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The Integrating 3D Building with 3D GIS Platform for Facility Management

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Abstract

Building physical resource management is essential to building management and maintenance. This state enables efficient building management. Meanwhile, Chiang Mai University has a master plan for smart city development. This research aims to integrate the 3D building data into the 3D GIS platform to prepare it as a future model for building resource management. The research method is to create a three-dimensional model of the building and import it into a 3D geographic information platform. The result of importing the physical data and visualizing 3D images also stores data attributes in the model, which can be expressed to help manage resources effectively.

Disciplinary: Civil Engineering & Technology.

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1 Introduction

At present, building physical resource management is important to building management and maintenance and enabling efficient building management, and stepping into the elevation of city management to be a smart city (Chotipanich, 2004). However, many agencies have begun to develop physical resource management by upgrading from building physical resource management to city physical resource management, but because cities are large areas, information is fragmented and discrete. Causing problems in data collection; as a result, various agencies use computer technology to help collect data, analyze and organize data to consolidate information on the same platform. This issue will make resource management more convenient, accurate, and efficient (Thongmuenwai & Kenaphoom, 2017).

The Ministry of Digital Economy and Society (MDES) has assigned the Digital Economy Promotion Agency (DEPA) to drive and develop smart cities in Thailand. Meanwhile, Chiang Mai province is one of the first seven provinces; the MDES has a development plan to step up to become a smart city. It planned to focus on tourism promotion smart farming model for agriculture and organized the Chiang Mai City health project with cooperation from the organization both government agencies, universities, and science and technology parks so that Chiang Mai Province is ready to enter the digital age and can also support the entry into an aging society in the future sustainably.

At present, Chiang Mai University is one of the leading organizations in the region with the readiness and potential to help drive smart city policy. Combining many-body of knowledge, building physical resource management, geographic information system three-dimensional model, and the internet of things (IoT) create a platform where information can be collected and analyzed in real-time. This condition will help in the decision-making of the administrators effectively. In this regard, Chiang Mai University has developed the Chiang Mai University Educational Development Plan Phase 12 (Chiang Mai University, n.d.) with a proactive strategy Number 1 about environmental and energy innovation. The university has set the goal of being a leader in creating, managing, building capacity, and sharing knowledge. Sustainable green innovation technology leads to the design of the smart city development master plan at Chiang Mai University called CMU Smart City-Clean Energy.

Therefore, to ensure that the management of the university area is consistent and according to the Chiang Mai University development plan, the idea was to create a three-dimensional model of the building. Thus, digital data is integrated into a 3D information platform as a guideline for effective management.

2 Literature Review

2.1 Sustainable Smart Campus

Over the past few years, the city has developed in various areas. However, most of them are under the same function, which does not use modern technology, causing problems in the city such as scarcity of resources, traffic jams, and inefficient management. At the same time, people tend to understand that the word "city" is a densely populated place. The city can also be categorized in a variety of ways, such as classification by size or population can be classified as large cities, small cities, or classified by population characteristics as a minority group and can be classified according to the location of the city as a port city, or a border city. Cities can also be categorized in two ways; qualitative and quantitatively classified cities are categorized as qualitative cities such as commercial, industrial, and administrative. According to Harris (2016), quantitatively classified cities are industrial cities, wholesale cities, and university cities. As measured by employment statistics from the 1930 Industrial and Commercial Census looked at 605 cities with populations of 10,000 or more residents and interactions which is the model of the university city. It is interesting to study physical resources because it is a city with various physical resources and has a small educational territory. This term is the simple understanding to analyze and manage resources suitable for experimenting with various information systems studies. Neupane (2020) proposes that the concept of a sustainable smart city with facility management is a key to achieving sustainability. It uses an analytical process that consists of 3 tools: geographic information system (GIS), building information modeling (BIM), and the internet of things (IoT) to solve data collection problems and process data from different operating platforms, including working in two dimensions difficult to manage facilities.

The GIS is the process of working on geographic information with a computer system. The data is related to the area's location and presented in the form of a map. The data is stored in the form of a data table that can work with the analysis of mathematical data such as the spread of the epidemic relocation invasion, change in use of space, and is a database for physical resource management of the city (Kumar, 2014). Nowadays, GIS is increasingly applied in managing the city's physical resources, which uses data from the IoT to analyze with various algorithms to manage the city sustainably and create a smart city. A BIM is used as a model that contains the basic information needed to operate and manage physical resources. BIM is a new technology developed to collaborate civil engineering, architecture, and mechanical engineering systems. So, there are three parts to having a consistent understanding of the construction drawing (AppliCAD Pubilc Company Limited, 2018). BIM has a granularity in the level of development (LOD) that ranges from 100 to 500. The LOD 100 is described in detail as the design stage. The beginning of LOD 200 will be the design phase of the building plan, the LOD 300 phase of the design development for use in construction, the LOD 400 during construction, and LOD 500 during the delivery period, as shown in Figure 1.

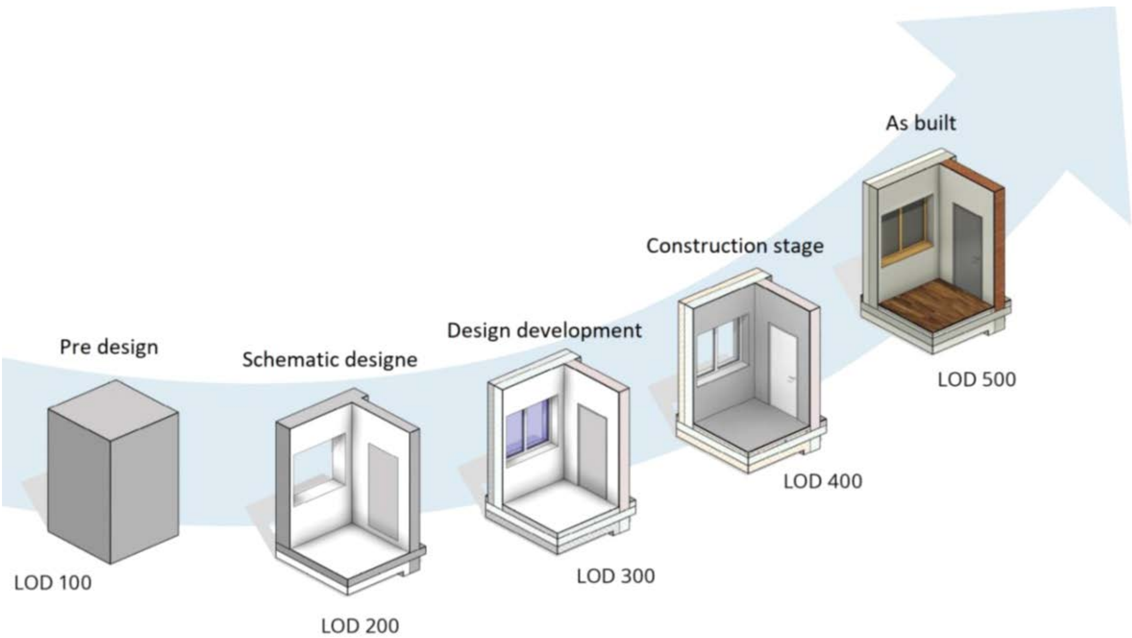

Figure 1: Level of Development (LOD)

Zaballos et al. (2020) have experimented with college towns. It was found that a smart city must be a city that can support the needs of its citizens and promote sustainability in both building structures and the environment. Therefore, a smart campus to analyze the results before applying to large cities. It is because the use of information technology in large areas is complex. There are limitations in terms of space, budget, and computers that can support the capacity of all data, which combines data according to actual conditions. It uses IoT models to examine environments and gain insights into comfort levels.

Moreover, in the future can also plan to share knowledge and experience for future sustainability to be a model used to manage the physical resources of the entire university and every campus. It is to create a better understanding of physical resource management. Therefore, reviewing the literature and research will be the content in the next section.

2.2 Facility Management

The building's physical resource management manages the physical data of the entire building. The important thing is the relationship between people, process, and place, as shown in Figure 2. Buildings are not defined by users alone but according to job requirements and vary with the global economic conditions. Consequently, it shows the relationship between buildings and the change in the world. As a result, a changed conceptual model was needed for modern building management (Chotipanich, 2004).

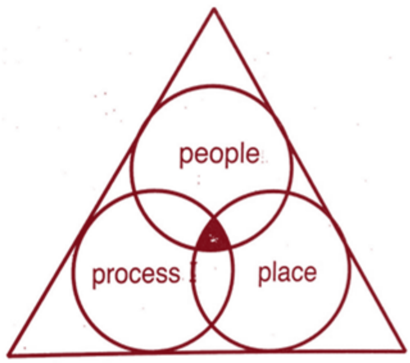

Figure 2: Relationship between workers and buildings for the management of building physical resources.

However, all three management areas need tools to help make the work easier to manage. The management of physical resources in the manner of the university will give a novel of people, processes, and place, which will give the same meaning but will be added to the part of the larger study area.

Le et al. (2019) examined the relationship between data interactions of city intelligence modeling (CIM) technologies through an in-depth investigation. The information on the physical building resources is essential for advanced resource management processes. In the same way, Rich & Davis (n.d.) studies geographic information for facility management. Establish a relationship between building physical resources and facility management to benefit resource management in conjunction with geographic information.

It is to create an understanding of data collection for physical resource management through information models. Therefore, the definition of the digital twin model was studied as a guideline for creating such a process. This point will be contented in the next section.

2.3 Digital Twin Model

A digital twin is a digital simulation of physical resources, processes, and systems combined with artificial intelligence that can learn independently and perform data analysis to create dynamic digital models to be able to change physical resources or digital environment to change according to the actual change and if the algorithm is suitable, it will be effective in predicting the future. Currently, the development of these processes will be applied to buildings, infrastructure, and the environment. Evans et al. (n.d.) found that digital twins face various challenges because the work process is a multidisciplinary collaboration. Therefore, much knowledge is required in engineering, architecture, and computer programming. Moreover, even knowledge of GIS is essential for the digital twin. Gathering this information and then putting it into action is a complex and challenging problem. However, if there is a suitable algorithm and control accuracy, it will be able to create models that predict the future and solve complex city problems.

Li et al. (2020) study real-time GIS, a scientific information system that can collect actual data through IoT data to create a data analysis model and show high-speed spatial results in smart cities. In addition, Marzouk & Othman (2020) study the infrastructure needs for smart cities using the integration of BIM and GIS to plan and forecast urban expansion. By focusing on the issue of smart cities managing the city's physical resources to support the demand for resources such as freshwater use and electric power to be efficient and sustainable.

Min-Allah & Alrashed (2020) explores the concept of a smart campus by combining smart technology with physical infrastructure for more efficient and sustainable services. The bringing various technologies into the university, the operation of the IoT system to store information about Student's face recognition smart card for analyzing physical resources such as classroom usage data. Students' study time and room use can be planned, and Li (2021) studied smart campus management using IoT systems to plan effective teaching and learning on the GIS platform.

This paper will study the integration between BIM and GIS technologies on a 3D platform to be a model for future building resource management. The methodology will be explained in the next section.

3 Method

Integrating the 3D building with a 3D GIS platform for facility management has two main steps in the research; 1) creating a 3D model and 2) creating a platform for collecting physical data. The detail will be described the steps in detail.

3.1 Creating a 3D Model

Today's construction drawings are saved as CAD files and PDFs and can be used to create 3D models with Revit or other 3D modeling programs. Construction is used as a model is necessary to have the completeness of data to model at LOD 300 resolution. The architectural models are the essential floor plans in 3D modeling.

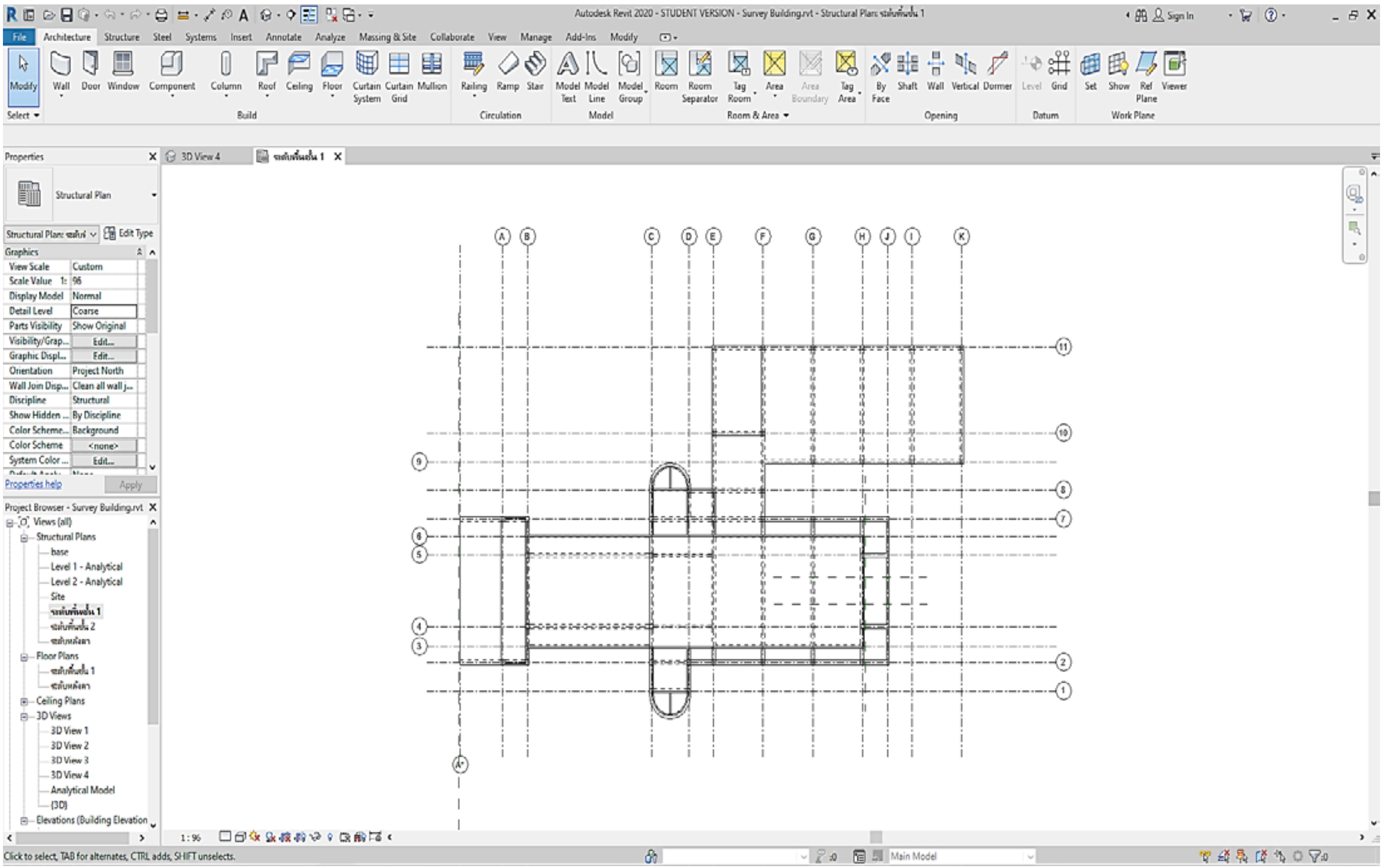

Figure 3: Interface of Autodesk Revit

3.2 Creating a Platform for Collecting Physical Data

Build a platform to collect physical data using the SuperMap-iDesktop tool; the program collects data through the data source and retrieves the desired data through the layer, which can be used to create a display as a map or map 3D scenes.

To import physical data, It must create a workspace, which is the main working area of the program, and have a file type of ".smwu" and then create a data source to divide the physical data types. The file type is ".udbx". The data import tool uses the import BIM data function. For building 3D models, it can be imported into three types of files: 3DXML, Revit, and IFC.

4 Result and Discussion

4.1 The 3D Building Model

Building construction data will be used as a model to create a 3D model using Autodesk Revit. This research will use 3D models with a resolution of LOD 300, showing only architectural works in sufficient displaying 3D data. However, if used in maintenance or energy collection, the model resolution is LOD 400 or higher because it needs to use the sub-device data in the 3D model for display.

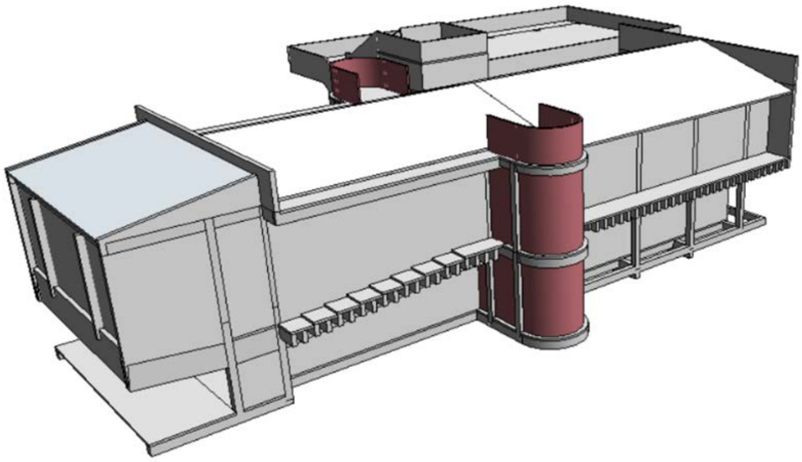

Figure 4: The 3D building model.

4.2 The Physical Data Platform

By importing physical data and visualizing 3D images, data attributes are stored in the model, which can be expressed to help manage resources effectively. This section presents the results of data ingestion and the characteristics of data imported into the data collection platform and creates and prepares data for management.

The results of importing building model data show that the Revit import requires the installation of the SuperMap plug-in in Autodesk Revit and has licensing restrictions, making it difficult to import. Access data directly through this function. The recommended method is to convert model files from Revit and Sketchup to IFC files first and then import them through the IFC function in every program.

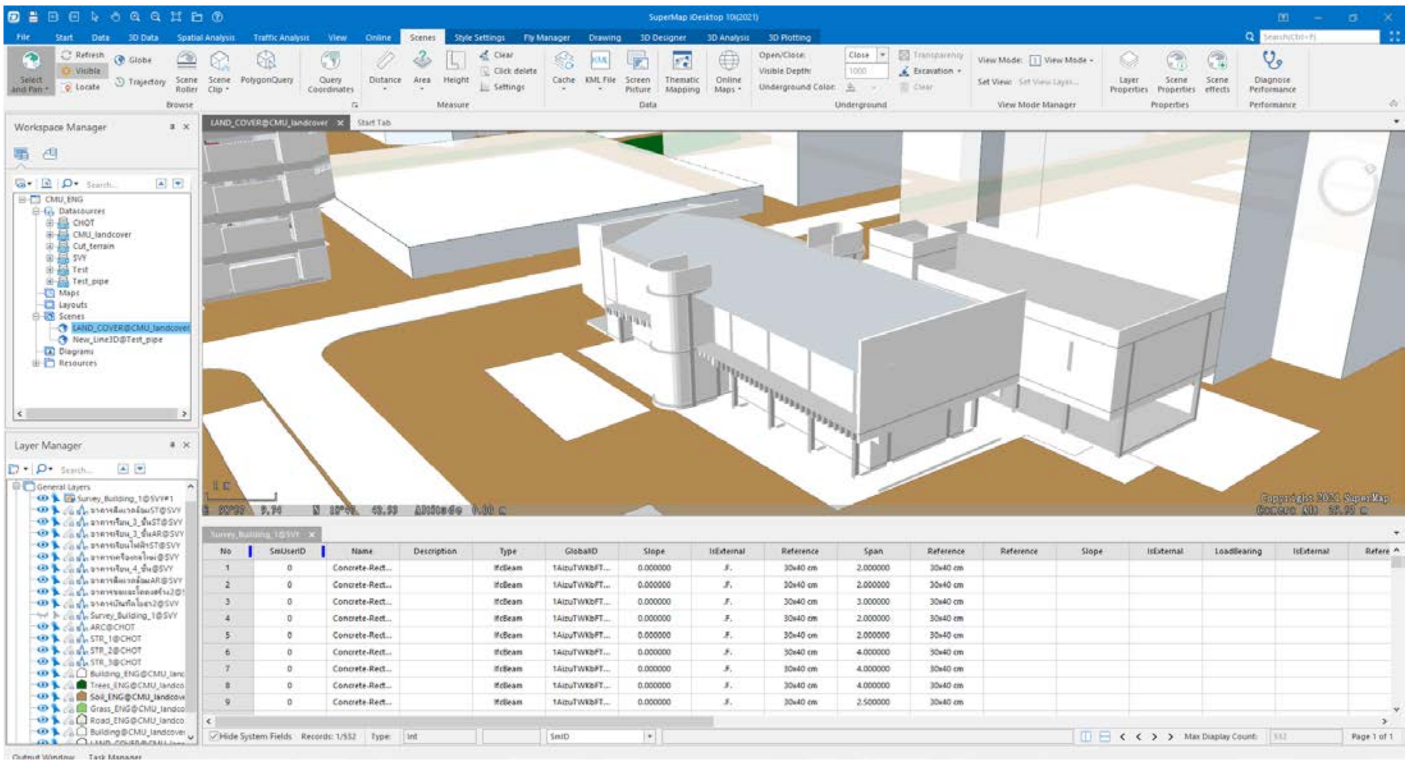

Figure 5: The 3D building model and the data attributes shown on SuperMap.

5 Conclusion

Developing a 3D visualization system for building resources allows for an overview of the building's 3D model, which significantly affects managing the building's physical resources. Furthermore, the 3D model data is collected on the same platform, which is easy to manage. Building 3D modeling is also part of the future digital twin platform, which will combine 3D models with sensor data acquisition to enable more granular management, such as building energy consumption management and building maintenance planning.

Building and collecting buildings' physical data is an essential foundation for future building management. Because in addition to collecting physical data in the platform, it is also possible to manipulate data within the platform to present more detailed information. This point makes management decisions more accurate. In this research, additional classroom locations and areas were presented. Allows building managers to see the location of various rooms clearly inside the building through a single platform which is helpful for classroom use. It can also be applied to sensors to study classroom air quality and energy.

Even if physical data is collected on a single platform, it will be helpful for management. However, users need to be very knowledgeable in using the platform. The platforms for collecting or handling information are very complicated to use. Using a web portal is a good solution for presenting information and as a tool for use in management. Because of writing a web portal, the processes can create specific options and impressions the r want. This solution allows users to easily and quickly access the information they need.

6 Material and Data Availability

All information has been included in this article.

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8 References

AppliCAD. (2018). *Building information modeling (BIM)*. Retrieved January 2022, https://www.applicadthai.com/articles/

Chiang Mai University. (n.d.). Educational development plan of Chiang Mai University phase 12 (2017-2021).

Chotipanich, S. (2004). *Facility management*. Bangkok: Chulalongkorn University printing house.

Evans, S., Savian, C., Burns, A., & Cooper, C. (n.d.). Digital twins for the built environment. *The Institution of Engineering and Technology*.

Harris, C. (2016). The nature of cities.

Kumar, T. V. (2014). *Geographic information system for smart cities*. E-143, Lajpat Nagar, Sahibabad, Distt. Ghaziabad, UP - 201005, India: Copal Publishing Group.

Le, T., Hassan, F., Le, C., & Jeong, H. D. (2019). Understanding dynamic data interaction between civil integrated management technologies: a review of use cases and enabling techniques. *International Journal of Construction Management*, 1-22.

Li, W. (2021). Design of smart campus management system based on internet of things technology. *Journal of Intelligent & Fuzzy Systems*, *40*(2), 3159-3168.

Li, W., Batty, M., & Goodchild, M. F. (2020). Real-time GIS for smart cities. *International Journal of Geographical Information Science*.

Marzouk, M., & Othman, A. (2020). Planning utility infrastructure requirements for smart cities using the integration between BIM and GIS. *Sustainable Cities and Society*, *57*.

Min-Allah, N., & Alrashed, S. (2020). Smart campus—A sketch. *Sustainable Cities and Society*, *59*.

Neupane, P. (2020). *A conceptual framework of facility management with artificial intelligence for a sustainable smart city*. Nepal.

Rich, S., & Davis, K. H. (n.d.). *Geographic information systems (GIS) for facility management*. Manhattan Software 425 Fortune Boulevard, Suite 200 Milford, MA 01757 USA.

Thongmuenwai, P., & Kenaphoom, S. (2017). Cooperation between public and private sectors of smart city development (in Thai). *Journal of Research and Development Institute, Rajabhat Maha Sarakham University*, *4*(1).

Zaballos, A., Briones, A., Massa, A., Centelles, P., & Caballero, V. (2020). A smart campus' digital twin for sustainable comfort monitoring. *Sustainability*. *12(21)*, *9196*.

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