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Historical environment conservation of Pathok Negoro mosque of Mlangi with virtual reality technology

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ABSTRACT

The historic environment is one of the national identity. It provides character to the people. *PathokNegoro* Mosque is one of the nation's identities, which is known as the only one in the world. The mosque environment is closely related to the historical footprint of the founding of Yogyakarta, a royal city in Indonesia. The built environment of the mosque is a form of defense of the Islamic kingdom in Yogyakarta. A wise political idea from Sultan Hamengkubuwana I, the first king in the Islamic kingdom in Yogyakarta. His work, which has been more than three (3) centuries old, needs to be preserved and maintained. The *PathokNegoro* Mosque of Mlangi is one of the mosques that serves as a regional defense, within the defense system of the Islamic kingdom in Yogyakarta. *Mlangi* mosque environment is a defense system that became the first center of the development of Islam in the Islamic kingdom in Yogyakarta. Maintaining the historical environment has many ways, where the environment needs to be understood holistically. In order to feel the meaning behind the empirical phenomenon, it is necessary to do documentation that can describe the atmosphere of the environment as a whole. Virtual Reality technology can be used to document, study, and disseminate tangible and intangible features from a historical environment. In this study, the techniques of initial observation and measurements for the collection of environmental data under the guidance of *Pathok Negoro* Mosque has been done regularly. Making 3D images of PathokNegoro Yogyakarta mosque environment is done using Auto CAD, Sketchup, and Unity 3D software. The result is to get a digital picture of the artificial environment, including the atmosphere. Physical data is equipped with historical information on the environment. The purpose of this study is to obtain a picture of the real conditions and atmosphere of the Pathok Negoro mosque of *Mlangi*. Conservation of the artificial environment is an effort to maintain the existence of the work of the architect's predecessor, as an identity that is expected to be enjoyed from time to time, as a national historical document. Besides, this study seeks to explain the process or steps of making virtual reality applications and the problems encountered during manufacturing. This study uses applicative research methods from the Virtual Reality program. The research objects was arranged in the form of physical data, which are redrawn in two and three dimensions (2D and 3D) to include in the program. The results of this study are in the form of Virtual Reality Applications that can show an artificial environment with an immersive, interactive, insightful, and high level of imagination from the environmental research objects of the Pathok Negoro Mosque of *Mlangi*.

Key words : *Conservation, Environment, History, Virtual reality*

Introduction

The historical environment and architecture of the building

Our nation's architectural works have begun since pre-Islamic times to the present. Recently, pre-Islamic, Islamic culture, and traditions produce much real work in their environment. The works of architecture including the artificial environment became one of the traces of our nation's history(Handinoto 2010).

Architectural and artificial work produced during pre-Islamic and Islamic times has hundreds of years old. Every architectural work has a real concept. These concepts form architectural works into a specific, meaningful artificial environment.

Javanese architecture buildings build with Javanese concepts. Among the use of dimensions and sizes of buildings and materials that use the size of human body parts, such as hands, feet, hand reach, foot reach, and et cetera (Fatimah, 2015). Commonly, the site uses the size of the founder's human body. Thus, that one building with another building will have different sizes, even though the units are the same, forming the diversity of Javanese buildings. This diversity is the local content and contains specific meanings.

The meaning is not only read from the physical condition of the artificial environment, but also the atmosphere, aura, climate, social culture of the community, the religious system, and others that are not measurably visible as part of the artificial environment (Antariksa, 2009).

The mosque is one of the artificial environments that functions as a religious building and is part of architectural work. A mosque is a place/building for prostration, which is establishing one's prayer service/congregation. The mosque is a place to meet and strengthen relationships (*silaturrahim*), especially fellow Muslims, such as: meeting each other/shaking hands, asking each other's condition, listening to lectures, and discussing to increase understanding of religion and practice in daily life.

Prayer can be done anywhere on earth as in the open field in the presence of good weather. *Saheeh* Muslim: 315 and Bukhari 323, stated that the conditions for the Prayer are clean (holy) from dirt and unclean, facing the *Qiblat*, starting prayer time and not above the grave.

The mosque is an artificial environment/building (large space), to carry out worship (prayer) in congregation, listen to lectures (knowledge) about religion, and Friday sermons.

Among several propositions about the mosque, from several hadiths one of them, which is narrated by Bukhari [323]: From Jabir bin Abdillah, Rasulullah*sallallaahu 'alayhiwasallam* said:

"I was given five things that were not given to anyone before me: ……, the earth was made for me as a mosque and holy, anyone of my people who encounter prayer times then pray."

Some mosques in the world are buildings that have historical value as well as features in terms of architecture, sound, air, and lighting. The mosque building is closely related to construction technology and historical value. The phenomenon that occurs lately shows that there is a tendency of some people; the physical form of the mosque is likened so that local wisdom is lost. Though the main characteristics of the mosque are: leading *Qiblat*, there is a place of prayer, there is a place where the imam leads the prayer, there is a *Khutbah* and gives lectures, a place of ablution (clean/holy) with supporting parts that must follow specific provisions, so that anyone (visitors) who come to the mosque and from anywhere, feels "comfortable" to worship, listen to sermons and lectures.

In Indonesia, the names of the mosques distinguished according to their categories, including the Grand Mosque, the Gedhe Mosque, the *Musajik* Mosque, the Jami Mosque, the Great Mosque, Surau, Meunasah, Langgar, and Musalla (Mushalla). The form of the mosque at the time of the Prophet, the Caliph period, after the Caliph and now, received a legacy of local building concepts..

QubaMosque during the Caliph, continued to the mosques now; in fact, it has experienced changes following the development of the number of worshipers and science. Furthermore, some parts of the mosque building are there, and some people say "heresy." Whereas, all of these parts are the development of the number of worshipers, because of the development of technology/science to obtain comfort in the mosque and its geographical location on the surface of the earth (Bhakat, 2019).

The *Pathok* Negoro Mlangi Mosque is one of the Javanese Islamic mosque. Build in 1774. The mosque's building is still known today. The *Pathok* Negoro Mlangi Mosque, in its history has changed several times in the form and architecture of the building. Changes occur related to the political situ-

ation in the Yogyakarta region(C.D.A. Depari 2013). The mosquewas built during the reign of Sultan Hamengku Buwana I, has an extraordinary concept and philosophy. Aside from the mosque as a place of worship, it also functions as the boundary and peripheral of the Mataram Islamic kingdom in Yogyakarta. This mosque is part of the political strategy of Sultan Hamengku Buwana I, the first king in the Islamic kingdom in Yogyakarta, Indonesia.

The mosque's environment was built to defend the country from Dutch colonialism at that time. Its physical appearance in Javanese architecture shows the philosophical meaning of the triumph of the Islamic Mataram kingdom in Yogyakarta. The mosque as a form of embodiment of Islam is manifested in a strategic concept of statehood, based on consideration of the security situation at that time.

Parts of the Pathok Negoro mosque, including the Mlangi Mosque, are designed with concepts and have specific meanings. For example, the existence of a pool that is around the porch building has a particular meaning from the design concept. The use of the main structure called Sokoguru has concepts and meanings. The use of a two-tiered Tajug roof and the appearance of the building as well as the atmosphere created in the main part of the building, the foyer, the hallway, and the courtyard of the mosque have defined concepts and meanings. The mosque environment that formed with buildings and local climatic conditions forms a specific built environment.

The *Pathok Negoro Mlangi* Mosque, as a historical building is inseparable from the development of its community, which continues to develop following the development of the era, science, and technology.

The younger generation who do not understand the existence of the Pathok Negoro Mlangi mosque as a historical building with a high philosophical value is feared to have a different understanding from the initial concept of its establishment.

Efforts are needed to maintain the existence of this historic mosque and efforts to maintain understanding of the Pathok Negoro Mlangi mosque concept and its architectural environment.

To be able to appreciate the condition and atmosphere of the Pathok Negoro Mlangi mosque as one of the historical buildings that have meaning and philosophy for the Indonesian people, it takes experience to be able to see and feel the atmosphere at the Pathok Negoro Mlangi mosque. The physical documentation that has been made so far has been unable to fulfill the purpose of understanding. Virtual Reality Technology is one of the technologies that allow computers to simulate a virtual environment that can interact with users in real-time and continuously. Not like other simulation technologies that only rely on interaction through monitors and input devices such as mice and keyboards. Virtual Reality brings a better experience to the user as if the user is in the virtual environment. Virtual Reality combines human senses such as vision, hearing, touch and also smell whichare incorporated in a 3D virtual world. The application of Virtual Reality technology has now penetrated various disciplines and fields such as education or education, health, Military, Psychology, and also Entertainment.

In this study, Virtual Reality is used as a medium to educate the general public and especially young people to get to know the environment and historical buildings that are the nation's wealth. Through this technology, the 3D virtual environment will simulate the state of the built environment of the Java mosque and invites users to interact directly with the virtual environment. The Virtual Reality system will display and reintroduce the structure of the building and its environment as historic heaps. Documentation in the form of photos, videos, and other written documents has not yet reached a comprehensive understanding.

By utilizing technological advances, identification, conservation, and preservation of historic buildings that have meaning, philosophy, and meaning of the built environment architecture in Indonesia can be conducted using Virtual Reality technology.

How Virtual Reality works

Virtual Reality (VR) technology is a way of virtual reality in an artificial environment object. VR is also used to provide the experience of feeling simulation in a built environment, which is usually not reached as a whole when visitors come directly to the environment.

Virtual Reality Technology is an effort to document historic buildings by documenting all parts of the building and its environment, both physical and atmosphere so that it can be read and felt like a whole the parts of the building and its environment. Readers can have a visual and physical experience,

even can feel and see the reconstruction of buildings or parts of the building that have been damaged, replaced, or changed to the atmosphere and views that should be under the conditions of the building concept.

Virtual Reality technology used in the conservation efforts of the Pathok Negoro Mlangi mosque building. Intangible factor conservation by planning programs using Virtual Reality technology. This technology is designed not only to be able to see the physical building but also to understand the apparent meaning displayed in 3 dimensions. Virtual Reality, in general, is a simulation that are raised through the device, with computer or smartphone media.

Virtual Reality according to Mihelj (Mihelj *et al*., 2014) is an artificial environmental concept with a high level of immersive, interactive, insightful, and imagined, that is by replicating the environment and the ability of the five human senses, so that virtual reality users can interact with objects in the built environment.

The role of the Virtual Reality program is as a non-physical effort, an effort to preserve the environment for researchers and promotion for tourists where later they can learn accurately and enjoy the meaning of space experience through 3-dimensional visuals. This model is suitable to be used to introduce historical buildings in the era of the technology-milineal era.

Efforts to preserve the built environment in a non-physical way using virtual reality technology was conducted. Yang *et al.,* (2015) conducted a study evaluating digital technology as a digital preservation tool for historic buildings in China. Who took the study of Taipei Xia Hai City God Temple building along with *dougong*, which is the traditional Chinese wooden structure connection technique. Yang and the team conducted several digital preservation methods using Virtual Reality, Augmented Reality, and Digital Scanning technology. Ramzi Hassan (2013), along with a team of historians, archeologists, and architects, reconstructed the ruins identified as the Hisham kingdom complex in Jericho Palestine in the Ummayad period beginning in the 8th century. The simulation shows its reconstruction in the form of a 3-dimensional environment with a middle eastern desert atmosphere, where users can see the type of material, interacting by walking around the park kingdom to enter the royal chamber.

According to Ramzi Hassan (2016), researchers from NMBU who presented VR technology innovations at the UN seminar titled peace in the middle east, said that this technology can be used as an experimental tool that supports the investigation and documentation of preservation and conservation processes, while increasing the sensitivity of the public of historical sites and easier to understand.

The strategy to maintain the environment created by the Pathok Negoro Mlangi mosque was physically conducter by analyzing the building's parts and circumference. Strengthening is done by analyzing the forces that occur in buildings and their effects on building structures and materials.

The structure of the building is one of the objects of research. The structure of the mosque building is determined by considerations of local conditions at the time of its construction (Figure 1). Therefore, planning and formulating strategies for building sustainability is a pretty consistent effort.

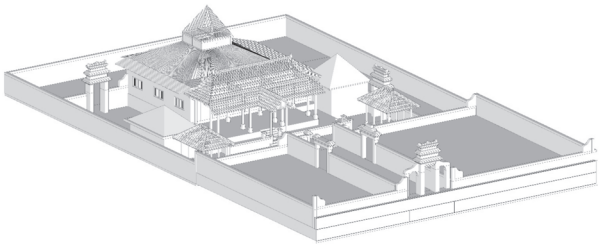

Fig. 1. An example of a description of the structure of a building in the process of the Virtual Reality program
Source: redrawn from field data results

The application system flowchart has several stages in the form of continuous processes. In this section, a flowchart is made to clarify the stages or processes contained in the application (Fig. 2).

Problem

When people visit the artificial environment, often,

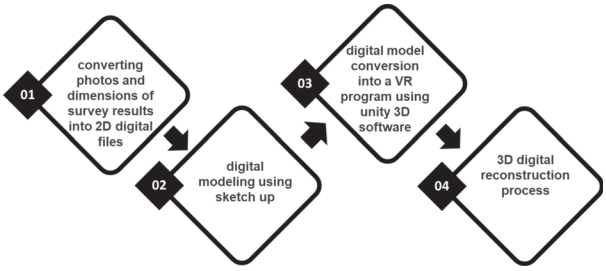

Fig. 2. Outline of the application
Source: Research er, 2018

the environmental conditions cannot be recorded maximally. Among the building structures that cannot be seen directly. Because the part was covered with building cover material, the history of changes and ruins of buildings, changes in the visual environment and so forth. Limited time cannot record the condition of the built environment as a whole.

Virtual Reality (VR) application aims to facilitate people who want to learn more about the condition of the built environment at the Pathok Negoro Mlangi Mosque. In this case, the object of observation can be seen virtually.

VR technology is not widely known by our society. The application of VR technology in the preservation of the Pathok Negoro Mlangi Mosque building needs to process in such a way that all levels of society can use it easily.

The research question, how is the process of making a conservation program using a digital virtual reality program

Research Objectives and Objectives

Creating a Virtual Reality application program for the conservation of historical buildings with the case of the Pathok Negoro Mlangi Mosque in Yogyakarta, with engineered technology. Resulting in building conservation techniques that are quickly operational and reach the expected goals and targets.

Significance of the Study

Assisting in the conservation program of building preservation and built environment in Yogyakarta, Indonesia, as a comprehensive document. Both physical documents and atmosphere documents. Research location and research object

1. Research location

Research location in Yogyakarta, Indonesia. The *Pathok Negoro* Mosque is a political configuration of the Yogyakarta Sultanate. The *Pathok Negoro* Mosque consists of five buildings, which are manifestations of Javanese and Hindu concepts called Mancapat. The *Pathok Negoro* Mosquewas located in strategic locations in the pattern of political governance of the Yogyakarta Sultanate.

2. Research objects

The *Pathok Negoro* Mosque Mlangi as part of the Pathok Negoro Mosque, which functions as a regional defense in the Islamic kingdom in Yogyakarta, Indonesia.

Preservation Program

Preservation is an activity to preserve something for a specific purpose. Preservation activities can be interpreted as caring or maintaining, and rebuild or rebuild (Budiarto *et al.,* 2016). Hence, preservation can be interpreted as preserving an object, either by taking care, if the object is still intact in its original way, or rebuilding the object, if the object has been damaged or completely lost. Preservation, which are all elements of management, finance, storage, assistive devices, labor, and methods used to preserve library materials, documentation, archives, and the information they contain.

According to Lasa HS (H.S. 2009) in the Indonesian Librarian Dictionary, Conservation can be interpreted as 1) policies and activities that include protecting library materials from damage. This activity includes the methods and techniques used and conducted by technicians. Conservation activities that are usually conduction are densification, incapsulation, or lamination, making micro films, storage in digital or electronic form; 2) use of chemical or physical procedures in library maintenance and storage to ensure library durability.

Preservation aims to preserve the information contained in order to maintain its integrity while conservation or preservation is more to the means or techniques, processes and methods used to protect from being easily damaged.

Purpose of Preservation and Conservation

The purpose of preservation is to make an object, usually of high historical value, to remain as it is to serve as lessons, references, and study material of historical value. Some principles according to Cohen (Cohen, 2001) that become the background of preservation and conservation activities are:

1. Finding or obtaining Physical Identity from the Region (Physical Identity of Environment).
2. Finding or getting a Sense of Place. Historical heritage is the only thing that connects with the past and connects us to a specific place.
3. Finding or getting the value of History (The Historical Values of the City District). In the course of the nation's history, there are important events to be remembered, respected, and understood by the community. Activities to preserve the environment and historical value buildings that are part of the history of the past.

4. Increasing the Value of Architecture in Buildings and Regions or the Environment. Maintaining the environment and historical buildings and because of its intrinsic value as a work of art in which there are high achievements in the arts, including beauty.
5. Increasing economic benefits. Existing buildings, especially those that have historical value often have economic advantages. Empirically it shows that utilizing existing buildings is often cheaper than building new buildings.
6. The generator of Tourism and Recreation activities. The unique historical value of a place or region can be an attraction for tourism activities and attract it to the place.
7. Source of Inspiration (Place of Inspiration). In many historic buildings and environments, it will be associate with a sense of patriotism and the value of nationalism as well as significant events in the past.
8. Increasing value. Education or Education in the Community. Through buildings and historical environments as artifacts basically can complete written documents about the past to commemorate certain events or events in the past.

Virtual Reality Technology

The first thing to do in the process of making an application is a visit to the research location, in this case, the Pathok Negoro Mlangi Mosque, to determine the shape and position of the object, so it expected that the results displayed can resemble the original conditions. 3D objects and their textures are created using the Blender application so they can import into the application created. The provision of collision features aims to prevent users from penetrating objects. The position, shape, and object contained in the application resemble the original state contained at the factory location. The main obstacle in making this application is the time of manufacture, so it cannot make a detailed factory map. The main building, stage, and warehouse have been created, only small objects contained in the main building have not been able to complete.

Mihelj (Mihelj *et al.,* 2014) in his book "Virtual Reality: Technology and Application" said that Virtual Reality is an interactive computer simulation that uses one or more devices like sensors to replace the human senses with the aim of users dissolving into the virtual environment (virtual environment) (Fig. 3).

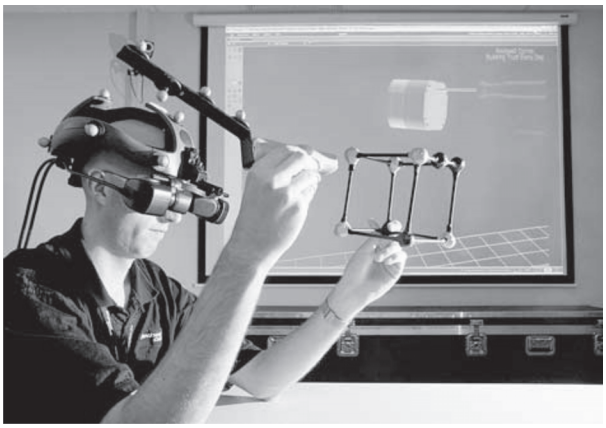

Fig. 3. Virtual Reality Simulation Users
Source: https://sites.google.com/site/virtual reality introtonewmedia/vr-education (2015)

Virtual Reality is a technology created so that users can interact with an environment that is simulated by a computer (Virtual Design Environment), an actual environment that is emulated or really an environment that only exists in imagination. Simply, Virtual Reality is the appearance of three-dimensional images generated by a computer, which looks real with the help of certain equipment. The most important feature is that by using a device designed for a specific purpose, this technology is able to make people who feel the virtual environment fooled and believe that what they experience is real. Some of the most common Virtual Reality devices are:

1. Joysticks or gamepad
2. Force balls or tracking balls
3. Controller wands
4. Data gloves
5. Voice recognition
6. Motion trackers or bodysuits
7. Treadmills

Virtual Reality in the Preservation and Conservation of Historical buildings

Developed countries like Europe have used Virtual-Reality technology for various purposes, including the preservation of historic buildings. Even the development is very rapid for the tourism sector (Guttentag, 2010).

One example of a city that successfully utilizes Virtual Reality technology for the preservation of its historic buildings is the city of Cluny in France. Cluny is known as a medieval Roman city that has an essential site for Europe and is protected by

UNESCO. Funded by the European consortium and UNESCO, they designed a scenario that would allow anyone to project themselves in Cluny's history virtually. Cluny Abbaye is the largest cathedral in 11th-century Europe, which was largely destroyed by the bombing of World War II. At present, for research involving public participation and at the same time for tourism several screens are installed on the site, facing the object represented. It works like presenting a lost historical fragment with the concept of confrontation between the past and present. Several points of view of buildings and areas of the city that have been destroyed or changed over time, through this screen can returne to the original decoration (Fig. 4).

Fig. 4. Some historical objects in France that are realized in the Virtual-Reality model (Visualization tools can be in the form of Immersive space, panoramic screens, cellphones, or tablets)
Source: TerraDynamica, (2011)

Research methods

The method used in this research is the application of virtual reality programs in the process of documenting the historic built environment. This research divide into three (3) stages of discussion. Stage 1 is the preparation stage, which is conducted preparatory activities in the form of a literature study of the Pathok Negoro Mlangi Mosque building. Conducted through field observations in the form of data collection measurements and taking photographs in the Pathok Negoro Mlangi Mosque complex which is done several times to get the required data completeness.

Stage 2 is the analysis phase, analyzing in order to devise a strategy in maintaining the existence of a building. In this step, a review of literature related to approaches and theories is conducted to produce an analytical framework that is ready to be used to read, analyze, interpret and conclude strategies for maintaining buildings. Stage 3 is the synthesis stage, formulating an analytical framework for developing building defense strategies, related to the built environment and strategies for maintaining building structures.

The Flow of Thought of Research

By the objectives and research outcomes to obtain a strategy model to maintain the Pathok Negoro Mlangi mosque building, as part of the defense form of the Islamic kingdom in Yogyakarta, Indonesia, the strategic steps are prepared as a method and the flow of thought in this study, as follows

1. The first step

The first step is to outline the background of the Pathok Negoro mosque. Current conditions, the significance of the mosque for the Islamic kingdom in Yogyakarta. A historical search of Pathok Negoro Mlangi mosque needs to be conducted in-depth to get the conditions and atmosphere of the built environment by the concept of building it. From the results of a historical search will found whether there is a change in the physical and non-physical environment for virtual reconstruction of 3 dimensions.

2. Second step

Formulate research objectives based on background. In this step, the need for accurate data from the history of the mosque.

3. Third step

Build an analytical framework to develop strategies for maintaining the existence of buildings. In this step, a review of literature related to approaches and theories is conducted to produce an analytical framework that is ready to be used to read, analyze, interpret, and conclude strategies for maintaining buildings. On the part of the structure of the building, analysis of the load and force occurs, so that it can find the meaning of the building structure. Thus, it will be easier to take steps to maintain the building physically.

4. The fourth step

By the research objectives to obtain a strategy to maintain the building, then in every building architectural characteristics, structures, and meanings must be found in the building.

5. Step five

Form an analytical framework for developing building defense strategies, with the application of virtual reality programs.

Research Implementation

The study begins by outlining the background of the PathokNegoro mosque as a whole, the current conditions in the Pathok Negoro Mlangi mosque, the significance of the Islamic royal mosque in Yogyakarta. Furthermore, the search for the history of the Pathok Negoro Mlangi mosque needs to be done in-depth to get the condition and atmosphere of the mosque by the concept of building it. From the results of history tracing will find whether there is a change in the physical and environmental buildings for reconstruction of virtual three dimensions.

Data Collection of Pathok Negoro Mlangi Mosque

Data collection activities conducted with surveys and literature studies. The survey results in the form of photographs and dimensions of the mosque size. In the study of literature, a study of literature related to the approach and history was conducted to produce a collection of information and understanding to use as a basis for analyzing, interpreting, and summarizing the architectural characteristics of the building and environment of the *Pathok Negoro Mlangi* mosque.

Digital Reconstruction and VR Computer Program

The digital reconstruction process can be conducted after the mosque, and environment data are obtained. There are at least three steps that must be taken to carry out digital reconstruction and VR computer programs as follows (Guttentag, 2010).

1. The first step

The first step is the conversion of photos and dimensions of the survey results into a 2D digital file created using AutoCAD. This step is the initial stage of interpretation of the size and material of the mosque. This stage obtained an initial description of the size and photograph of the mosque's material

2. Second step

The second step is the interpretation of the scale of the 3D model. Digital modeling using Sketchup software. The results of this stage are digital models that are complete with size and material.

3. Third step

The third step is the conversion of digital models into virtual reality programs using Unity3D software along with the creation of an interface design that will use. This stage is the final stage of the 3-dimensional digital reconstruction process. This step changes the results of the model from Sketchup into an application program complete with image and sound features.

In the analysis of the built environment, in this case, the *Pathok Negara Mlangi* mosque building, divided into parts of the building called the head section, consisting of the roof and its construction, the body part, consisting of columns, walls and floors, and the foot part of the building foundation

Research Result

Start from the depiction in 2 dimensions of the building and environment, followed by depictionof 3 dimensions of the building and environment. The result is in the Figs. 5-11.

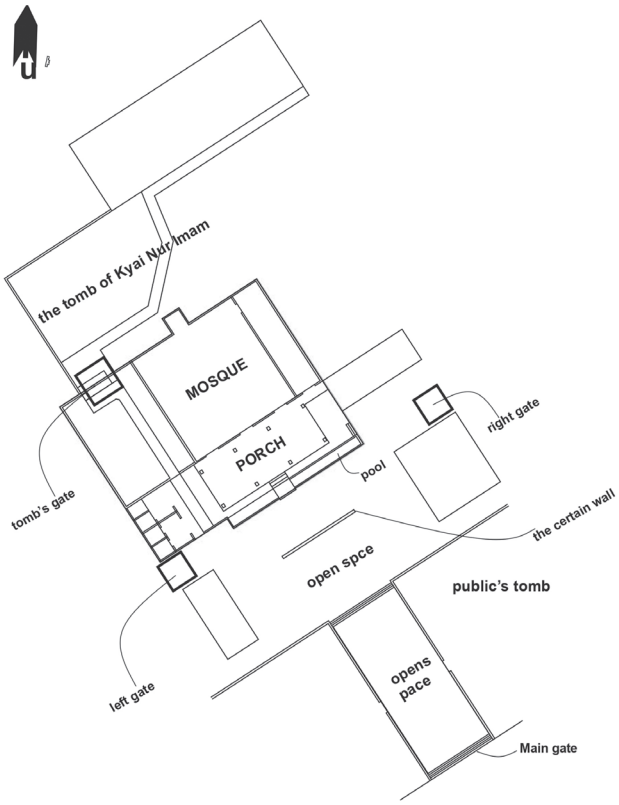

Fig. 5. Floor plan picture of Pathok Negoro Mlangi environtment
Source: Analysis process

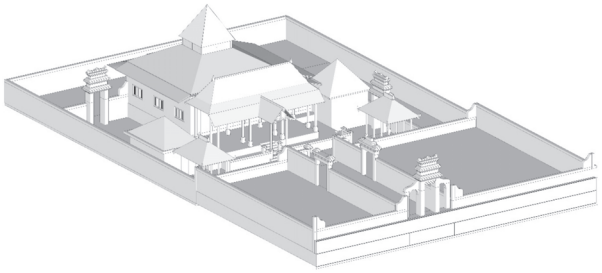

Fig. 6. A picture of the Pathok Negoro Mlangi mosque
Source: Analysis process

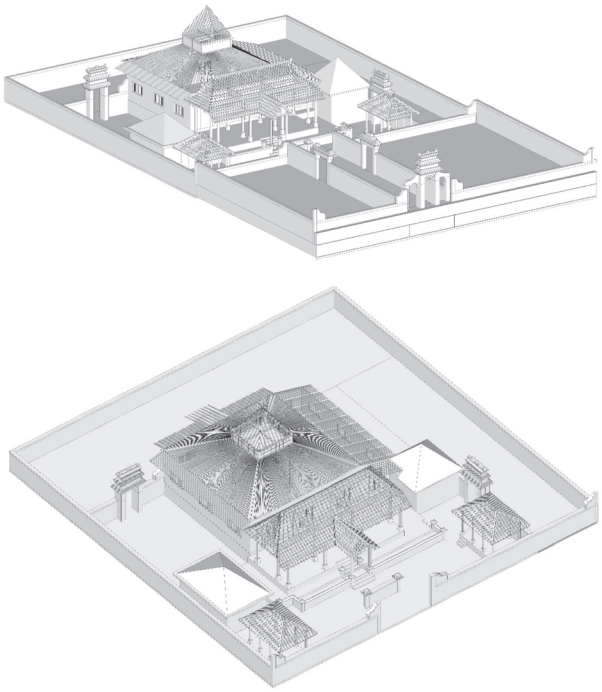

Fig. 7. 3D picture of structure building Pathok Negoro Mlangi mosque
Source: Analysis process

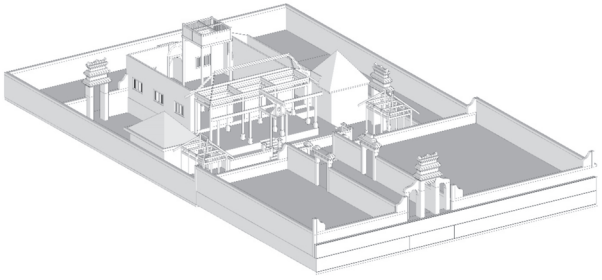

Fig. 8. 3D image of lay out of Pathok Negoro Mlangi mosque
Source: Analysis process

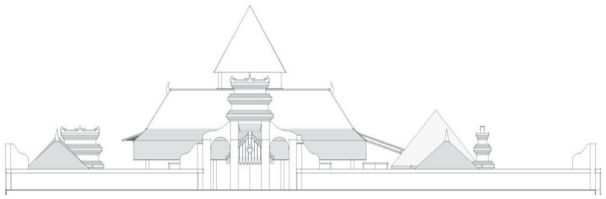

Fig. 9. The picture looks 2D of Pathok Negoro Mlangi environment
Source: Analysis process

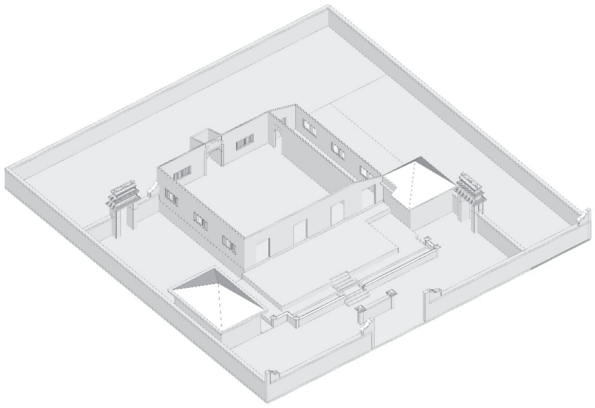

Fig. 10. 3D picture of special space of Pathok Negoro Mlangi environtment
Source: Analysis process

Fig. 11. Looks of sketch up picture of Pathok Negoro Mlangi mosque
Source: Analysis process

Results of the process of image visualization of the environment with Virtual Reality

Figure 12-14 were resulted of the analysis process.

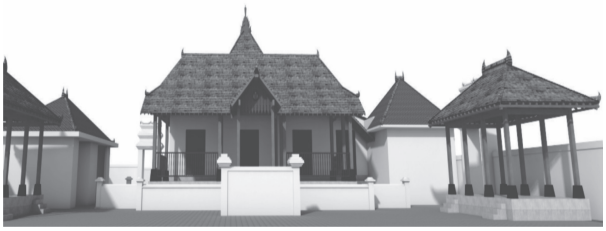

Fig. 12. Rendering image of Pathok Negoro Mlangi environment
Source: Analysis process

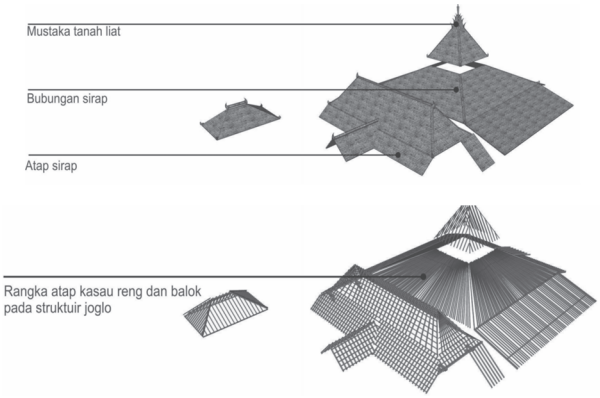

Fig. 13. Explodametries structure of Pathok Negoro Mlangi mosque. *Source:* Analysis process

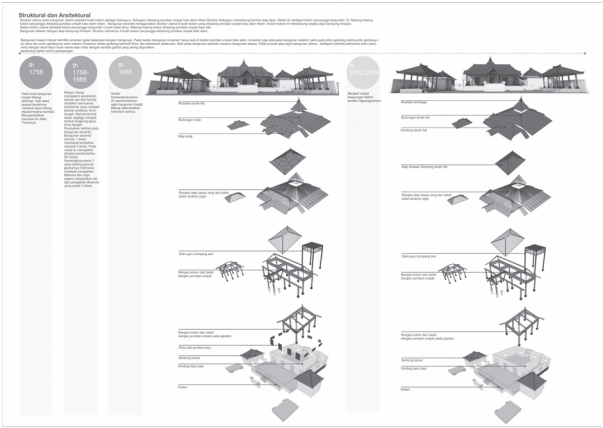

Fig. 14. Processing result of digital Virtual Reality *Source:* Analysis Process

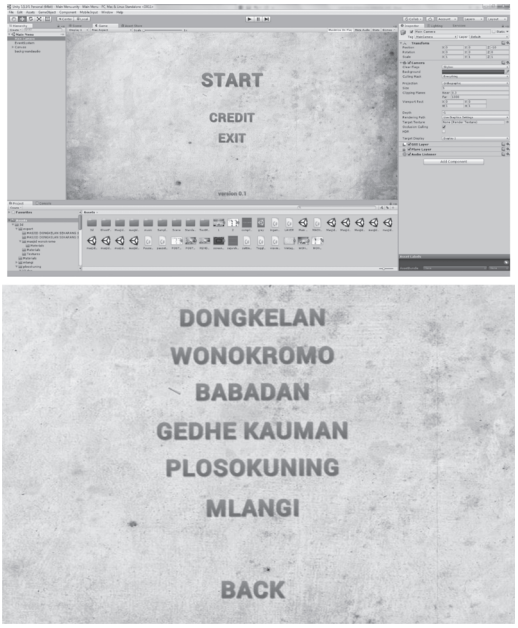

Fig. 15. Step on operational of Virtual Reality *Source:* (Setyawati *et al.* 2019)

Fig. 16. Example of result on the first page ini Virtual Reality programs
Source: Result Researches

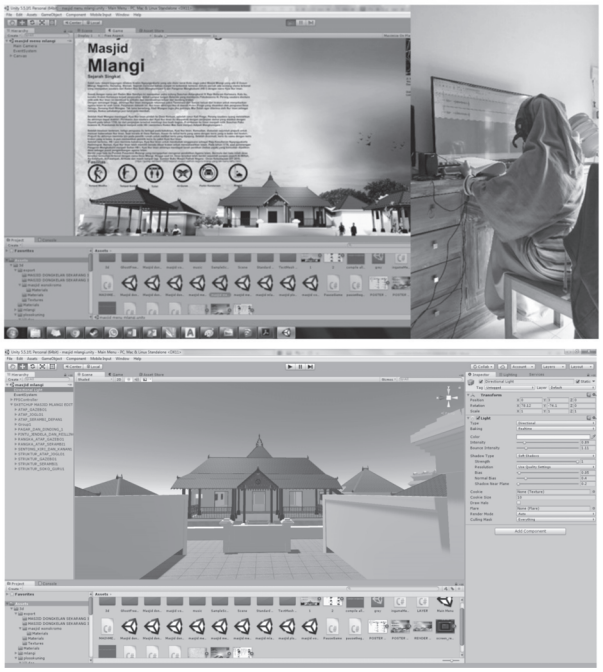

Fig. 17. Sound filling process
Source: (Setyawati *et al.*, 2019)

Results of image visualization process of the environment with Virtual Reality

The picture above is the process of recording supporting audio to explain the early history of the PathokNegoro mosque which was recorded in Indonesian, Javanese, and English. Furthermore, visual comfort is applied by daytime lighting to buildings to bring out architectural characteristics and control the camera at the normal human eye height of 1.6 meters.

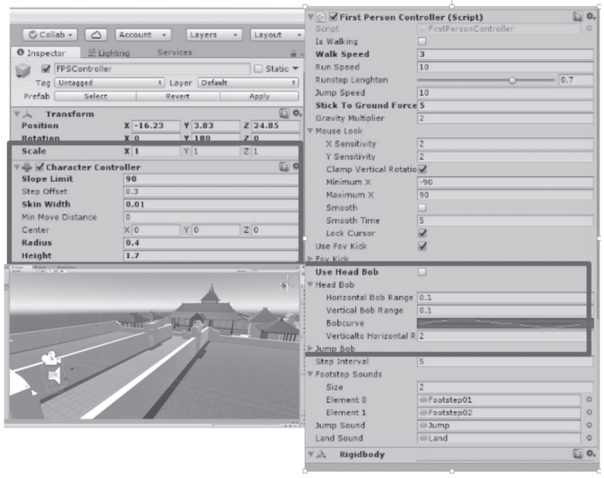

Fig. 18. Image of the legal process of visica
Source: Research analysis

The next process is applying physical laws such as gravity. Users can walk and run at an adjustable speed, users can also interact with 3D objects in a virtual environment. The process is done using C # scripting

The next process is applying physical laws such as gravity. Users can walk and run at an adjustable speed, users can also interact with 3D objects in a

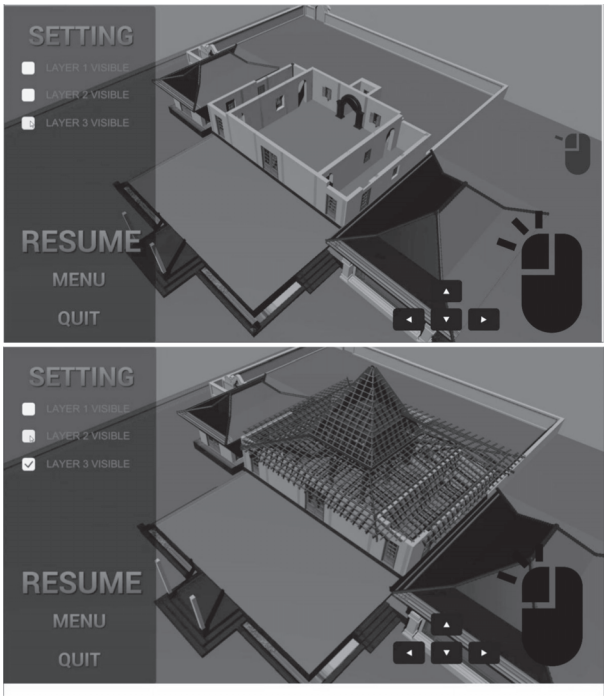

Fig. 19. Image of navigation picture
Source: Result Researches

virtual environment. The process is done using C # scripting

Conclusion

This research successfully applied Virtual Reality technology to document the tangible and intangible elements of the historical building of Pathok Negoro Mlangi Mosque. Good responses were obtained from testing the Virtual Reality application, shown through the immersive, interactive, insightful, and imaginative factors of the VR PathokNegoroMlangi Mosque application.

This research summarizes the process or steps to create VR applications and the problems encountered during application creation. The research activity starts from collecting research object data. The data is then used to redraw in two and three dimensions to be included in the Unity 3D program. The challenge encountered during the research was the process of making detailed ornamentation and material colors at the 3D model stage. Technical difficulties experienced by researchers in the preparation phase of research tools, especially computers used require high graphics cards.

This research opens opportunities for researchers in academia and practitioners such as historians, humanists, psychologists, and architecture especially in the field of preservation of historical buildings using digital media, in addition to research on space perception, as well as simulation of human interaction with computers.

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