technology system in efforts to revitalize historical buildings at the Jakarta Bahari Museum? The purpose of this research is to provide a combination of smart building technology system applications into historical buildings in an effort to revitalize the historical buildings of the Jakarta Bahari Museum.

Through this research, it is hoped that effective and sustainable solutions can be found to integrate modern technology in the conservation of historic buildings, while ensuring that such innovations do not reduce the historical and cultural value contained in them.

In *The Burra Charter* (2013), the term conservation was agreed upon as a term for all preservation activities, i.e. the whole process of managing a place so that the cultural significance it contains is well preserved. See table 1

Table 1. Conservation Process Type

No	Conservation Process Type
1	Change
2	Maintenance
3	Preservation
4	Restoration
5	Reconstruction
6	Adaptation and Interpretation
7	New Building / Hybrid

	Revitalization: Preserving, and Reintroducing the use of Buildings
8	Revitalization: Retaining associations and meaning
9	Interpretation

Source: The Burra Charter, 2013

In the dynamic development of the built environment, the concept of *Adaptive Reuse* emerges as a creative, sustainable solution to the challenges of maintaining architectural heritage.

In the writing of Kim Donghwan (2018), it explains that *Adaptive Reuse* is used to solve the problems of the built environment, either through the physical - non-physical addition of buildings to expand their capacity. The provision was written by Kim Donghwan. See figure 1.

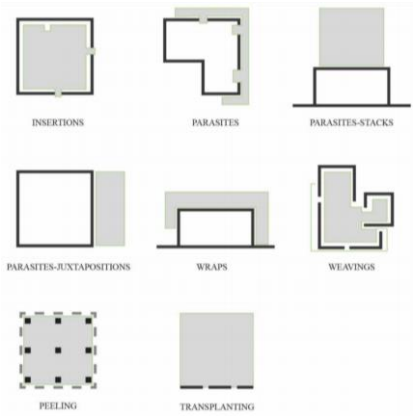

Figure 1. Adaptive Reuse Type, Bollack Analysis

Source: Kim Donghwan, 2018

Bollack's theory underlines the importance of maintaining the original character while adding new elements that work. In the context of adaptive reuse, we can compare several aspects based on the principles described by Bollack, In this context, we will compare seven aspects of adaptive reuse according to Bollack's theory: wraps, weavings, peelings, transplanting, insertions, parasites, stacks, and juxtapositions.

Then Kim Donghwan (2018), attempted to match Bollack's theory with a comparison pie chart that has points such as, facade, social, economic, energy performance, space, historical heritage, and spirit. See Figure 2.

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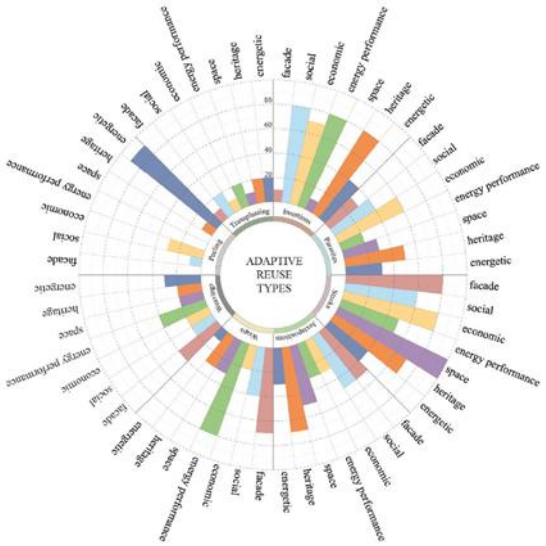


Figure 2. Comparison of Adaptive Reuse in terms of 7 Aspects with Bollack's Theory
Source: Kim Donghwan, 2018

The pie chart above has seven points with different advantages for each point, this pie chart method helps what type of adaptive reuse is suitable for the revitalization of cultural heritage buildings.

When viewed from the energy performance of the building, the types of adaptive reuse, wraps and insertion, have a very high diagram for the revitalization process of cultural heritage or historic buildings. However, the types of peeling, transplanting, and parasites have the lowest diagram.

Research Methods

The research method used is a qualitative method with a narrative descriptive approach. The collection of some data and information obtained through the research will later be analyzed and then the results can be in the form of an overview and strategy for applying the concept to the revitalization of the Bahari Museum building.

Research Stages

1) Preparation and Implementation Stage: At this stage, the primary and secondary data search process is carried out. Primary data was obtained through field observation, while secondary data was obtained through literature studies.
2) Analysis Stage: The analysis carried out includes analysis by considering regulations and mapping models to determine the adaptation of smart building systems as a design guideline.
3) Synthesis Stage: The results of field observations, literature studies, and data analysis are accumulated to determine the design concept. The principles of revitalization and conservation ethics are considered in the determination of this concept.
4) Conclusion Stage: This stage is the final result of research in the form of an overview and application of design simulations based on regulatory and design concepts.

Research Object

The object of the research is the Bahari Museum, a museum that stores collections related to the Bahari and hospitality of the Indonesian people from Sabang to Merauke which is located opposite Sunda Kelapa Port.

Research Location

Jl. Ps. Ikan No.1, RT.11/RW.4, Penjaringan, Penjaringan District, North Jakarta City, Special Capital Region of Jakarta 14440.

Data Collection Techniques

This data collection is an integral part of data analysis activities. The data collection activities in this study are by studying field documentation, literature.

Data Processing and Analysis Techniques

1) Data Reduction: defined as the selection process, focusing attention on simplifying and transforming general data that emerges from written records in the field. Reduction is carried out since data collection begins by making summaries, coding, searching themes, creating clusters, writing memos and so on, with the intention of setting aside irrelevant data/information.
2) Display Data: is a description of organized information that provides the possibility of drawing conclusions and taking actions. The presentation of qualitative data is presented in the form of narrative text. Presentation can also be in the form of matrices, diagrams, tables and charts.
3) Verification and Confirmation of Conclusions: is the final activity of data analysis. Drawing conclusions in the form of activities. interpretation, namely finding the data that has been presented. Between the data display and the drawing of conclusions, there are existing data analysis activities.

Results and Discussion

Physical Analysis of Cultural Heritage of the Bahari Museum

a) Historical Narrative of the Bahari Museum

Revitalization requires understanding and redescribing the historical construction of buildings to strengthen narratives and arguments in the physical treatment of buildings to be revitalized. See table 1.

Table 2.
Timeline of the History of the Bahari Museum

Year Period	Description
1652	The architecture of the Bahari Museum was designed by Jacques de Bollan, in the historical book Adolf Heuken.
1652-1771	The building of the Bahari Museum was built in stages and underwent many changes, the VOC built a warehousing complex in the vicinity of the port of Sunda Kelapa: on

	the west side (Westzijdsche Pakhuizen) known as the BAHARI Museum, and on the east side (Oostzijdsche Pakhuizen) known as the Spice Warehouse.
1839	Governor General Dominique Jacques de Eerens built the port traffic control tower now known as the Syahbandar Tower.
1939-1945	During the Japanese occupation, precisely during World War II, the warehouse became a logistics place for military equipment of the Dai Nippon army.
1945	After Indonesia Independence, it was used as a logistics warehouse for PLN (State Electricity Company) and PTT (Post Telephone and Telegram).
1993	The Bahari Museum according to Governor's Decree Number 475 of 1993 is an object of BCB, protected. The area of the Bahari Museum area began to be crowded with residents.
1997	The historic warehouse looks more intact after being renovated by the Jakarta Regional Government and inaugurated as a Bahari Museum on July 7, 1997 by Ali Sadikin, who at that time served as the Governor of Jakarta.
2016	There was an eviction in the area of the Bahari Museum, Fish Market, under the leadership of Governor Basuki Tjahaja Purnama, and began to be ordered.
2017	Bahari Museum on fire, in area C3 A2 A3.
2018-2022	Revitalization of the Bahari Museum.
2023 (Now)	The Bahari Museum is reopened to the public, and is still being restored at some points.

Source: Author's Analysis

b) Physical Identification of the Bahari Museum

This identification provides an in-depth understanding of the physical condition of the Bahari Museum as the initial material for analysis in the revitalization process with the adaptation of the Smart Building system. See figure 1.

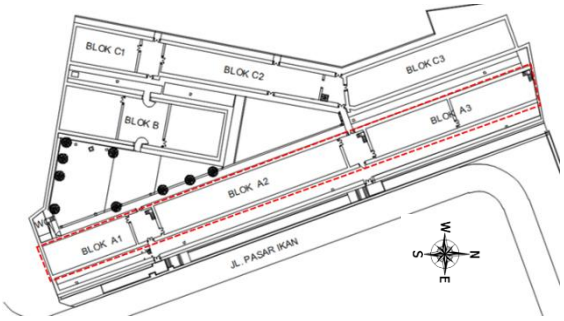


Figure 1. Bahari Museum Siteplan
Source: Author's Analysis

The Bahari Museum consists of three blocks with the same floor level (1st, 2nd, and 3rd floors/attic). After a fire in 2017 that hit blocks A3, C2, and C3, the building was reconstructed in 2018-2022 using modern materials. This study differentiates the treatment of unburned blocks (A1, A2, B, C1) from those that are reconstructed (A3, C2, C3), considering the differences in interventions on historical architectural elements. The research focuses on blocks A1, A2, and A3 as an overall representation.

Significant Value Mapping Analysis

a) Significant Assessment,

Significant assessment of cultural heritage is the process of determining the level of importance or value of a cultural site in the context of history, archaeology, or other cultural values. See table 3.

Table 3. Technical Standards for Significant Assessment

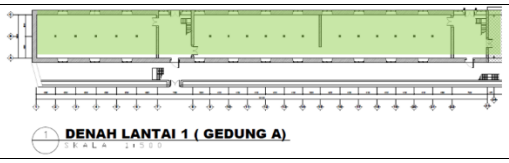
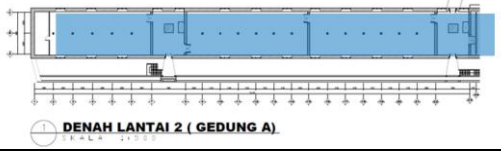
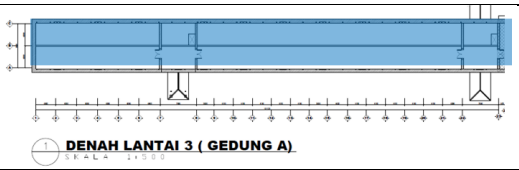
Classification (Color)	Information
Special	These components are rare items with original materials, high integrity, and are important for understanding the building as a whole.
Important	This item is important because it retains the original material, key elements, and meaning, with minimal changes.
Medium	Materials or elements of moderate significance have been modified, but are still important to the character and value of the property.
Intrusive	Intrusive elements damage the character of the property, and its elimination reduces the negative impact on its significance.

Source: Law No. 19 of 2021

b) Analysis of Mapping Elements of Historic Buildings of the Bahari Museum

This mapping allows for the integration of significant elements in conservation and revitalization plans holistically. The assessment begins with observations on the building and its relevance in conservation. See table 4.

Table 4. Technical Standards for Significant Assessment

Blok A1 & A2

This green zoning area is still possible for intervention.

Blue zoning is considered important because there is a real wooden board material from its time.

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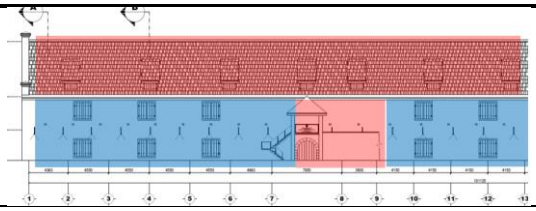
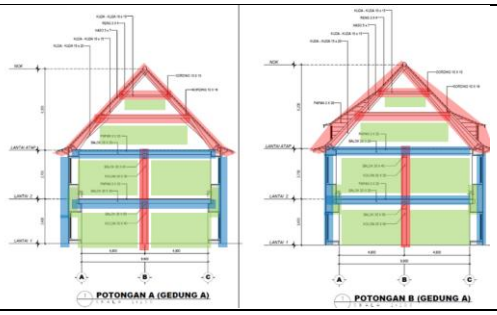
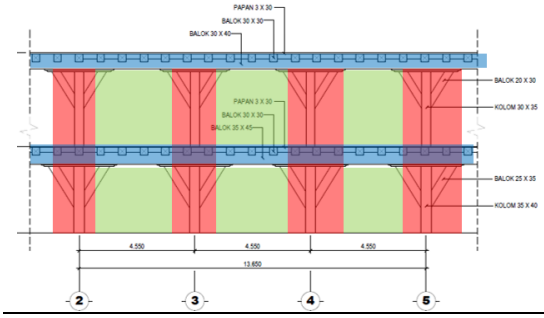


Special red zoning, classification A buildings must not be deformed. Blue zoning is important because of past characteristics.

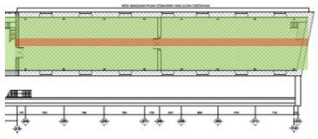


Green zoning is the outer layer of the inner wall that can be intervened for the adaptation of new functions.

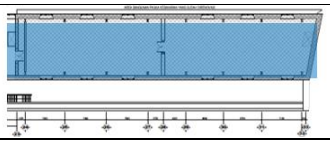


Green zoning is the outer layer of the inner wall that allows intervention for the adaptation of new functions.

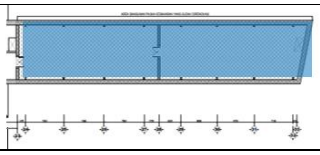
Blok A3



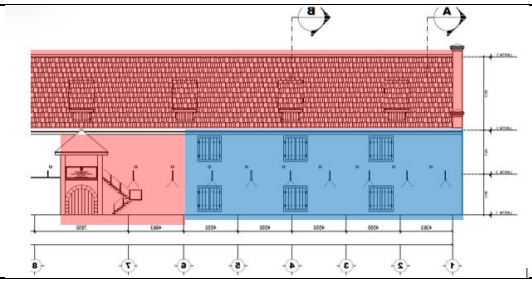
Green zoning allows for intervention, while red zoning is a row of columns of fire residue that can be defended.



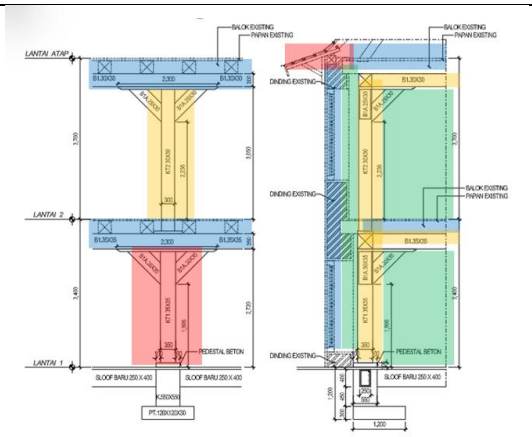
Blue zoning is important because there is real wooden plank material from its time.



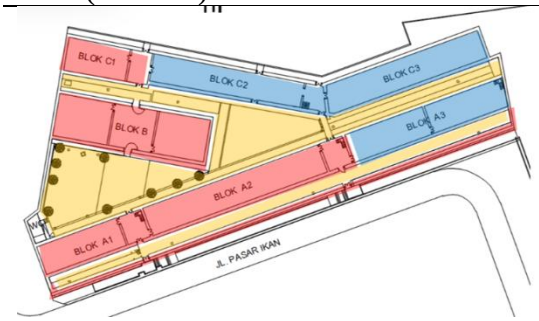
Blue zoning is important because there is real wooden plank material from its time.



Special red zoning, classification A buildings must not be deformed. Blue zoning is important because of the character of the reconstruction.



In the reconstruction area, burnt residual elements such as the easel columns (red) and the 2nd floor (blue) were retained. A new element that resembles the original shape, but with a different material (steel replaces wood), marked with an orange color (intrusive) and can be intervened.



Macro mapping of the Bahari Museum Block Area: blue for burned areas with important architectural value, red for original and special objects, the fence of the fort in front is also red, and intrusive landscape areas that can be intervened for building mechanical purposes.

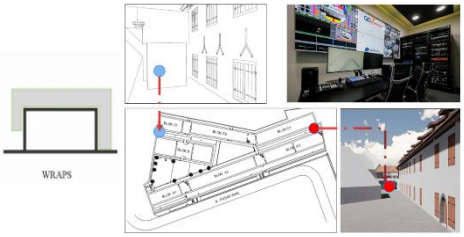
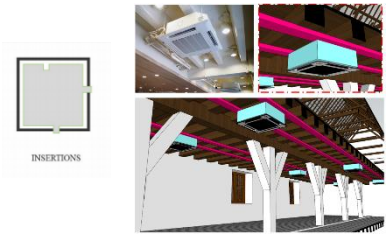
The color-coded element mapping approach provides a clear and purposeful structure in analyzing historic building elements. By determining conservation priorities (red and blue) as well

as adaptation areas (green and orange), revitalization strategies can be carried out effectively, efficiently, and while respecting the historical value of the building.

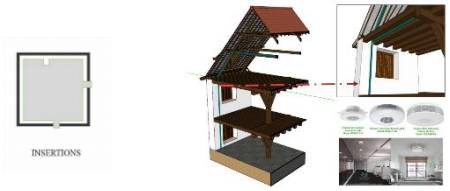
Adaptation of Smart Building Technology for Historic Buildings

After the initial analysis, the study focused on the application of smart devices to historic buildings, adapting Bollack's theory. The concept of application is limited to two types: Insertion and Wraps, which balance Heritage and Energy Performance. The analysis also considers significant assessments to preserve architectural elements of historical value. See table 5.

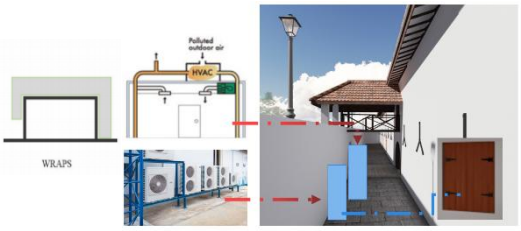
Table 5. Smart Building System Application in Revitalization of Historic Buildings,

Blok A1 & A2	
Type Adaptive Reuse	Illustration of the application of smart buildings to the historical building of the Bahari Museum
A. Basic System	
	
Smart systems require control rooms and servers. A small additional building with a simple design so as not to interfere with the visual of the cultural heritage, with façade wraps without attaching to the original building.	
B. VAC System	
	
Non-ducting air conditioning features minimal visual intervention is recommended, with additional mounts to avoid damage to architectural elements, especially on the 2nd floor beams which are blue zones.	

The roof floor must have minimal intervention to maintain the strength of the material. Floor-standing air conditioners are effective for tall rooms, with motion sensors adjusting the airflow according to the position of the visitor.



The Insertions method sticks directly to the wall in the green zone without damaging the authenticity of the brick. The installation of the roof floor follows the shape of the gusset by the method of clamping or clamp the pipe.



The Outdoor unit is placed on the ground with a mounting frame, not attached to the landscape floor to keep the material safe. Installation through the bottom window, upward distribution with careful perforation.

C. Lighting System

Small components such as switches and outlets are carefully placed on the walls of the green zone, using screws so as not to cause cracks in the material.

The lights on the 1st and 2nd floors use custom armature with closers according to the size of the beams, as little as possible perforations. Clamp case models are considered with the right installation steps.

The roof floor is recommended to use a smart lamp hanging with sensors or dimmers, considering the low intensity of use. Hanging lamp is effective for lighting from height.

D. Sistem Energi Alternatif

Alternative energy systems for solar panels are recommended for large buildings, but not in parts of the building so as not to interfere with the exterior visuals. Can be installed on landscape and road posts around the fence.

E. Sistem keamanan keselamatan api

Fire alarm and sprinkler systems should be applied with a minimum of screws, using model clamps to maintain the

originality of the building. Smoke detectors and alarms can be installed on beams or roof floors.
Blok A3
A. Lighting System "New Area”

Lighting uses the Mapping Smart System for the BAHARI Museum, with a modern model for the exhibition installation. New materials are taken into account less, while existing walls can be wrapped with installation partitions.
B. System (Opening) / Access control "New Area”

Existing windows are covered in clear acrylic to prevent cooling leaks, with visual minimal window models that can be opened as an alternative. Additional doors need to be applied with a smart system model for better protection.

Source: Author's Analysis

The above research analyzes the application of smart buildings in the revitalization of historic buildings, considers the historical value of architectural elements, and shows how cultural heritage buildings can adapt to modern technology.

Conclusion

The conclusion of this study is that the application of a smart building system in the revitalization of the Jakarta Bahari Museum can be an effective solution to integrate modern technology without damaging the historical value and architecture of the building. By dividing building elements into conservation priority categories (red and blue) as well as areas that can be adapted (green and orange), revitalization strategies can be carried out in an organized manner and in accordance with conservation principles.

The application of intelligent technology systems, such as VAC systems, adaptive lighting, alternative energy of solar panels, fire safety security systems, and automatic opening systems, is integrated into the mapped areas, while maintaining and respecting the historical and aesthetic value of the building. This approach allows for efficient and effective revitalization, while preserving architectural elements of high historical value, ensuring that the Bahari Museum remains relevant in the modern era without compromising its authenticity and identity as a historic building.

Bibliography

Arinto, F. X. E. (2018). Preservation in Architecture Based on Architectural Archetypes Through the Graphic Methods. ARTEKS : Jurnal Teknik Arsitektur, 3(1), 37–44. https://doi.org/10.30822/arteks.v3i1.52

Berawi, M. A., Yatmo, Y. A., Sari, M., Larasati, S. P., & Roberts, E. (2023). Nusantara Smart Building Guideline: Green and Digital Transformation. Nusantara Capital Authority.

Danang, T. (2019). Kuliah Umum Konservasi Museum Bahari. https://www.itb.ac.id/.

Dirdjojuwono, R. W. (2003). Buku Sistem Bangunan Pintar. Pustaka Wirausaha Muda. Indonesia.

Handayani, Y., & Harie, S. (2021). Museum Bahari Sebagai Media Pembelajaran Sejarah. Alur Sejarah: Jurnal Pendidikan Sejarah, 4(1). https://journal.lppmunindra.ac.id/index.php/alursejarah/article/view/9175

Handri, H., Taqiuddin, Z., & Huda, K. (2021). Bangunan Pintar dan Penerapannya di Indonesia. Raut: Jurnal Arsitektur Dan Perencanaan, 10(2), 40–51. 10.24815/raut.v10i2.25708

Hildayanti, A. (2020). Strategi Pelestarian Kawasan Cagar Budaya dengan Pendekatan Revitalisasi. TIMPALAJA : Architecture Student Journals, 2(1), 72-82. https://doi.org/https://doi.org/10.24252/timpalaja.v2i1a9

ICOMOS. (2013). The Burra Charter : the Australia ICOMOS charter for places of cultural significance 2013. Australia ICOMOS Incorporated.

Karimi, R., Farahzadi, L., Sepasgozar, S. M., Sargolzaei, S., Sepasgozar, S. M. E., Zareian, M., & Nasrolahi, A. (2021). Smart built environment including smart home, smart building and smart city: definitions and applied technologies. Advances and Technologies in Building Construction and Structural Analysis, 179.

Kim, D. (2018). Adaptive reuse of industrial buildings for sustainability : analysis of sustainability and social values of industrial facades [The University of Texas at Austin]. http://hdl.handle.net/2152/67980

Kumar, A., Sharma, S., Goyal, N., Singh, A., Cheng, X., & Singh, P. (2021). Secure and energy-efficient smart building architecture with emerging technology IoT. Computer Communications, 176, 207–217. https://doi.org/10.1016/j.comcom.2021.06.003

Malik, F. (2023). Aesthetics in Building The New Capital City of Indonesia: (Lesson learned from Jakarta which is 1000 years old). Proceedings of the 2nd International Seminar on Cultural Sciences of Brawijaya, ISCS 2022, 9–10 November 2022, Malang, Indonesia. https://doi.org/10.4108/eai.9-11-2022.2329443

Noaime, E., & Mashary Alnaim, M. (2023). Examining the symbolic dimension of Aleppo's historical landmarks. Alexandria Engineering Journal, 78, 292–305. https://doi.org/10.1016/j.aej.2023.07.054

Polkinghorne, M., Pearson, N., van Duivenvoorde, W., Nayati, W., Tahir, Z., Ridwan, N. N. H., Forrest, C., Tan, N. H., Popelka-Filcoff, R., Morton, C., Kowlessar, J., & Staniforth, M. (2024). Reuniting orphaned cargoes: Recovering cultural knowledge from salvaged and dispersed underwater cultural heritage in Southeast Asia. Marine Policy, 163, 106074. https://doi.org/10.1016/j.marpol.2024.106074

Wong, J. K. W., Li, H., & Wang, S. W. (2005). Intelligent building research: a review. Automation in Construction, 14(1), 143–159. https://doi.org/10.1016/j.autcon.2004.06.001