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An Application of Smart Building Concept for Historical Building Using Automatic Control System. Case Study: Fatahillah Museum

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ABSTRACT

An activity of conservation for an old historical building has become an important issue nowadays in Indonesia, particularly in Jakarta. One of the concepts is by implementing the concept of a smart building into an old historical building using a concept which could maintain economically and financially. Some old historical buildings within Jakarta have been revitalized with a new function which is known as an adaptive reused concept. Although, this concept has been regarded not effectively implemented to reduce energy consumption. To solve this problem, this research will deliver an alternative solution by introducing the application of smart building concept within an old historical building using automatic control system. This system will cover the air conditioning and lighting system within the building. This research will conduct a comparative method from some precedent studies and will use an inductive approach. At the final phase, this research will provide a solution design by simulating the using of an automatic control system within an old historical building.

Keywords: smart building, historical building, automatic control system

1. Introduction

Jakarta Old Town has been regarded as one of urban heritage in Indonesia which had the impact of globalization. One of the efforts from government to preserve and conserve all historical buildings within the area is by applying the concept of a smart building. The application of this concept is one of the initiative programs from the government to enhance and upgrade the quality of the historical building itself. One of the significant historical building within Jakarta Old Town district is Fatahillah Museum which has been known as Jakarta Historical Museum (Museum Sejarah Jakarta). Fatahillah Museum is located at Jalan Taman Fatahillah No. 1, Jakarta and had been used as City Hall for VOC in colonial era (Stadhuis van Batavia).

The local government of Jakarta has designated the building of Stadhuis as Fatahillah Museum, to preserve the existence of this historical building. By adapting new use as a museum, this building could be maintained continuously and has a sustainable memory from past for the next generation. Although, this building has a degradation of utility from time to time. To solve this problem, this research will provide an alternative solution in enhancing and upgrading the quality of Fatahillah Museum. By applying a concept of smart building for Fatahillah Museum, this building could be more comfortable and safe for the visitors. And for sure, this will impact the increasing of

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the visitors to the building. The main problem of Fatahillah Museum is the need of lighting either natural lighting or artificial lighting and the air conditioning within the building. This condition could spoil the artifacts, the paintings, the sculptures and everything in the museum. The using of both aspects (lighting and air-conditioning) could be controlled by using automatic control system. This research will provide the suitable control system for lighting and air-conditioning system. By using this control system, the energy consumption could be minimalized as well, thus could reduce the maintenance cost for Fatahillah Museum particularly and historical building generally.

2. Material and Methods

Smart Building Concept.

There are some definitions about a smart building refer to some experts, according to Cardin (1983) [1], smart building is a building which has been completed with building service control system automatically. Referring to The Intelligent Building Institution Washington (1998) [2], a smart building could be defined as a building which integrating some system to manage all resources effectively in a central coordination to maximize technical performance, investment, and to minimize operational cost and flexibility. Yang and Peng (2001) [3] has defined a smart building as a building which has a capability to learn (learning ability) and to adapt the performance with the users as well as the environment. Sinopoli (2010) [4] has determined the systems of a smart building which is involving intelligent component installation and integrated one to another. Those systems are as follow: HVAC Control, Lighting Control, Audio Visual, Video Distribution, Access Control, Data Network, Voice Network, Power Management, Video Surveillance and Fire Alarm.

According to Roestanto (2003) [5], there are some aspects that should be considered in applying a concept of a smart building. Those aspects are lighting, air conditioning, safety and fire alarm, communication, transportation, mechanical (plumbing, etc), electrical.

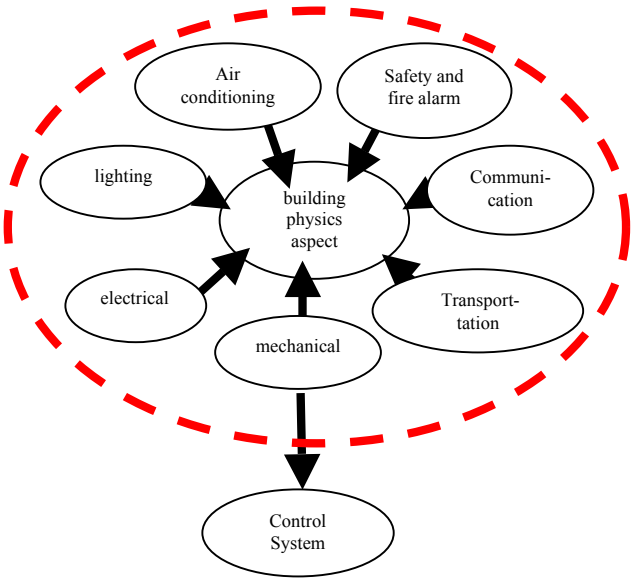

Figure 1. Aspects in Smart Building Concept
Source: Roestanto W.D, 2003 [5]

There are some differences between smart building concept and green building concept, even though both concepts is delivering some building innovation which is showing a modern technology building. According to Innovation Norway Program (2017) [6], there are some common aspects between green building concept and smart building concept, those aspects could be shown as follow:

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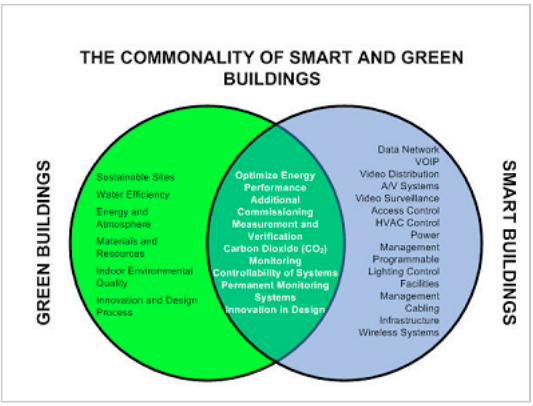

Figure 2. The Commonality between Smart Building Concept and Green Building Concept. Source: Innovation Norway Program [6], has been accessed on 20th March 2017

Historical Building

Hidayati (2009) [7] has explained that, in architecture, all kind of historical building could be related to the word of heritage which is in Indonesia could be determined as "warisan" or "pusaka". Heritage could be divided into two part, intangible (for example music, tradition, and culture) and tangible (artifact, historical sites, and historical buildings).

Sasongko (1986) [8] has underlined that historical building should be preserved and become a cultural heritage if the building has some criteria as follow:

1. **Aesthetic,** which represents particular architectural style
2. **Complexity,** which represents the building with special architectural style but could be preserved as a particular building type
3. **Special,** which represents the uniqueness of building type or as the last example of building type
4. **Historical,** which represent the historical value of the building or become a historical site of particular historical event
5. **Distinctive**, which represent the excellence and uniqueness of the era when the building was built, such as the tallest building in the world, the biggest building of the world, or the longest bridge of the world.

The above criteria has been adjusted from the PERDA DKI Jakarta No. 9/ 1999 [9], article 8 (Local Government Regulation) about Pelestarian dan Pemanfaatan Lingkungan dan Bangunan Cagar Budaya – Preservation and Environmental Utilization and Culture Building Heritage. The designation of building heritage should fulfill this below criteria:

1. History
2. Age
3. Originality
4. Specific and distinctive
5. Landmark
6. Architecture

Bahri (2015) [10] in his previous research has explained that referring to historical aspects, as well as architectural aspects, designated buildings for conservation within Jakarta Old Town Area, in particular, and within Indonesian Heritage sites, in general, can be classified into four different classes as follows:

Grade A: Historical old buildings with high architectural value. These kinds of buildings cannot be changed, added to, destroyed or rebuilt.

Grade B: Historical old buildings with a specific character of the form with good structure, creating a better environment and a harmonious living space. Buildings with this classification cannot have their main structure, main roof or facade changed. Changes can be made to the interior of the buildings, as well as some destroyed elements. However the form of the building should remain the same.

Grade C: Historical old buildings with so many changes because the condition is so bad; thus, buildings in this class can be changed and rebuilt again, however the changes should still follow the facade pattern of the

surrounded buildings. Basically, the new building should be in keeping with the context of the old one.

Grade D: Buildings with this classification are all historical old buildings which can be totally changed because the building has been destroyed and cannot be protected anymore. These buildings can be rebuilt with urban planning showing concern for the environmental scale so that works will not disturb the surrounding area.

An activity of conservation for historical old building has become an important issue nowadays in Indonesia, particularly in Jakarta. One of the concept is by implementing the concept of smart building into historical old building using a concept which could reduce the energy consumption and maintenance cost. The main problem for the building is lack of utility, this research will provide how to maintain energy by using automatic control system thus it could reduce the energy consumption.

Roestanto (2003) [5] has explained that energy manager will provide its capability for user to configure some energy system. To manage the using of lighting or air conditioning for example, it will need a lighting control which could manage the lighting as minimum as it is. Generally, Laela (2015) [11] has explained that lighting control will include switcher, dinner, sensor, and programmer. Switcher will be used to turn off and turn on the light, dimmer to control the intensity of light. Sensor will be used as a detector which is working based on user activities or could control the power of the light in the room thus the light could be turn on and turn off automatically. And the last one is programmer which will be used to control lighting in complex way, not just on or off but could control in particular condition. There are some lighting sensors that will be discussed in this paper, as follow:

1. **Passive Infra Red (PIR) System**
   This system will manage the lighting using infra red control from human. The light will be on during people inside the room. The existence of the people within the room will be detected by this system. According to Otomo and Wildian (2013) [12], this system will turn on the light automatically soon as there is a person inside the room, and will turn off the light automatically as well in while after the person leaving the room.

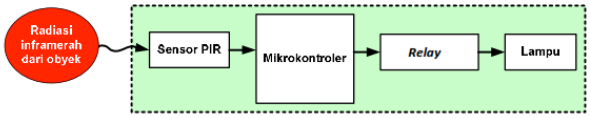

Figure 3. Diagram of Block Detector to detect the existence of an object
Source: Scientific Journal: Control System for Lighting, Galoeh Otomo and Wildian, 2013 [12]

2. **Lux Sensor System**
   This system will be used to control the intensity of the lighting in the room whether it is too dark or too light. By using this sensor, the need of the lighting could be control depend on the activity within the room. Usually, the sensor will use module sensor of lighting intensity BH1750 which is having digital lighting which produce digital signal to control the light. By using this module, it will be not necessary to use complicated formulation, because BH1750 has been regarded as an accurate tool.

3. **Motion Sensor System**
   This system usually has been plugged into ceiling with 1,25-4,00-meter high. This sensor has been used to control the movement of the user in the room which has been known as motion sensor. The light will be automatically on and off if there is particular movement in the room.

Figure 4. Motion Sensor Tool
Source: Laela (2015) [11]

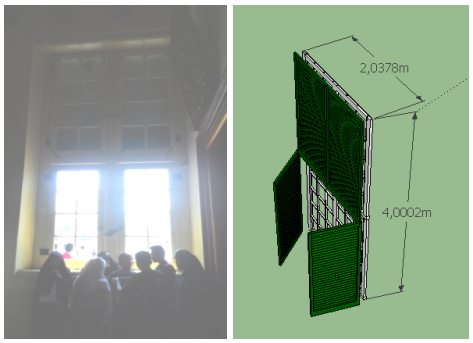

Figure 5. The Existing Condition of Lighting Intensity In The Building
Source: analysis, 2017

3. Results and Discussion

The case study has been conducted is Fatahillah Museum which is located in the area of Jakarta Old Town. The existence of this museum is become a landmark within area, because of its historical of Dutch era. This building is used to be a City Hall in Dutch era, and finally to keep the building, local government has reused the building as a museum, historical museum of Jakarta. The maintenance of this building is very high and the building is lack of utility as well. Regarding to this condition, researcher is trying to provide an alternative solution to solve this problem. There will be two steps in this research, first one is by identifying the existing condition of the building referring to the need of the light, and the second one is by providing the plan of the implementation of automatic control system within the building. This paper will cover the first step of the research.

This follow figure has shown that, the intensity of the lighting which going inside the building through the windows is quite low. All the windows are facing north-south, which is very ideal in architectural way. For the previous function as an office, the lighting of this building is ideal (about 20-100 lux), but for museum, it does not meet the standard (about 50-500 lux).

By using lux meter, it could be identified that mostly of the room have been shown a lack of lighting intensity (has been shown in red color, see figure 8). This condition will become a start point to examine how to fulfil the minimum standard of the lighting for museum. Researcher will use three systems to apply the automatic control system to solve this problem. Those systems are lux sensor, infrared sensor and motion sensor.

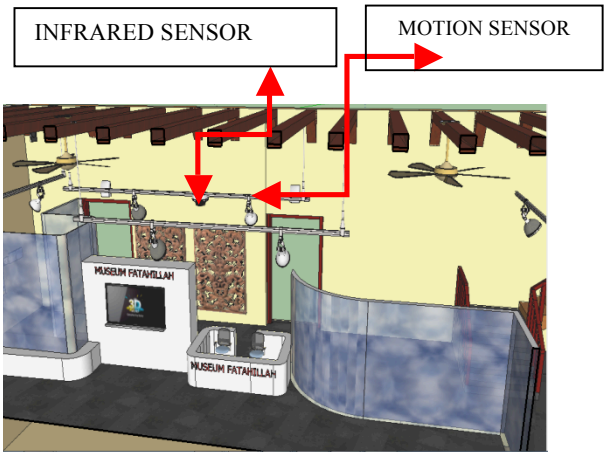

Figure 6. the layout of infra red sensor and motion sensor in the room
Source: Analysis, 2017

Usually, each room has a particular area which is significantly has many visitors, and will need more lighting to accommodate the vision of the visitors. For this reason, researcher will plan to put some motion sensor which could detect the motion of the visitors easily. To support this system, researcher plan to put lux sensor as well on the windows which could control the intensity of the lighting particularly from natural lighting.

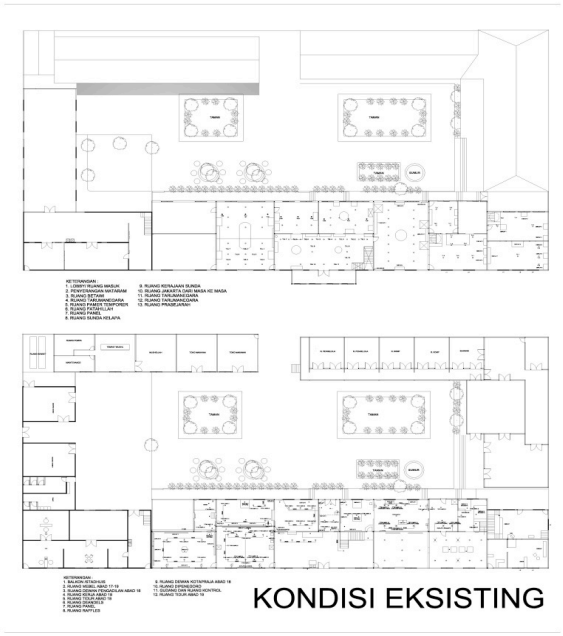

Figure 7. The layout of existing plan of Fatahillah Museum (first floor and second floor)
Source: analysis, 2017

Figure 8. the result of lighting assessment within Fatahillah Museum (first floor and second floor), which show the intensity of the lighting in each room of the building.
Source: analysis, 2017

4. Conclusion

As one of the efforts to maintain the old historical buildings within the Jakarta Old Town Area, the local government has been encouraged to deliver a concept of adaptive reuse with new functions for old historical buildings. To support this initiative, the researcher has proposed an implementation to adopt a smart building concept for the old historical building. One of the case studies is by implementing this concept for Fatahillah Museum within Jakarta Old Town Area. As a museum, Fatahillah Museum is not feasible to fulfill the standard of a museum, either for the lighting use or the temperature condition within a building. The intensity of lighting for this building is very low and not fulfill the standard of lighting for a museum.

By identifying the intensity of the lighting, the researcher could provide the minimum standard of lighting for Fatahillah Museum. And by using automatic control system for the building, the using of lighting energy could be reduced significantly. As a previous study mentioned before, the energy use for lighting could be reduced about 30-60% by using this automatic control system. In the next phase of this research, the researcher will provide the simulation of the application the automatic control system within the building of Fatahillah Museum.

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