Three Dimensional Modelling of Building Tangible Assets Using Terrestrial Laser Scanner

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Key words: Engineering survey; Laser scanning; Positioning; Asset; Building; 3D

SUMMARY

Building has two kinds of asset, tangible and intangible asset. Tangible asset in building could be the building itself and its objects in it, while intangible asset could be freehold, rights to build, or rights to use. To organize or know the information about building tangible asset, asset management is needed. Asset management is activity of treasure organization that consists of planning the need of asset, acquire, inventorying, legal auditing, appraising, operating, maintaining, updating or eliminating to asset transferring effectively and efficiently. In fact, one of the activity of asset management, inventory, is nevertheless executed with manual procedure. As example, usually in each room of building, there is one paper that has information of room assets. With such simple method, the risk of information loss will be bigger and also it is intricate to update the information. One of the solution of manual inventory is three dimensional modelling of asset. With three dimensional modelling, asset data will be stored three dimensionally and digitally also information can be added directly. Three dimensional modelling is carried out by terrestrial laser scanner (TLS). The output from TLS is point clouds that will be modeled into three dimensional shapes according to the scanned object. The use of terrestrial laser scanners for three dimensional modeling of building tangible assets will improve spatial accuracy, thus building user or manager will easily identify the location of the assets.

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1. INTRODUCTION

Asset management is the science and art to guide wealth management that includes the process of planning asset needs, acquiring, inventorying, conduct legal audit, assess, operate, maintain, renew or eliminate to transfer assets effectively and efficiently. The purpose of asset management is to simplify the decision-making process so that the assets managed effectively and efficiently [1].

Asset management has an important role to ensure that asset management and maintenance are undertaken, decisions about assets covering procurement, maintenance, operational and removal costs will be required to provide information on the condition of the asset in order to answer the projected needs of public sector organizations to perform its functions optimally. Strategic objectives of asset management include the realization of administrative order, the creation of efficiency and effectiveness of asset use, asset security, and the availability of accurate data or information [7].

Currently the asset management process still uses the conventional way. Assets are only coded, recorded and made an asset plan. This conventional way has such flaws, cannot give an idea of the shape of an asset, it is difficult to find the location of a particular asset, and it is difficult to update the asset information. Therefore, it is necessary to update the asset management process by utilizing the existing technology. Building Information Modeling (BIM) is one of existing technology that can be used for the asset management process.

Building Information Modelling (BIM) is an approach to building design and construction in which reference building model that created using one or more parametric component based, 3D modelling systems. System of BIM can exchange information about the building in one or more agreed standard file formats, with each other and with other systems which confirm to the agreed formats. Those exchanges are regulated by a set of protocols. Thus BIM consists of BIM reference model, standard formats for data exchange, and information interchange protocols [11].

In Indonesia, BIM is still rarely used, including in terms of building asset management. This is due to the lack of human resources that control the BIM and the amount of equipment is still small. However, in developed countries BIM has begun to be implemented and integrated into the building asset management process. This is due to the emergence of awareness of the needs of three-dimensional and accurate spatial data. Indonesia is a country that is still developing and of course in the future BIM technology will begin to be widely used in Indonesia [9].

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To be able to do BIM modeling, a data source is needed. The source can be manually measured with measuring tape or 3D point clouds from laser scanner. In this research the data source that used are 3D point clouds of a classroom. Point cloud data contain the dimension, shape, color, and position of the assets in the classroom. With that information, the model of assets can be made. In this research, the software that used to make BIM models is Autodesk Revit.

2. METHODOLOGY

2.1 Literature Review

2.1.1 Terrestrial Laser Scanner (TLS)

Laser ranging systems have been in use in a variety of industries for decades, with the first patented instruments appearing as early as the late 1980's. 3D scanning was first applied in the Architecture, Engineering, and Construction (AEC) industry in the 1990's with the market debut of the first integrated commercial systems for 3D scanning and since then the growth in the industry have been rapid and profound. Early adopters found value in industrial plant applications to capture existing conditions, where poor existing documentation and complex equipment made retrofits and maintenance difficult [14].

Scanning systems primarily capture the physical position of a target object, represented as a series of points (forming a "point cloud") typically in Cartesian coordinates (XYZ). This is accomplished by comparing the emitted and returned light pulse, and determining the value of the target object in relation to the position of the scanning instrument The laser scanner calculates the position by measuring the angle of the scanner assembly (scanner head and reflector) and the time of light travel [14].

2.1.2 Level of Development (LOD)

In the BIM modelling process, there is a stage of completion of the design stage. This phase level is called the Level of Development (LOD). The Level of Development (LOD) Specification is a reference that enables practitioners in the AEC Industry to specify and articulate with a high degree of clarity the content and reliability of Building Information Models (BIMs) at various stages in the design and construction process. The LODs are not defined by design phases. Rather, design phase completion, as well as any other milestone or deliverable, can be defined through the LOD language. There are several ranks of LOD, from 100 to 400 [2].

In this research, the model rank is LOD 300. This means the model element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphical information may also be attached to the Model Element. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modelled information such as notes or dimension call-outs. The project origin is defined and the element is located accurately with respect to the project origin [2].

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2.1.3   Building Information Modeling (BIM)

BIM is a digital representation of the physical and functional characteristics of the facility within the building. BIM serves as a source of knowledge about in-building facilities that will form a basis for making decisions during the life cycle of the building from the beginning onwards [10]. With the advent of BIM, designers and builders have a better way to create, control, and display information. Some of the advantages that first time users can expect to realize are as follows [5]:

1. Three dimensional design visualization to show reality of building, thus building team and client are more understand the design
2. Integrated design documents to minimize error
3. Interference checking to see conflict among architectural, structural, and mechanical elements in 3D
4. Automated and easy to updating the building components.
5. Material quantity take-offs allow better predictability and planning.
6. BIM allows to explore sustainable strategies that can design better buildings and make a better world.

BIM procedure consists of main four steps, first identify high value BIM uses during the project planning, design, construction, and operational phases, second is creating process map to execute BIM, third is exchanging information, and the last is developing the infrastructure in the form of contracts, communication procedures, technology and quality control to support the implementation. BIM also categorized into five main purposes. First is gathering information about building, second is generating the information about building, third is analysing to examine elements of building and determine the viability for the building, fourth is communicating information or design about building elements that can be shared or exchanged, and the fifth is realizing to make or control or develop element building using the previous information [12].

2.2 Material and Method

This section shows material which is used in this research and the method to process the material. The methods of data processing is shown in Figure 1.
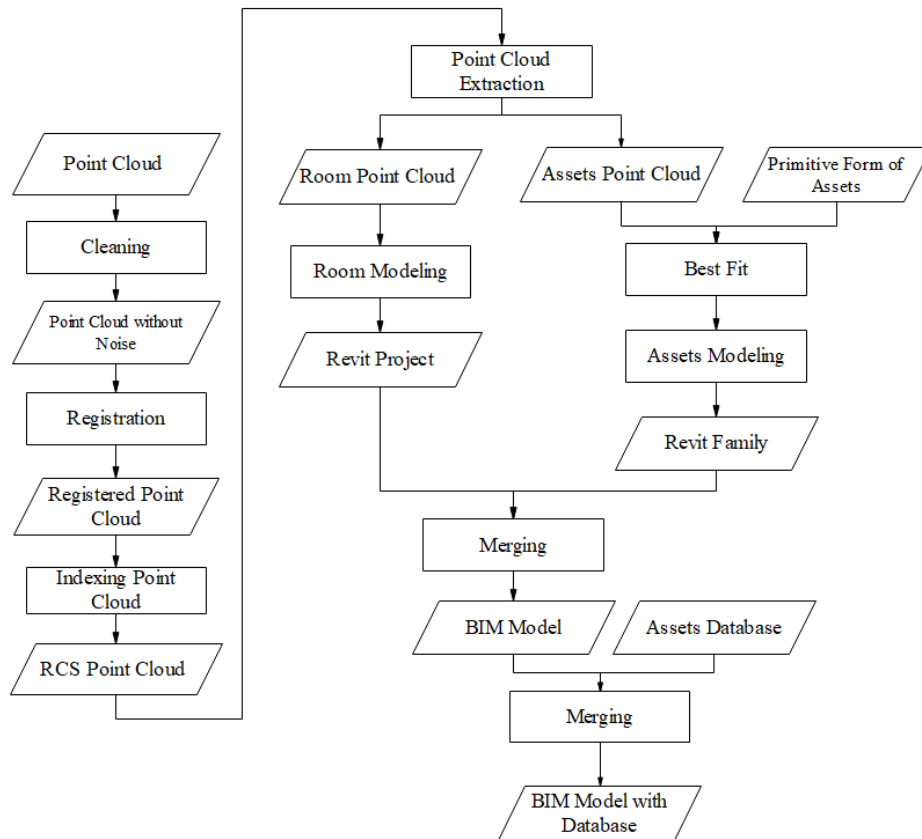
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Fig 1. Data processing methods

2.2.1 Point Cloud Cleaning

The raw scan data contain a lot of noise, so cleaning needs to be done. This process is done manually using Maptek i-Site software. The result is a point cloud without noise or unneeded points. Point cloud without noise will make the registration process easier and give better results.

2.2.2 Point Cloud Registration

Registration is the process of aligning some point clouds so that they are in the right position against each other. The point cloud data can be registered to a reference point cloud by translating and rotating manually to the same point, then continuing with global registration to fix the position [6]. Validation is needed after the registration done. Validation can be done by manually observing the result and checking the distance RMSE (Root Mean Square Error).

The distance RMSE value indicates the accuracy of the registration process. The smaller the RMSE value, the better the registration results. The distance RMSE describes the mean distance of the distance between the sample points used in the registration process. To minimize RMSE value, the global registration process is done in several iterations. The final value of RMSE depends on several factors such as, the amount of scan data, scan resolution, and the amount of

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overlap. The value of RMSE will vary with each set of scan data and there is no minimum value to be able to say that the scan data has been registered finely [6].

2.2.3 Point Cloud Indexing
The final software for building the BIM models is Autodesk Revit. The point clouds that have been registered using Maptek i-Site need to be converted to an RCS format to be able opened in Autodesk Revit. This process is called Indexing and done with Autodesk Recap.

2.2.4 Point Cloud Extraction
BIM models divided into room model and asset model. To make the modeling process easier, point cloud of the assets needs to be separated from classroom point cloud. This process is done using Autodesk Recap with clipping tools. Each of the assets point cloud stored in separate files.

2.2.5 Creating the BIM Model
Autodesk Revit BIM model divided into 2 types, Project and Family. Revit project is the model that used for storing the Revit family. In this case, Revit project is classroom model and Revit family is the asset model. Point cloud of the classroom used as a mold for classroom modeling in Revit. Point cloud of assets used as a guidance for remodeling a template of certain asset. By using this method, the results are classroom model and asset model. Then the model of assets is inserted into classroom model.

2.2.6 Assets Database Integration
After the BIM modelling process is complete, the next step is to create an asset database. The contents of the asset database are based on the needs of the user. Each asset model that has been created contains editable descriptions with adding parameters to Revit family. To be able to create database files or connect to database files, Revit DB-Link add-in and a database programs are needed. In this research, Microsoft Access is used as database program. By using Revit DB-Link it is possible to export a Revit project in a database file, make data changes, and import it back into Revit project.

3   RESULT AND DISCUSSION
3.1 Result
The BIM model are :

1. Classroom model. Consist of walls, ceilings, and floors. Figure 2 shows the classroom model. The shape and dimensions is similar to the one in the real world because it was based from point cloud data. The point cloud data from laser scanner has high accuracy and density.
2. Asset model. The model's shape had similarity with the original assets in the real world, but the dimensions have a slight error. This error is affected by the laser scanner resolution. In this research the laser scanner resolution is 12.5 mm, so it was expected a 12.5 mm error in each side of the model. Figure 3 is an example of a desk model.

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The asset model, then inserted into a classroom model in its correct position as in the real world.
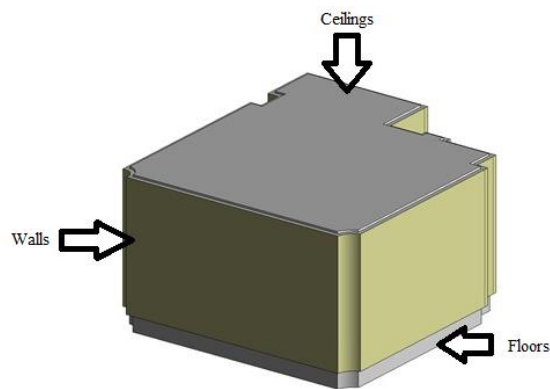

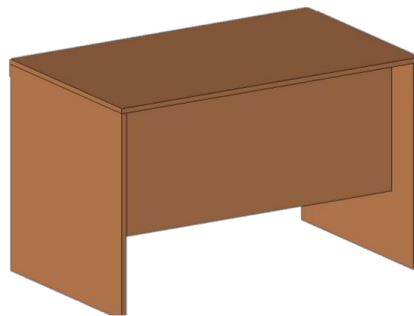Fig 2. The result of making a classroom model

Fig 3. The model of a desk

The final BIM model is the Revit project that contains a Revit family, in short, it was a classroom model with assets. Figure 4 shows the final BIM model. The final BIM model is ready to be integrated with assets database.

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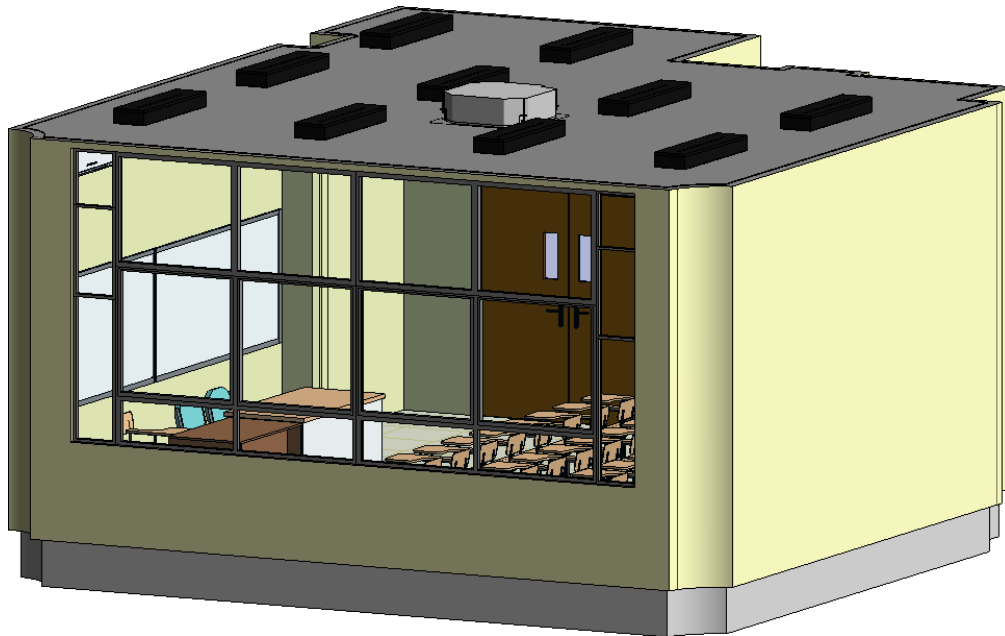Istanbul, Turkey, May 6–11, 2018

Fig 4. The final BIM model

3.2 Discussion

The final BIM model can be used for various purposes. In this study used for inventory of government assets in the form of furniture and electronic appliance. Inventory data included are date of inventory, asset name, location code, asset code, brand / type, year of purchasing, seller, procedure to get asset, price, and condition. The addition of these attributes is done on Autodesk Revit by adding parameters. Adding a new parameter is shown in Figure 5.
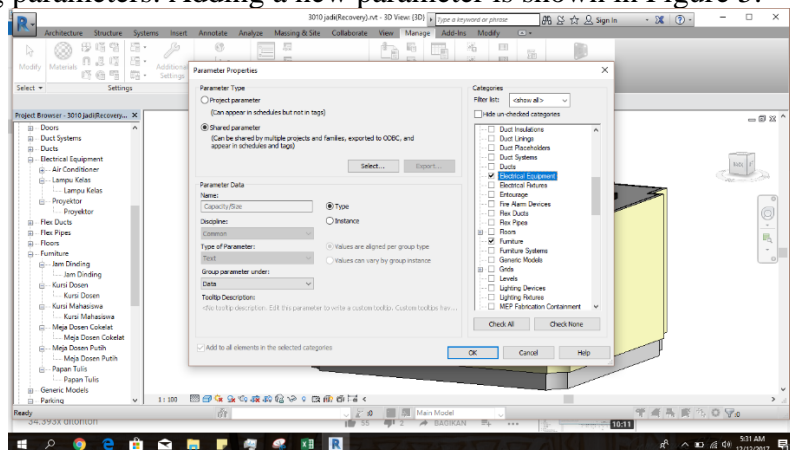

Fig 5. Adding a new parameter

In Microsoft Access data editing is done by adding elements to the new attribute, one of which is to add the location code and assets. Location and asset codes refer to Regulation of the Minister of Home Affairs Number 108 Year 2016 on the Classification and Codification of

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Regional Property and its attachment. For example, the location code has the format "12.32.73.08.01.15.99" and the asset code is "1.3.2.05.02.06.069.0001" described in Table 1 and Table 2.

TABLE 1
LOCATION CODE FOR ASSET

No.	Code	Explanation
1	12	Owned by local government
2	32	Province code for West Java
3	73	City code for Bandung
4	08	Code for Education and Culture Sector
5	01	Code for Local Education Board
6	15	Year of purchase
7	99	Code for Bandung Institute of Technology (Simulation)

TABLE 2
ASSET CODE FOR ASSET

No.	Code	Explanation
1	1	Code for asset
2	3	Code for fixed asset
3	2	Code for equipment and machine
4	05	Code for office and home equipment
5	02	Code for home equipment
6	06	Code for another home equipment
7	069	Code for lamp
8	0001	Number of lamp

The main reason of Autodesk Revit use of this research is to follow one of BIM concepts, data integration with the models. In Autodesk Revit can be done cost calculation, scheduling, and future development plan. Also, all aspects of a building can be integrated well and easily accessed according to user needs.

4 CONCLUSION

BIM can be used in the process of local government asset management and as a tool for decision making. The reason is because BIM can integrate three-dimensional graphical data with complex text database building. BIM can also assist local governments in preparing budgets for the next year or planning to change the assets.

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BIOGRAPHICAL NOTES

Dr. Asep Yusup Saptari, S.T., M.Sc, born in 1970, Graduated in 1995 as Engineer in Geodesy Engineering from Bandung Institute of Technology (Indonesia), obtaining Master degree in Geoinformatics from Hochscule Fur Technik Stuggart (Germany) in 2002 and doctorate degree in Geodesy and Geomatics Engineering in 2016 from Bandung Institute of Technology (Indonesia). Now, Dr. Asep Yusup Saptari, S.T., M.Sc is member of Survey and Cadastre Research Group in Bandung Institute of Technology, Indonesia.

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