

Digital Documentation of Heritage Buildings using the Principles of Heritage Building Information Modeling (Case Study: Cirebon City Hall)

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Abstract— Cirebon City is an old city which is rich in heritage buildings from the Dutch colonial era which still survive today, one of which is the Cirebon City Hall building. As a cultural heritage building, based on the results of field visits, the City Hall building does not have complete drawing documents and material specifications. This is thought to be experienced by most other cultural heritage buildings. In answering the above problems, along with the development of Architecture, Engineering, and Construction technology, the planning process to building maintenance and repair can be managed digitally using a variety of Building Information Modeling (BIM) based tools. In the case of cultural heritage buildings, the principle of BIM technology used is Heritage / Historical Building Information Modeling or H-BIM. H-BIM is used for heritage and archeology, documentation, research, conservation, renovation, and asset management as digital information data on cultural heritage buildings. This research begins by conducting a survey of building geometry measurements and identifying building materials, then compiling the information based on the principles of Heritage-Building Information Modeling (H-BIM). The documentation resulted in a digital model of building reconstruction complete with other non-geometric information of more than 1500 building elements. This information is organized based on the classification of building elements in the BIM. The data in the BIM format is used as a cultural heritage building document asset which can then be used in making maintenance and restoration plans for the building. Besides that, the 3-dimensional geometry model of the building can be used as a virtual museum for cultural heritage buildings (*Abstract*)

Keywords—documentation, BIM, heritage, conservation, reconstruction, virtual building (*keywords*)

I. INTRODUCTION

The development of the Indonesian nation cannot be separated from the existence of historical objects as a cultural feature that developed at that time, in the form of writings, buildings, objects, works of art, and customs. These historical relics need to be preserved and managed appropriately through efforts to protect, develop, and utilize to advance national culture for the greatest prosperity of the people (Law No. 11/2010 concerning Cultural Heritage). One of the historical relics that need to be preserved is in the form of buildings as cultural heritage buildings [1]

Based on data from the National Cultural Heritage Registration System, until 2020, out of 98,397 registered as Cultural Heritage objects, only 1,609 have been designated as Cultural Heritage Objects, and 1044 are Cultural Heritage Buildings (<https://cagarbudaya.kemdikbud.go.id/> accessed on 27 April 2020).

The city of Cirebon is an old city that is rich in cultural and historical heritage, including the heritage of cultural heritage buildings from the Dutch colonial era which still survives today. Based on the Decree of the Mayor of Cirebon Number 19 of 2001, many buildings from the Dutch colonial era are designated as Cultural Heritage Buildings, one of which is the Cirebon City Hall building. As a Cultural Heritage Building, it is currently known that the Cirebon City Hall Building does not have a complete As-Built drawing with accurate technical specifications. So that it will be very difficult for the building manager to carry out maintenance of the building and plan to repair the building.

Currently, digital technology cannot be separated from the world of Architecture, Engineering, and Construction (AEC), with the implementation of Building Information Modeling - BIM (Building Information Modeling). BIM as a new approach that represents the digital development process is used to facilitate the exchange and interoperability of information in digital format [2]. BIM is used in the project cycle from the design, construction, operation, and maintenance stages[3]. According to Hossain (2018) and Yeoh (2018), BIM is not only applied to new buildings, but it is possible to apply it to existing buildings [4]. BIM Further use related to the use of BIM in the management of building facilities converges on the application of BIM in the digital cultural heritage building reconstruction process known as Historical / Heritage - Building Information Modeling. (H-BIM) [5]. In the Burra Charter, it is stated that conservation can include the process of maintaining and reintroducing a function, maintaining association and meaning, maintenance, preservation, restoration, reconstruction, adaptation, and interpretation [6]. Conservation related documentation must be kept in a permanent archive and open to the public, meeting security and privacy requirements [6]. From the background of the issue of the condition of cultural heritage buildings in Indonesia, the importance of conservation documentation,

The initial step of the research is to conduct literature studies from several books and journals with the topic of Building Information Modeling (BIM), especially Heritage Building Information Modeling (H-BIM). From the literature study, it was obtained information on how to remodel existing buildings and add some non-geometric information to the building model [5].

Making a 3-dimensional geometric model of the Cirebon City Hall building begins by determining the coordinates of the building, using the Google Earth application, at one corner of the building as the global coordinates of the building.

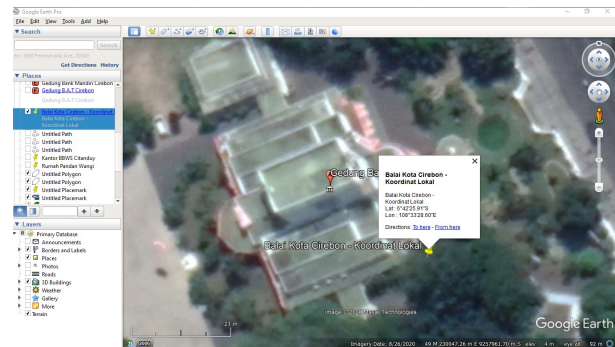


Fig. 5, Determination of building coordinates using google earth software

The coordinate data is inputted into the Archicad software to determine the position of the building to be made by global coordinates. The purpose of using global coordinates is to prepare building geometry data for use in coordination and collaboration using augmented reality or mixed reality on the physical location of the building.

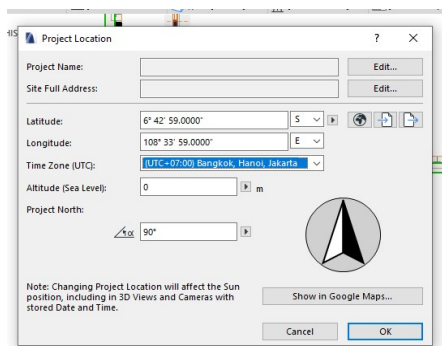


Fig. 6, The input process coordinates on the Cirebon City Hall Building using ArchiCAD software

The 3-dimensional modeling of buildings carried out at the time of this study was limited to architectural design, especially on building facades, but used all building geometry elements in the ArchiCAD software, including; wall tool, column tool, beam tool, slab tool, window tool, door tool, and roof tool. As for the building geometry that cannot be formed using this tool, the solution is to use the Morph tool.

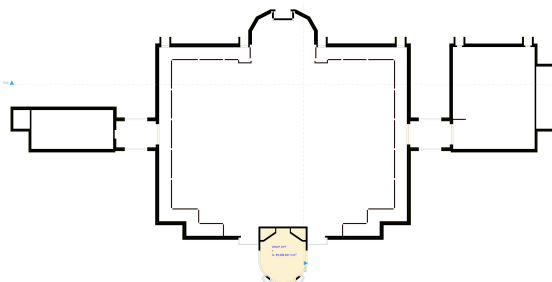


Fig. 7. Floor Plan

With the BIM Archicad, each building elements are assembled one by one, based on primary and secondary data, until the overall 3D building model matches the condition of the existing building.



Fig. 8, Perspective View 1

Furthermore, this 3D building model automatically generated documents such as plans, elevations, and sections of the building.

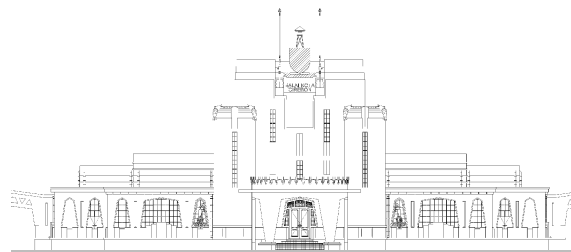


Fig. 9, Front Elevations

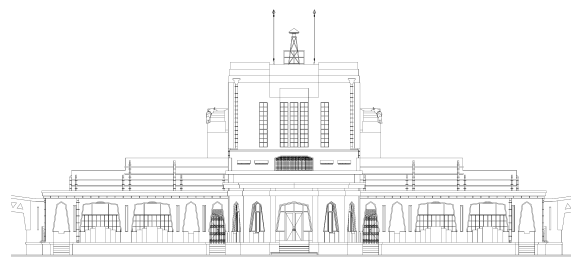


Fig. 10, Rear Elevations

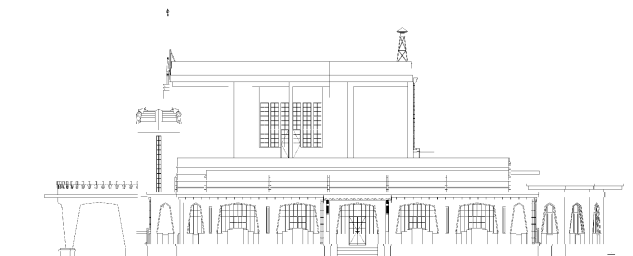


Fig. 11, Left Elevations

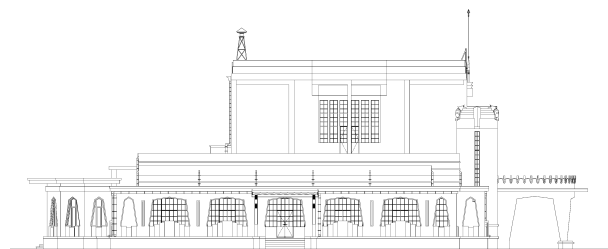


Fig. 12, Right Elevations

IV. DISCUSSION

1. Main Entrance and Canopy

The main entrance of the Cirebon City Hall building is in the middle of the facade facing east.

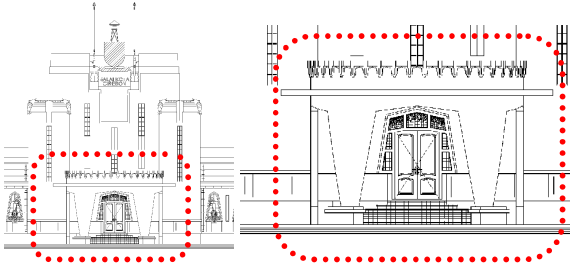


Fig. 11, Main Entrance

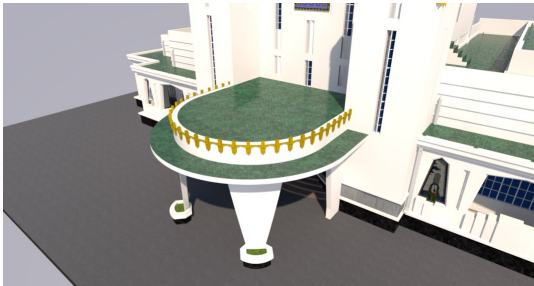


Fig. 12, Main Entrance

Modeling of the basic part of the building consists of the base of the building as a result of the elevation of the building, using river stone material, brick walls, the main entrance of the building with tile finishing material, and the road in the site using asphalt material.



Fig. 13, Canopy base section

The geometric elements of the building with simple shapes and parallel height between the base and the top are made using the morph tool, according to the shape and dimensions of the measurement results.

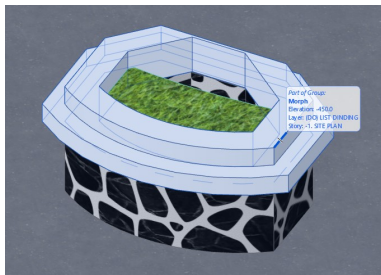


Fig. 14, Parts of canopy based

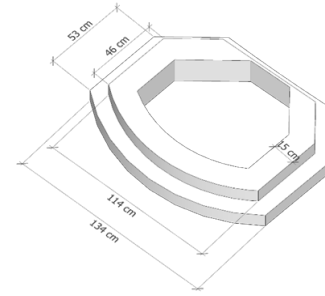


Fig. 15, Top Parts of canopy based

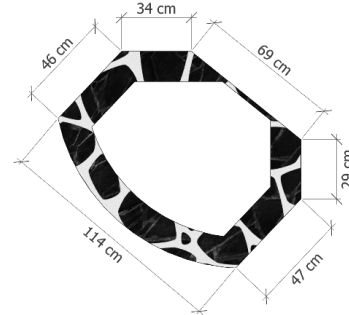


Fig. 16, Lower Parts of canopy base

Entrance canopy section, consisting of building elements walls, doors, windows, and roof plates and equipped with shrimp-shaped ornaments

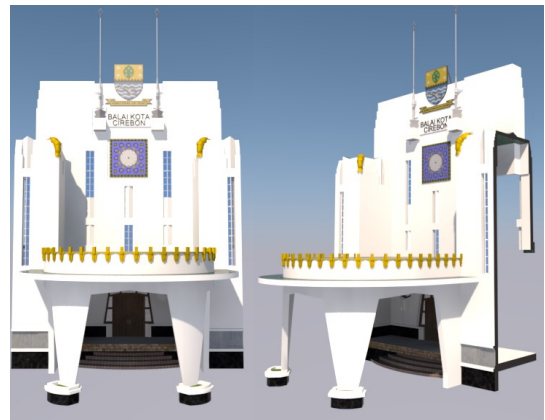


Fig. 17, 3D Section of Entrance and Canopy

Furthermore, each element of the building is given an ID element, designation information (component), and material information, while volume information is obtained automatically from the geometry of the building elements created (Table 1).

TABLE 1, Elements ID, BIM Elements, Materials and Volumes

Element ID	BIM ELEMENT	KOMPONEN	VARIABEL : MATERIAL	LUAS AREA m ²
CL - 001	SLAB	PLAFOND	BETON	17.38
CL - 002	SLAB	PLAFOND	BETON	48.38
DOO - 001	DOOR	PINTU	KAYU JATI	12.22
EW - 001	MORPH	LIST DINDING	BETON	2.75
EW - 002	MORPH	LIST DINDING	BETON	2.75
EW - 003	MORPH	LIST DINDING	BETON	1.78
EW - 004	MORPH	LIST DINDING	BETON	2.36
EW - 005	MORH	LIST DINDING	BETON	1.78
EW - 006	MORHP	LIST DINDING	BETON	2.36
FL - 001	SLAB	LANTAI	TEGEL	0.7
GR - 001	SLAB	RUMPUT	RUMPUT	0.36
GR - 002	SLAB	RUMPUT	RUMPUT	0.36
GR - 003	SLAB	RUMPUT	RUMPUT	2.74
GR - 004	SLAB	RUMPUT	RUMPUT	2.75
MO - 001	MORPH	ORNAMEN	BETON	10.74
RF - 001	SLAB	ATAP	BETON	17.43
RF - 002	SLAB	ATAP	BETON	48.46
ST - 001	MORPH	TANGGA	TEGEL	23.05
SW - 001	WALL	DINDING	DINDING BATA	96.97
SW - 002	WALL	DINDING	Dinding	13.42
SW - 003	WALL	DINDING	DINDING BATA	13.77
SW - 004	WALL	DINDING	DINDING BATA	27.23
WC - 001	WALL	BATU TEMPEL	BATU KALI	3.21
WC - 002	WALL	BATU TEMPEL	BATU KALI	3.21
WC - 003	WALL	BATU TEMPEL	BATU KALI	2.33
WC - 004	WALL	BATU TEMPEL	BATU KALI	2.33
WC - 005	WALL	BATU TEMPEL	BATU KALI	6.49
WC - 006	WALL	BATU TEMPEL	BATU KALI	6.49
WD - 001	MORPH	KACA	KACA PATRI	0.3
WD - 001	MORPH	KUSEN	KAYU JATI	1.2
WD - 002	MORPH	KACA	KACA PATRI	0.3
WD - 002	MORPH	KUSEN	KAYU JATI	1.2
WD - 003	MORPH	KACA	KACA PATRI	1.29
WD - 003	MORPH	KUSEN	KAYU JATI	6.97

The Cirebon City Hall building, which has been completely reconstructed digitally in the H-BIM format, can then be displayed and viewed in the form of virtual reality, augmented reality, and mixed reality. The combination of geometry and digital information encapsulated into an HBIM

with AR and VR has the potential to become a new way to interpret, understand, reuse, and preserve cultural heritage [10].

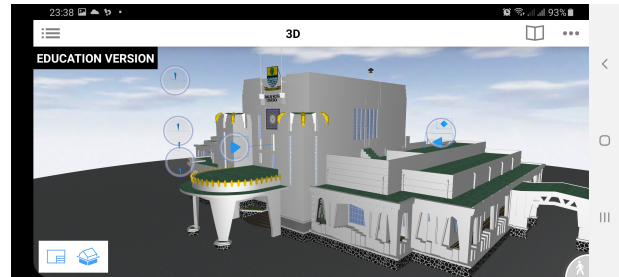


Figure 18, Modelling in BIMx View

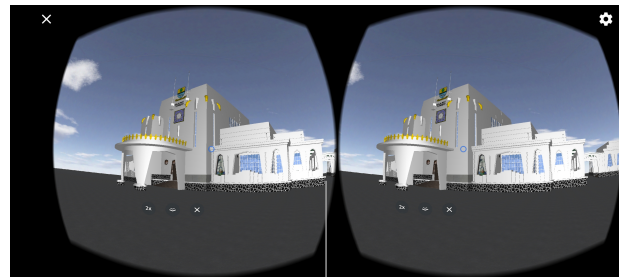


Figure 18, Modelling in BIMx View with VR Cardbord Mode

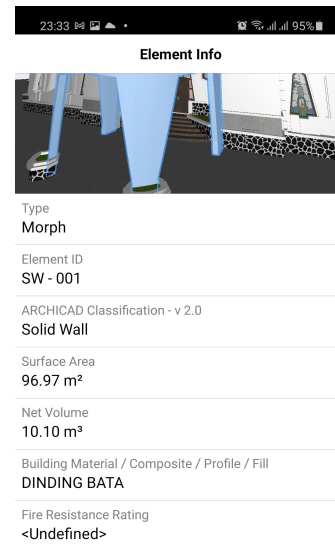


Figure 19, Information of building element on BIMx

V. CONCLUSION

In documenting cultural heritage buildings, the use of manual measurement methods can still be done, especially for buildings with an area that is not too large. The use of a 3D laser scanner can simplify the measurement process with high accuracy and in larger buildings. The results of the documentation in this study are only on the documentation of the outdoor side of the building and specifically in the discipline, followed by the indoor part of the building and involving the disciplines of structure and SMEP so that the

documentation is more complete to be used in the building operation process, maintenance planning and repair of cultural heritage buildings.

ACKNOWLEDGMENT

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