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MANAGING 3D ASSET MANAGEMENT USING CITYGML CONCEPT

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Abstract:

In the last decades, three-dimensional asset management is one of the significant practices that is rapidly being used nowadays. Nowadays, 3D GIS has been applied in various applications, especially asset management. A major problem that faces the country at present is the lack of effective tools for managing and maintaining the assets. Currently, in Malaysia, there has been a system that develop by the government named Malaysia Immovable Asset Management System (MySPATA) that is used for the recording, managing, and monitoring government immovable assets. However, this system has not been very successfully utilized due to data complexity and complication in the documentation. This also happens because there are issues involving the management of spatial data due to the growing complexity in infrastructure and limitation of applications. In the surge of digitized economies and industrial improvement, the usefulness of data visualization is becoming increasingly significant in sectors such as smart city planning, construction, management, and services. Therefore, for this to happen, integration between 3D asset management and the CityGML concept is needed This paper focuses on managing 3D asset management using the CityGML concept. CityGML is an independent geospatial information model for semantic 3D city and landscape models that contain various features and modules such as spatial information, data integration, and data visualization. Integration of current technology which is Geographical Information System (GIS) and CityGML concept being employed for 3D asset management. A 3D asset management modeling is being developed using the CityGML standard to track spatial assets, maintain asset records, and sustain an accurate inventory of assets. Thus, in the future,

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an effective GIS database management will be developed to ensure adequate system performance and operational.

Keywords:

GIS, Asset Management, CityGML, 3D Modelling

Introduction

In new decide, the world has a rapid growth in economic and urban development. This happened due to the increase in population and modernization. In recent years, Malaysia has had the highest rate of urbanization in Asia (ThinkCity, 2021). This rate of urbanization is increasing because of the mitigation of population and high demand for facilities and buildings. As a result, for this new revolution, a smart city concept is proposed. Smart City comes as a strategy to reduce the problem due to rapid urban growth and urbanization (Bakri & Kasim, 2018). The smart city can be utilized to ensure the condition of the city management is habitable and improve the quality of citizens. Therefore, it is necessary to begin to find a smart way of managing urban areas. The management of urban areas can be including asset management, facility management, road, and transport management, and more.

Moreover, GIS is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface (Geographic, 2017). GIS enables users to see, analyze and understand the pattern and relationship of the datasets more easily. The element in GIS asset management is to visualize work history and related data using GIS, saving time by implementing custom workflows, tailoring processes to specific users, and generating the report. For smart city projects, the geographic information system (GIS) provides advanced and user-friendly features (Shahrour, 2018). GIS provides an IT infrastructure that integrates not only every stakeholder but also every smart city process, starting from planning and conceptualization to development and maintenance (Group, 2020). Asset Management refers to the management of the asset that involves managing, monitoring, and maintenance. Moreover, GIS in asset management helps to track, maintain and sustain asset records (AssetWorks, 2021). The basic elements of a geospatial approach include location, land-use patterns, distances, and interactions, implying that GIS is critical to city management and smart city concepts (Li, Batty, & Goodchild, 2020).

This paper focuses on the management of 3D asset management systems using the CityGML concept. The CityGML is an open-source international OCG standard for modeling. Storing, and exchange semantic 3D city models (Kutzner, Chaturvedi, & Kolbe, 2020). Besides, CityGML developed by the Open Geospatial Consortium is one of the most common information standards for Geographical Information System (GISUser) on a micro-level (Zadeh, Lan, Dee, Pottinger, & Staub-French, 2019). Therefore, the information exchange in CityGML-based tools is tremendously challenging. Hence, there is a need to facilitate the interoperability between data formats in information levels based on CityGML concepts.

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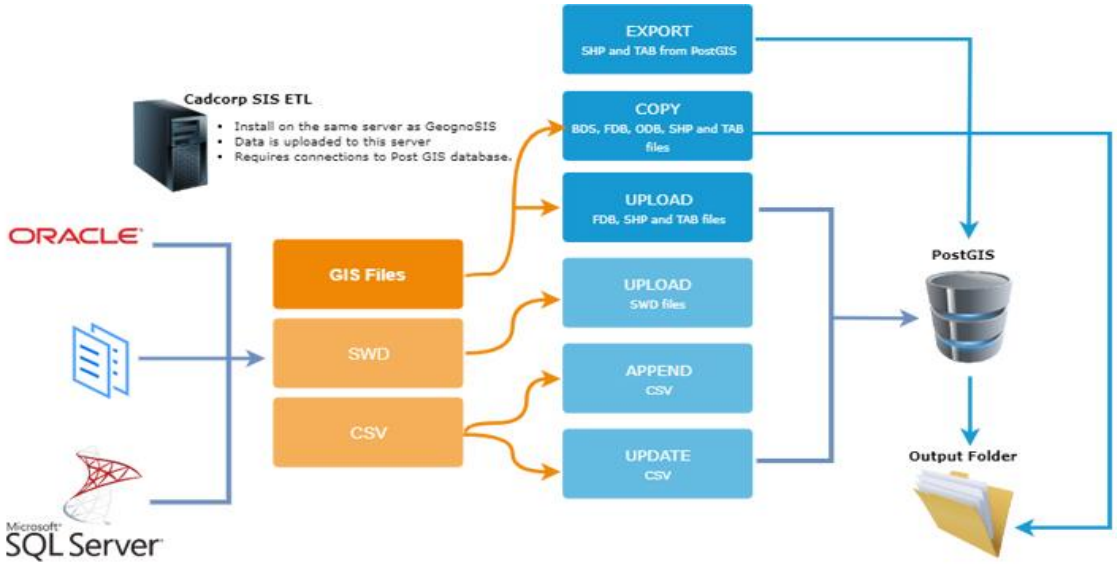
Figure 1: Spatial Data management (GISUser, 2020).



Moreover, the limitation and benefits of using GIS in asset management systems are also discussed. The use of GIS in asset management supported the capture, management, modeling, analysis, and display of 3D modeling. Figure 1 shows GIS spatial data management workflow for database coordination. The workflow shows the workflow of data management that manages and controls the flow of data between files, databases, and servers. Moreover, the figure also illustrates the different types of formats used from different types of datasets and the type of tools and platforms used to read the datasets. Due to the complexity of infrastructure, different types of data collection methods will be used such as aerial laser scanning and terrestrial laser scanning. Thus, a suitable database management method must be determined that is suitable with of current methodology and scope of works.

Related Works

The publications related to asset management is covering a large scope. There is numerous research that explores this topic. Some researchers focusing and studying on asset management. Facility and assets management has become a crucial practice in an era of income generation in an education institution, the need to provide better service to clients/students or the public as well as minimizing the maintenance cost has become a challenge to the institution (Mohd Aizat Saiful Bahri, Abdul Maulud, Rahman, Ridzuan Oon, & Che Hashim, 2020). Moreover, assets and space are one of the important sections in facility management in any organization (M. A. Saiful Bahri et al., 2019). Besides, repair and maintenance play a crucial role in the life of a building namely hindering risks of building, using proper materials and appropriate tools to reduce life-cycle cost (Aghili, Bin Mohammed, & Sheau-Ting, 2016; Horner, El-Haram, & Munns, 1997). However, through the practical experience and discussions with practitioners, there are several problems related to the implementation of the standard and the use of standardized data being noticed (Noardo et al., 2021). The available models, such as BIM and CityGML, mainly represent geometric and semantic information indoor spaces (i.e assets), and rarely describe the topological adjacency relationship of interior spaces (Sun, Zhou, & Hou, 2020). This causes the management and maintenance of assets life cycle cost a burden to a certain organization. Hence, by using the CityGML standard, a different approach for the detailed generation of an object within a semantic 3D city model provide a substantially

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updated data model regarding asset management (Beil, Ruhdorfer, Coduro, & Kolbe, 2020). Thus, this method helps in not only providing updated information but also reducing asset life-cycle costs.

Methodology

The methodology of the study consists of four phases. 1) 3D Modelling, 2) Data Conversion 3) Data Model and 4) 3D Visualization. The study area is using Putrajaya Energy Commission Building. The building is also known as the Malaysia Diamond building. The building also is designed and built on the concept of a sustainable building considered the following aspect which is a reduction in fossil fuel usage, water conservation, sustainable building materials, waste minimization and avoidance, indoor environmental quality, traffic, and transport management, and construction and demolition management plan (Energy Commission, 2021). In the first phase, a 3D model is constructed to study and understand the features of the Putrajaya Energy Commission Building. Figure 2 shows the real image of the Diamond Building and its 3D model.

Figure 2: Image of Energy Commission Diamond Building, Putrajaya, Malaysia (left) and its 3D model (right).

The 3D model is drawn using Sketchup software based on the floor plan and Google Map. The model is constructed based on the Leve of Detail 2 (LoD 2) and represents the building entities along with their semantic and spatial properties. Then, the 3D model is converted into the CityGML standard with ISO TC211 to understand the semantic 3D modeling and visualization. The data conversion happened using Georges Sketchup Plugins that functions to convert a SketchUp (.skp) file format into CityGML (.xml,.gml) format. The next phase is focused on the Data Model. The dataset is probed to organize how the data will be used in a database. Figure 3 shows the data model. The data type and data size are also included in the data model. The data model consists of information on the Diamond Building and immovable assets that will be the main study of this paper. Lastly, the study is focused on data visualization and information retrieval.

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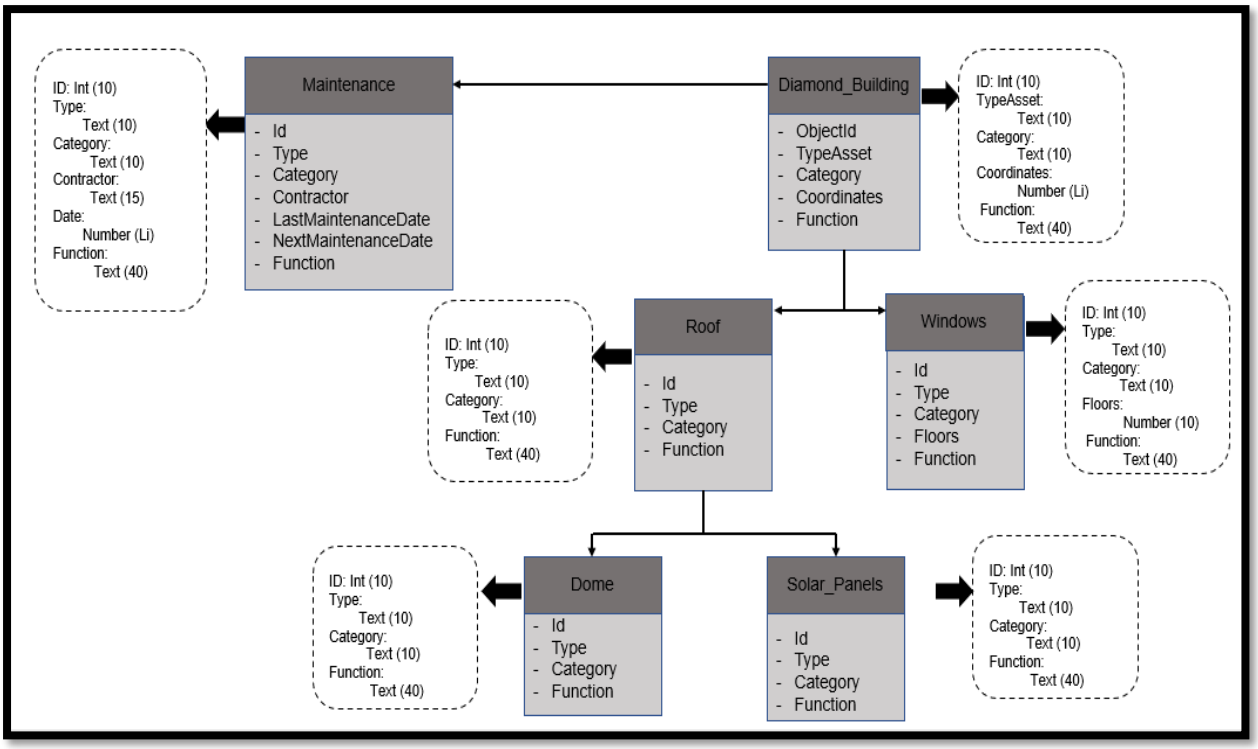

Figure 3: Data Model.

Result and Discussions

The result of the study is a 3D asset management using the CityGML standard. A CityGML model is produced (see Figure 4). The CityGML model contains semantic properties that are classified into several layers of features such as *WallSurface, GroundSurface, RoofSurface, Windows*, and *BuildingInstallation.* The model entity and geometry can be recognized based on these layers. The 3D model stored in CityGML can be used for asset management, energy planning, water conservation, sustainable building material, or even indoor environmental quality (Azri, Ujang, & Abdul Rahman, 2019; A. A. M. Nasir, Azri, Ujang, & Majid, 2020).

An asset management system is an aid in the management of infrastructure assets. The goals of the system are to minimize the total cost of operation and maintain assets as well as the work labor. The GIS asset management system is an information technology that uses data management practice coupled with the distribution of interactive map services and 3D Models. The general elements on this system are asset features, asset information attributes such as type, condition, date, construction specifications, and ownership records that all are maintained in a database. Then, this dataset will be translated into an interactive database and system making this asset information available to the system platforms when and where needed.

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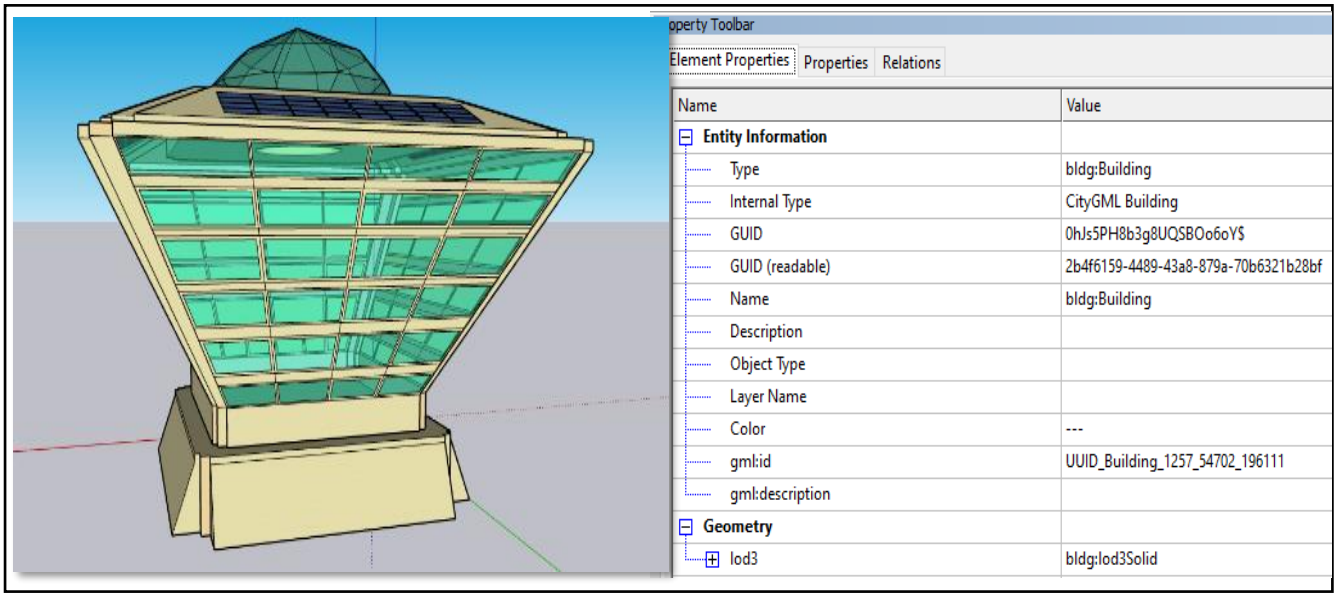

Figure 4: CityGML 3D Model (A. Nasir, A, M,, Azri, & Ujang, 2021).

Moreover, in asset management, the assets of the building and infrastructure are analyzed based on the functions, types, and locations of assets. Besides, the CityGML has supported this semantic information of assets. In this paper, the asset management is focused on immovable assets of the Putrajaya Energy Commission Building such as Diamond-shaped Dome, Low-emissivity (Low-E) glass windows, and solar panels. Figure 5 shows an example of asset management for Solar Panels on the *BuildingInstallation* element in XML data format. The asset management of the Solar Panel is part of asset maintenance. The asset maintenance involved cleaning, removing, and repairing the assets. The information that is retrieved from asset maintenance information is the name of the contractor, services, maintenance category, and maintenance dates. In the CityGML 3D model, this information on assets will be descript together with other properties elements. Therefore, this information can help assist the asset managers to measure and determine asset maintenance and asset monitoring. Moreover, updated data and information on asset management can be obtained.

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Figure 5: The Representation of Asset Management Maintenance Information of Green Building within CityGML Dataset (A. Nasir, A, M, et al., 2021).

Conclusions

In the conclusion, 3D GIS plays an important role to aid Smart City development. Moreover, GIS is one of the methods used for asset management system development. The GIS used spatial relationships to manage, coordinate and analyze all assets and associated work activities (Farallon Geographics, 2021). Besides, the integration of GIS current technology with asset management enables to production of a modern, user-friendly, open-source information system that can help in organizing inventory, managing the assets virtually and efficient maintenance. Moreover, the GIS is used throughout the life cycle of a smart city from the site selection and design through visualization and construction to maintenance. Asset management is an application that is integrated with current technology to alleviate energy consumption. In addition, asset management is one of the applications of a smart city in improving city management including monitoring and maintenance of building immovable assets.

3D asset management is not a new approach but has been introduced for a few years. Nowadays, 3D asset management has been increasing in demand for smart cities toward sustainable management. In Malaysia, the government also has introduced a system for managing and monitoring immovable assets for government agencies. Unfortunately, the system is not being utilized by all government agencies due to data complexation and documentation. Moreover, in this new decade of modernization, there is a need for a management system that have including spatial data management and a 3D visualize module. In this part, the CityGML concept plays an important role in the 3D city model. The CityGML concept contains various features and modules for data integration, data management, and 3D visualization. Besides, CityGML is the most suitable data model for the smart city as it complies with an officially accepted International Standard. The CityGML standard also can be used for other applications such as urban and landscape planning, 3D cadastre, architectural design, and more.

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This paper focuses on managing 3D asset management using the CityGML concept. From the result, a 3D CityGML model has been successfully being constructed through Sketchup software based on the building floor plan and google Maps. From this model, the properties and semantic information of the CityGML 3D model are available. Besides that, this CityGML 3D model also provided information regarding asset maintenance as the data record and monitoring especially to the asset managers or building owners. Thus, managing the assets of the building is important to assist the building owners and operators to measure operational and maintenance on regular commission to maximize operational efficiency while minimizing environmental impact

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