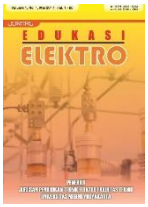
Volume 07, No. 01, May 2023, pages 36 - 43

JEE

Jurnal Edukasi Elektro

https://journal.uny.ac.id/index.php/jee



The Feasibility of the Smart Building Training Kit as Learning Media for Electrical Lighting Installation Practices in Vocational High Schools

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Abstract— The purposes of this study are: (1) to produce smart building training kit products, and (2) to find out the feasibility of the smart building trainer kit as a learning medium for Electrical Lighting Installation Practices in Vocational High Schools (VHS). This research employed the research and development (R & D) with the ADDIE model based on Branch (Analyze, Design, Develop, Implement, and Evaluate). The techniques to collect the data included interviews, observations, and questionnaires. The data obtained were analyzed descriptively. The research results show that (1) smart building trainer kit has been produced as a learning tool for Electric Lighting Installation Practices at VHSs with the dimensions of 96 cm in length, 67 cm in height, 25 cm in width at the bottom, and 13 cm at the top; and (2) the developed product was declared very feasible by material experts (95.83%), very feasible by media experts (89.06%), and appropriate by VHS students (80.8%).

Keywords: trainer kit, smart building, learning media, practice

Article received May 20th, 2023. Resubmitted May 29th, 2023. Final Acceptance May 30th, 2023.

1. Introduction

Indonesia, recently, has been one of the countries with massive building constructions in Southeast Asia. However, with the limited application of technology, such as the Internet of Things (IoT) and other smart building applications, the feasibility factors still become serious issues, such as security, comfort, convenience, and health. Lack of human resources who master smart building technology becomes the main cause. Implementing smart buildings will offer automation, digitization, and data connectivity to enhance its feasibility factor [1]. Graduates of Vocational High Schools (VHSs), especially in electrical installation engineering, are among the human resources in Indonesia who have not yet mastered smart building technology. They do not obtain sufficient training in smart building competencies due to the lack of school facilities to support practical learning, such as smart building trainer kits. It is revealed based on the preliminary studies in several VHSs in the Special Region of Yogyakarta. Though the learning objectives in the Electrical Lighting Installation course have included smart buildings, the learning is still in the form of theory rather than actual smart building practice.

This condition raises concern for this study (1) to develop a smart building trainer kit as a learning tool for Electrical Lighting Installation Practices in vocational high school (VHS), and (2) to find out the feasibility of the developed product in VHS. The urgency of this study is to facilitate students with smart building skills that align with the fourth industrial revolution. This competency is crucial for them to compete in the modern workplace.

Studies on smart buildings are beneficial to provide comfortable, healthy, effective, and efficient buildings for the residents. This research is different from other relevant studies, such as intelligent management of IoT-based health services in hospital buildings, which can provide orderly and comfortable services for patients [2], IoT for smart buildings at Gading Serpong Campus to support users' convenience [3], the analytical model of Open IoT Platforms for smart building [4], the use of smart building systems in two buildings to enhance the effectiveness of building use [5], and so on. The gap among those studies lies in the technology, objects, control facilities, and the use of the developed products. A smart building trainer kit is designed as a learning medium for Electrical Lighting Installation Practices in VHS. This research also supports the Green Economy priority because the smart building will apply the internet and other information technology to control the use of electric power that is easy, convenient, fast, accurate, and efficient. It is expected to contribute to a clean and green environment and ecosystem. Smart building is the concept of automatic technology in buildings to provide comfort and efficiency to the occupants. The smart building has several interconnected technological systems working together to suit the needs of integrated resource management [6]. The working principle of smart building is the integration of all components in the building. It works automatically based on system settings or Building Automation System (BAS). The components of a smart building can be triggered to create a complex system that enhances security and activity inside a building or home.

The Internet of Things, or IoT, is a collective network of interconnected gadgets and technology that allows gadgets to communicate with each other and to the cloud. Furthermore, the IoT can be interpreted as a connection of objects that can communicate via the internet network [7]. The IoT system contains five characteristics: Intelligence, Connectivity, Sensing, Safety, and Energy. The IoT architecture is divided into five layers, including (1) perception layers; (2) layers; (3) middleware layer; (4) application layers; (5) business layers [8]. Studies related to smart building include the intelligent management of IoT-based health services in hospital buildings during the Covid 19 pandemic and in the future. This research resulted in controlling the number of room occupants, location navigation, queue management, and environmental features in the hospital [2]. This study differs from the proposed research regarding the types of controls on IoT for smart buildings at UEU's Gading Serpong Campus. The study results showed that turning on and off lights, air conditioners, and computers could be done with IoT-based controls [3]. This study also differs in terms of the complexity of its control management. Another research on simple real-time energy analytic models for smart buildings using Open IoT Platforms shows that using Open IoT Platforms can display electrical parameters like voltage, current, power factor, and electrical energy in real-time graphs [4]. The product of this study is applied as a practical learning medium in VHS becomes the significant difference. Another research on the use of smart building systems in "The Edge Amsterdam" and "Glumac Shanghai" buildings found that the concept of the use of energy sources, lighting, electric vehicle charging facilities, and air regulation between the two buildings is dissimilar [5]. The research on smart building perspectives in supporting energy security indicates, based on a smart building perspective, the energy management in the building does not meet the requirements [9]. Another study of smart buildings in preventing covid 19 reveals that maintenance management's major challenges are costs, occupant behavior, and maintenance strategies [10]. Meanwhile, a study on the use of IoT in healthcare homes, smart homes, smart buildings, smart cities, transportation, and the IoT industry highlights that IoT is needed in these sectors to prevent Covid 19 [11]. The use of modern smart building architecture at the Parahyangan Citywalk Shopping Center in Kota Baru Parahyangan is the subject of another study. The study's findings led to the construction of a shopping mall in Kota Baru Parahyangan Bandung using modern architectural and smart building ideas considering the environment's orientation and various elements [12]. Another research on the design of the Wemos-based Smart Building Control at Citra Solutions Pratama, Ltd. This research produces a smart building control tool using mini Wemos D1 and web-based control [13]. The developed technology products become the main difference compared to those previous studies.

2. Research Method

This study employed research and development referring to the ADDIE model based on Robert Maribe Branch [14], including Analyze, Design, Develop, Implement, and Evaluate. Initial observations and studies of the smart building requirements in VHSs were carried out in the analysis phase. The design referred to needs analysis on smart building trainer kits as learning media for the Electric Lighting Installation practice course. In this stage, a job sheet was also designed to complement the implementation of smart building trainer kits as learning media. In the development stage, a smart building training kit and job sheets were made as a learning medium for Electrical Lighting Installation Practices. The design was to create smart building trainer kits and job sheets as practical learning media. The product development in the form of smart building trainer kits and job sheets was tested and validated by material and media experts to determine its feasibility level. The smart building products and job sheets were tried in the VHS Electrical Lighting Installation Practical course at the implementation stage. The evaluation was done at each stage, covering design, development, and implementation as a reference for the next stage. The techniques to collect data were interviews, observation, and questionnaires. The instrument's validity was determined by expert judgment, while the instrument's reliability was measured with Scott's reliability and Cronbach's Alpha formula. Scoot's reliability to determine the consistency level of the instruments was performed by two parties, media, and material experts. Meanwhile, the formula to determine the reliability of instruments for more than 30 people was based on Alpha Cronbach, which students did. The subjects of this study were teachers, material, and media experts, as well as the students of State VHS 1 Pundong. The data obtained were analysed with descriptive quantitative.

3. Results and Discussion

A needs analysis was conducted to develop a smart building trainer kit for Electrical Lighting Installation Practices in VHS as a learning medium. In brief, the syllabus and teaching modules for the course were analyzed based on the curriculum. The learning objectives related to smart building can be seen in Table 1.

Table 1. Learning objectives related to smart building on electrical lighting installation practice course

No.	Learning Objectives
1	Understanding the components and layout of the lighting installation control system (Smart Building).
2	Applying the procedure for installing the lighting control system (Smart Building).
3	Evaluating the installation of the lighting control system (Smart Building).
4	Implementing the components and layout of the lighting installation control system (Smart Building).
5	Installing a lighting control system (Smart Building).
6	Checking the installation of the lighting control system (Smart Building).

At the design stage, the framework and layout of the smart building trainer kit were produced. Additionally, a design of a job sheet has been completed. The framework of the product used mild steel with a length of 96 cm, 67 cm in height, a bottom width of 25 cm, and the top width of 13 cm. The panel mounted on the front was made of acrylic material with a thickness of 6 mm. The layout plan for the smart building trainer kit component is presented in Figure 1.

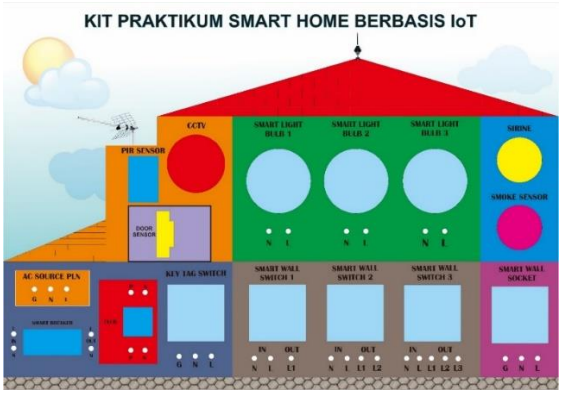

Fig. 1. Layout design of the trainer kit smart building

A complete smart building trainer kit product is created during the development phase to realise the product development design, which is tested in the next phase. The design of the developed smart building trainer kit as a teaching tool for electrical lighting installation practices is shown in Figure 2.

Fig. 2. Smart building trainer kit products as learning media for electrical lighting installation practices in VHS

A smart building trainer performance test was carried out to evaluate the developed products by observing the performance of each component and practical trials based on the job sheet that had been made. The results of the performance test for each component are presented in Table 2.

Table 2. The performance test on the components of trainer kit smart building

No.	Component	Specification	Functionality	
			Yes	No
1	Single switch	Bardi Smart WiFi Touch Wallswitch - EU 1 Gang - White	V	
2	Series 2 switch	Bardi Smart WiFi Touch Wallswitch - EU 2 Gang - White	V	
3	Series 3 switch	Bardi Smart WiFi Touch Wallswitch - EU 3 Gang - White	V	
4	Door Sensors	Bardi Smart Home WIFI Window & Door Sensor - no hub required	V	
5	PIR sensors	BARDI PIR Motion Sensors	V	
6	Breakers	BARDI Smart BREAKER ON OFF Switch Wifi Wireless IoT Home Automation	V	
7	Electric socket	Bardi Smart Wall Socket EU MF 10A Smart Outlet Electrical Plug - Black, EU	V	

No.	Component	Specification	Functionality	
			Yes	No
8	Light	BARDI Smart LIGHT BULB RGB+WW 12W Wifi Wireless IoT - Home Automation	V	
9	ELCB	RCBO/ELCB/RCCB TDM 1P+N TDB6 30mA 6A	V	
10	Card Switch	RFID 125Khz card Energy Saving Switch Energy saver switch hotel card	V	
11	Inbow Dos	White color box	V	
12	Electric socket	1 hole sitting type	V	
13	Bardi CCTV	INDOOR PTZ Smart IP Cameras	V	
14	Smoke Sensors	Wifi Smoke Alarm IoT - Smoke Sensor- Amazon Alexa	V	
15	Wall Mount CCTV Bracket	PTZ twiz lock brackets	V	
16	Head Charger 5 Volt	2 USB ports HK D38 shell	V	

The next test was a practical trial by referring to the job sheet, including the installation of electric lighting with (1) single scalar, series 2 switches, and series 3 switches with Smart WiFi Touch Wall switch facilities, (2) door sensors; (3) PIR sensors; (4) card switch; (5) Smoke sensors; and (6) INDOOR PTZ Smart IP Cameras. The six practical trials of the electric lighting installation can work well. It can be seen from the electric lighting system that can run as its function.

Table 3. Validation results from the material expert on trainer kit smart building products

No.	Assessment aspects	Maximal scores	Score from the expert 1	Score from the expert 2	Mean Score	Percentage	Categories
1	Quality of content and purpose	48	47	47	47	97,91%	Very Feasible
2	Instruksional Quality	48	47	43	45	93,75%	Very Feasible
	Total	96	94	90	92	95,83%	Very Feasible

Two media experts validated the smart building trainer kit product to determine its feasibility as a learning medium of Electric Lighting Installation Practices course in VHS. The validation results from those 2 media experts on the developed product are presented in Table 4.

Table 4. Validation results from the media expert on trainer kit smart building products

No.	Assessment aspects	Maximal scores	Score from the expert 1	Score from the expert 2	Mean Score	Percentage	Categories
1	Quality of content and purpose	48	41	45	43	89,59%	Very Feasible
2	Instruksional Quality	16	14	14	14	87,50%	Very Feasible
	Total	64	55	59	57	89,06%	Very Feasible

The smart building trainer kit product was tested in class in the Electrical Lighting Installation Practices learning process. The test involved 61 students of the XII Electrical Engineering Skills Competency in SMK N 1 Pundong. The students were required to evaluate the smart building trainer kit after completing the Electrical Lighting Installation Practices learning. Table 5 displays the findings of student evaluations of smart building products.

Table 5. Students' assessment on the developed product

No.	Aspects	Maximal scores	Total scores	Percentage	Category
1	Technical Quality	2928	2366	80,8%	Feasible
2	Content and Purposes	2440	1967	80,6%	Feasible
3	Instructional Content	2440	1982	81,2%	Feasible
	Total	7808	6315	80,8%	Feasible

The validation results by material and, media experts as well as students' assessments on the smart building trainer kit product are presented in Figure 3.

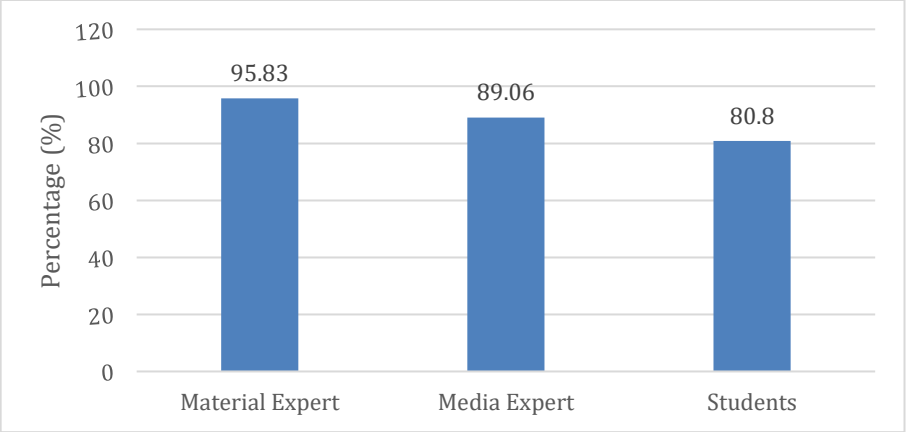

Fig. 3. The validation results by material and media experts as well as students' assessments on the developed smart building trainer kit

Based on the validation results conducted by 2 material experts on the feasibility of the smart building trainer kit, it was obtained a mean score of 95.83% or in the very feasible category. It means the content of the smart building trainer kit is very appropriate as a learning medium for Electrical Lighting Installation practices based on the basic competencies in the Independent Curriculum. Meanwhile, the validation results from the two media experts showed an average value of 89.06% or in the very feasible category. It indicates the developed smart building trainer kit is very appropriate as a learning medium for Electrical Lighting Installation Practices. As learning media, it can raise students' learning interest, convenience, attention, and motivation. The role of the teacher as a facilitator can be more effective with a smart building trainer kit as a learning medium. Similarly, 161 students consider the Smart building trainer kit appropriate (80.8%). In other words, the smart building trainer kit is suitable for learning a medium of Electrical Lighting Installation Practices. Students that have used the smart building training kit also give a positive evaluation. According to some students, using the smart building trainer kit for learning is enjoyable since it grabs their attention, helps them understand concepts, and concretizes abstract knowledge.

Several students also provide positive responses to the smart building trainer kit, especially the size of the smart building trainer kit, which is suitable and comfortable for the group practice of installing electrical lighting. Additionally, the smart building trainer kit is very useful for practice by setting it on the practice table, and it is also simple to store back after the learning is completed. It shows that the demension of the developed Smart Building trainer kit meets the standards and demands of the VHS students who are studying in a laboratory or workshop. Students' ergonomics aspects and needs are considered to support the hands-on Electrical Lighting Installation training in labs or workshops. The dimensions of the developed product are 96 cm in length, 67 cm in height, 25 cm in width for the bottom part, and 13 cm for the upper part. The board is installed with a slope adjusting the position of students as users. The smart building trainer kit is made of solid material and is simple to set up as a tool for practical learning. After the practical learning, the trainer kit is simple to be stored. With a suitable shape and size to the requirements and standard of practice in

the laboratory or the workshop, the smart trainer kit in this study allows students to participate freely in a group or individual practice. As a result, students are more at ease and enthusiastic about participating in hands-on learning activities for electrical lighting installations. This condition will effectively help them to enhance their competencies.

4. Conclusion

A smart building trainer kit has been produced as a learning medium for Electrical Lighting Installation Practices at Vocational High Schools. It has suitable dimensions for practical courses in a workshop or laboratory, i.e., 96 cm in length, 67 cm in height, 25 cm in width for the bottom part, and 13 cm for the upper part. The panel boards are made of acrylic with a thickness of 6 mm.

The developed smart building trainer kit in this study has been validated by material experts, resulting in a very appropriate category (95.83%) and the media experts with a very feasible category (89.06%). The students also consider the developed trainer kit appropriate for their learning media (80.8%) for Electrical Lighting Installation Practices courses in VHS.

5. References

[1] M. Indonesian, "It's Time for Indonesia to Apply 'Smart Building' Technology," retreived from https://mediaindonesia.com/teknologi/399778/sudah-saatnya-indonesia-terapkan-teknologi-smart-building on January 18, 2022.

[2] O. Akbarzadeh, et.al., "IoT -Based Smart Management of Healthcare Services In Hospital Buildings During Covid-19 and Futures Pandemics," *Wireless Communications and Mobile Computing*, Volume 2021.

[3] Sandfreni, et.al., "Counseling on IoT for Smart Building (Case Study of EUU's Gading Serpong Campus," *Jurnal Abdimas*, Volume 7, Number 4, June 2021.

[4] M. Nasar, et.al., "A Simpel Real-Time Energi Analytics Model For Smart Building Using Open IoT Platforms," *Jurnal Elektronika dan Telekomunikasi (JET)*, Vol. 19, Number 2, December 2019.

[5] M. Hendrananta, et al., "Application of Intelligent Building System In The Edge Amsterdam and Glumac Shanghai," *Prosiding Seminar Intelektual Muda*, September 5, 2019, Universitas Trisakti.

[6] M.M. Froufe, et.al., "Smart Buildings: Systems and Drivers Buildings," retrieved from https://doi.org/10.3390/buildings10090153 on January 18, 2022.

[7] C. Pfister, "Getting Started with the Internet of Things," *O'Reilly*, 2011.

[8] V. Shivangi, et.al., "Internet of Things: A Vision, Architectural Elements and Security Issues," *International Conference on I-SMAC*, 2017.

[9] D. Setiawan and Y.D. Kuntjoro, "Smart Building Perspective In Support Energy Security," *Jurnal Pertahanan*, Vol 1. No. 3. 2015.

[10] O. Temidayo, et al., "Making a case for smart buildings in preventing coronavirus: Vocus on maintenance management challenges," *International Journals of Construction Management*, Taylor & Fraches, 2020.

[11] M. Umair, et.al., "Impact of Covid-9 on IoT Adoption in Healthcare, Smart Homes, Smart Buildings, Smart Cities, Transportation, and Industrial IoT," *Sensor*, 21, 3838, 2021.

[12] Sulistiawan, Fernanda, and Andiyan, "Application of contemporary smart building architecture at the Parahyangan Citywalk Shopping Center in Kota Baru Parahyangan," *Teknika: Jurnal Sain dan Teknologi*, Vol. 17, Number 02, 2021.

[13] Sutabri, et.al., "Design and Build of a Wemos-Based Smart Building Control Tool at Citra Solutions Pratama, Ltd.," *Jurnal Teknologi Informatika dan Komputer*, Vol. 8, Number 1, 2022.

[14] M.R. Branch, "Instruction Design: the ADDIE approach," *Springer Science + Business Media*, New York, 2009.

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