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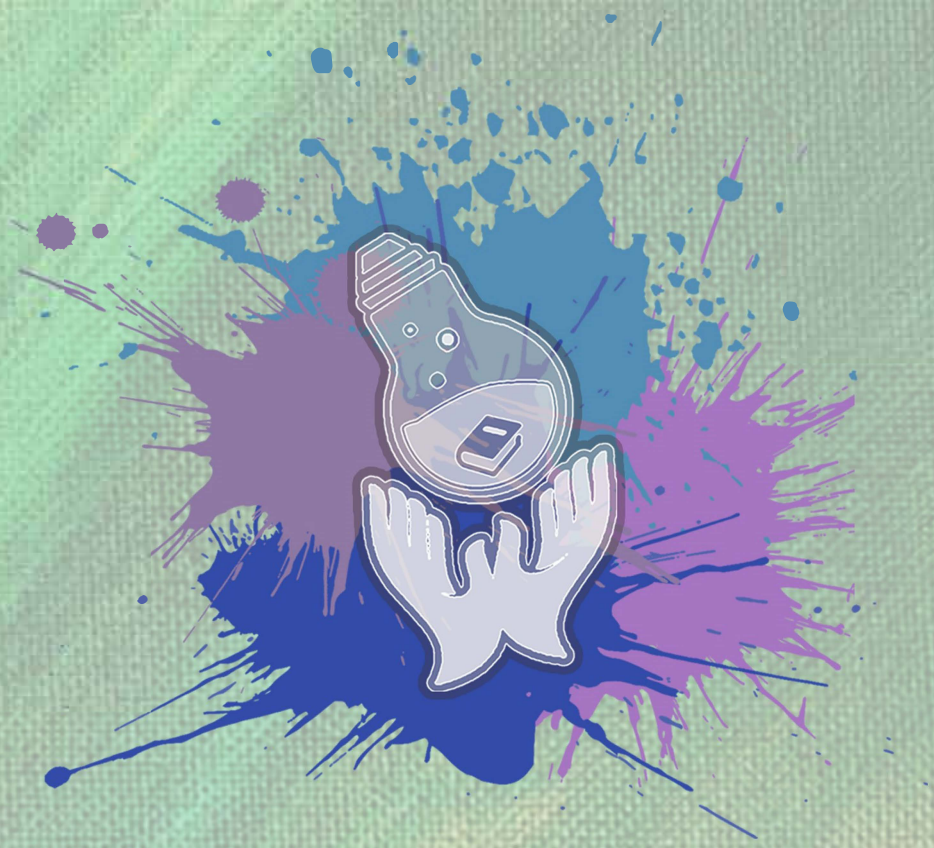

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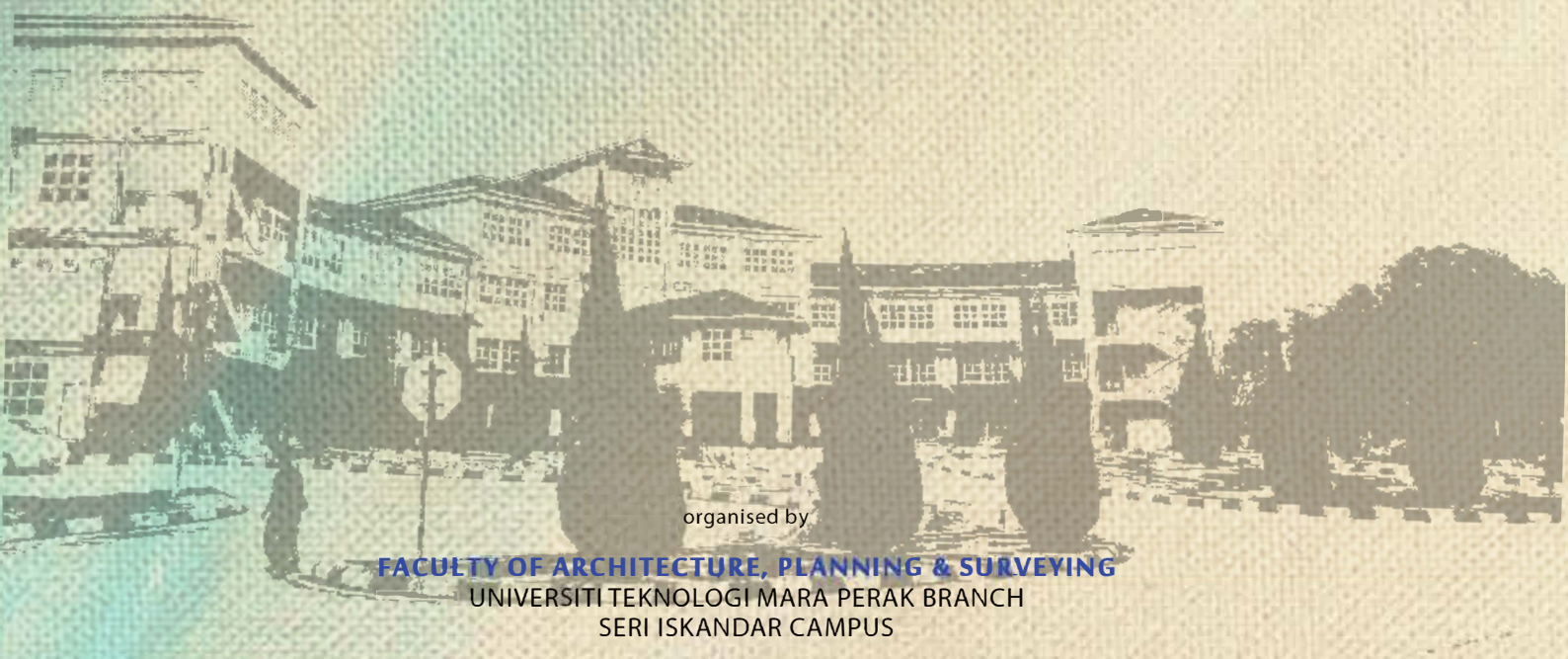

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DEVELOPMENT OF INTEGRATED HOME SECURITY AUTOMATION SYSTEM

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Abstract:
Building Information Modelling (BIM) is a methodology that influences data to analyze and predict outcomes through different phase of a building lifecycle. It helps in terms of facilitating the delivery of building information to the building stakeholders. In today's modernisation era, the emergence of the Building Automation System (BAS) gives a significant impact on the lifecycle of building by introducing a new way of energy usage management in a building. As a new technological system, BAS obviously has its challenges in implementation and management. Hence, the paper objectives are to identify the challenges in building management of BAS and determine how BIM can contribute to the growth of BAS and to integrate both platforms for increased building lifecycle efficiency. By integrating both platforms using a visual programming interface as the principle method, it can be deduced to overcome the issues of BAS by accessing the same data as in the BAS control panel but in an easier working and customisation interface and comprehensive detailing. Therefore, contribute towards more sustainability and efficiency of built environment energy management.

Keywords:
Building Information Modelling (BIM); Building lifecycle; Building Automation System (BAS); Energy usage; Implementation and management

1.0 INTRODUCTION

Building Information Modelling (BIM) is a methodology enabled by a set of software tools and processes for facilitating the creation and use of the digital representation of the physical and functional characteristics of a facility (Domingues et al., 2016).

The BIM implementation in the operation and maintenance stage is limited although the major allocation of overall building lifecycle cost is in the operation and preservation of a building and the requirement of data input also essential in this stage. The technology involved in operating a building is the Building Automation System (BAS). It is to ensure that efficiency of resources and energy is well maintained and subsequently reduce whole-life costing. However, there are issues in BAS usage such as complication in customising the BAS solution, complexity and inter-operability. The paper discusses the challenges in building operation and maintenance management of BAS and how BIM can contribute to the development of BAS to improve building lifecycle efficiency. Hence, this study had proposed a real-time BAS monitoring for BIM software in order to integrate the two systems to achieve greater operations optimisation.

2.0 LITERATURE REVIEW

This section will discuss the relationship between the current management of BAS and updated BIM features. The use of BIM software features in Revit Architecture Version 2019 (Dynamo) will be utilised to integrate the functionality of BAS element (Automatic Gate Prototype).

2.1 BAS management

There are three major hierarchy or level of functionality in a BAS. Domingues et al. (2016) stated that BAS system architecture can be organised into three layers: (i) The lowest layer is known as the Field Layer where the interaction with field devices (sensors, actuators) happens, (ii) the middle is an

Automation Layer, where measurements are processed, control loops are executed and alarms are activated, (iii) the top layer is the Management Layer, where activities or tasks such as system data presentation, forwarding, logging, and archival take place. So, the paper will discuss the issues and problems of the top layer (Management Layer). It is because of the difficulties and heterogeneity nature of the existing system without a standard solution from the various system vendors that provide an interoperability solution (Domingues et al., 2016).

There are always issues and challenges in implementing BAS in the construction industry. For instance, the complications in customise the established solutions and rules (Sinopoli, 2013). Moreover, it is common for facility managers to complaint about either incomplete or inaccurate (outdated) documentation (East, 2016). So, this issue highlighted the need of space re-arrangement and re-utilisation with help of visualisation for the system to operate accordingly to the latest demand and for the latter, in the case where the company that owned the building is no longer in business, building management can continue to function properly with reliable documented information database.

2.2 BIM Implementation

BIM is a well-known process and method for support in managing a building through its lifecycle. The implementation of BIM through the building lifecycle is a massive issue, especially in concept, design and pre-construction phases. However, there is seem to be limited budget for the usage of post-construction phase compared to the operations and maintenance stages where the major expenses been allocated (60%-85%) of the overall building lifecycle budget (Hardin, 2009).

As to date, the capability of BIM in stored the detailed data for the building components, the simulation and analysis still remain at the highest regard. As for BIM, the detail of objects (component specifications) was provided rather than merely geometrical characteristics. Therefore, BIM will utilise the objects beyond the limited function. For example, the ability of simulation features of the sun shading and heat absorption by the building elements will enhance the model analysis as compared to the building orientation and type of materials used only.

This is why the objects were integrated with behaviours (Turk, 2016). But, as the time evolves, BIM also needs to be updated with the additional features to maintain in line with the advanced technological relevance. Therefore, it is crucial and significantly related to integrate the features with an advanced BAS system. It is suggested that the real-time control of the objects within the BAS system will be a massive improvement to be considered in BIM implementation for the building lifecycle. The use of an automated security system such as main gate operation in BAS will be monitored and controlled from the BIM interfaces.

3.0 METHODOLOGY

In this research, to determine the BIM application in building lifecycle, two approaches will be used in order to ensure that the data is gathered comprehensively. The approaches are desk study and simulation of the integration between BIM software and BAS protocol prototype. The desk study was conducted to gather data and information about the challenges in building operation and maintenance of BAS and the current functional of BIM. On the other hand, a Revit Architecture Version 2019 (BIM Tool) with additional features of Dynamo (Visual Programming) will be the main tools for simulation. In order to integrate the software and other building services components (automatic gate), Arduino UNO Microchip (BAS Protocol) was specifically used.

4.0 ANALYSIS AND FINDINGS

4.1 Identification of challenges in the operation of BAS and current features of BIM.

From Table 1 below, the main challenges have been identified during the desk study of BAS operation and maintenance. One of the major challenges is modification and customisation. For example, complications in fault detection in BAS during the modification process where the process of analysing real-time data from a service system against a set of rules which addresses the interoperations of different services equipment. Therefore, to resolve the complication, a customisation of fault detection rules are required and consume time to be solved (Sinopoli, 2013).

Table 1: Cross-referencing between the challenges in BAS optimisation and the current features of BIM.

	Challenges in BAS Optimisation	Features of BIM to solve the BAS Challenges
1.	Modification and customisation. (Sinopoli, 2013)	Building knowledge of BIM for planning the layouts of sensors, tags, actuators and meters.
2.	BAS System is a closed specifications and too complex to use by nonspecialised personnel. (Domingues et al., 2016)	The hardware information of smart objects can be recorded, and their installation locations can be documented and visualised in 3D with a user-friendly interface.
3.	Most automation solutions are not able to inter-operate with other vendors' solutions. (Domingues et al., 2016)	Provides a perfect ontology database for Smart Built Environment (SBE).

4.2 Simulation of BIM features to the Integrated Home Security Prototype/Model.

From the above desk study analysis, it can be inferred that the current challenges in operating and managing BAS components shall be overcome by collaborating with the appropriate BIM platform as one of the solutions. On the other hand, the simulation of BIM features to the prototype model of the automated gate shows the integrated solution in solving the BAS challenges was identified for future development in software and hardware elements. Therefore, by integrating both platforms through visual programming in Dynamo interface (Figure 1), the data can be accessed or even imported to the BIM and can be monitored, modified and projected in a much easier user environment and comprehensively.

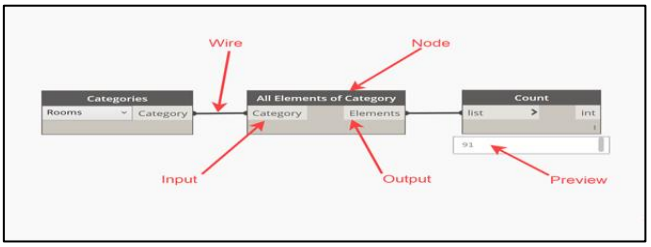

Figure 1: Sample Work Flow of Dynamo visual programming.

5.0 CONCLUSION

In conclusion, as the current era of automation is concerned, the construction industry also needs to involve in developing a strategy to optimise the BAS components in a building operations and maintenance. Thus, by integrating BIM and BAS, a building lifecycle management will be ensured to achieve greater efficiency and sustainability. Moreover, when the integrated automation building system has successfully achieved the objectives, market demand will increase accordingly. Henceforth, the industry players need to adapt to cater for the new market demand. In short, the integration between the BIM features and BAS system will enable the built environment sector to perform more efficiently and sustain as compared with other advanced industry such as automotive industry.

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