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Smart Electrical Appliances Application for UTHM Pagoh Residential College

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Abstract

The user's irresponsible attitude in controlling electrical switches lead to electricity waste. To propose an alternative way to reduce power consumptions at UTHM Pagoh Residential College, the Smart Electrical Appliances Application for UTHM Pagoh Residential College that blends Internet of Things (IoT) with electrical appliances, has been developed to provide an efficient method for users to control the appliances by using their smartphones. It is based on one room at UTHM Pagoh residential college and equipped with light bulbs and a fan with a DC motor. This project was made to reduce the cost of electricity and assist college residents in managing their daily life properly and encourage more efficient and convenient electricity usage using IoT technology. The agile development methodology has been chosen as it deems suitable for this project as it requires multiple improvements that was based on 6 phases which are planning, design, development, testing, deployment, and review. We have developed an IoT application by using C++ programming language that is used to connect the ESP8266 Wi-Fi module with the Blynk application to control the electrical appliances through smartphones while the voice control function with using Google Assistant also is applied for this project using the IFTT software. The interaction between user and Blynk application will send a signal to the Wi-Fi module that will interact with the relay module which will result in the switching ON or OFF of the electrical appliances. As a result, this project will be able to give its' users the opportunity to benefit it to experience the technology advancement, ease their daily life and conserve the electrical supply at the same time. In the future, this project can be used as reference at UTHM Pagoh Residential College to apply its' concept to their rooms to simplify the resident's life and preserve the electrical supply.

1. Introduction

Today's advanced technology is becoming more and more widely used because it offers an easy way of life to its users. In detail, IoT technology is increasingly being developed and used by people like the smart home system or home automation system. With technology like this, it should be used by more people or organizations because it

provides a more efficient life alternative. It was also developed to prevent its users from doing waste like wasting electricity.

Life as a student can be hectic with never endings assignments and projects non-stop. This could lead to carelessness in appreciating basic life necessities like water and electricity usage in residential college. Therefore, we propose the development of a prototype of an IoT device that allows residents to control the electrical household appliances in UTHM Pagoh Residential College using an internet and Wi-Fi connection. IoT has provided the applications to turn non-smart device into smart device, which allow users to access these devices through the internet [1]. The project seeks to minimize electricity consumption and prevent waste in residential colleges while providing an application that eases the daily life of the user. The more such facilities and appliances are added, it becomes inevitable to have easy and convenient methods and means to control and operate these facilities [2].

The Smart Electrical Appliances Application for UTHM Pagoh Residential College aims to provide a simple, user-friendly, and convenient way for managing electrical appliances in residential environment. We have received tremendous improvement in the technology, but still power consumption is one of the big issues all over the world [1]. By reducing energy waste and providing an easy-to-use interface, this project can help UTHM Pagoh's residents become more aware of their electricity usage and contribute to the conservation of resources. With the creation of this project, the electricity supply can be preserved and the residents of UTHM Pagoh Residential College can live their life without worrying about the status or condition of the electrical appliances.

1.1 Problem Statement

The availability of a reliable electrical supply is essential for various types of homes, particularly those housing multiple residents such as apartments, condominiums, and residential colleges. Many research investigations have indicated a positive correlation between the number of households and electricity consumption. As the number of households increases, so does the demand for electricity. UTHM Pagoh residential college, with its four rooms occupied by 12 residents, experiences significant electricity consumption. Unfortunately, some residents may not fully appreciate the importance of conserving energy and may unintentionally or intentionally waste electricity. In other words, the residents which are the students of UTHM Pagoh and some of them always forgot or purposely did not turn off the electrical appliances' switches when they leave their room to go to the campus or cafeteria. By providing amenities and user-friendly features, the application seeks to enhance the residents' experience and facilitate their daily routines. In today's modern era, people are increasingly interested in utilizing technology that simplifies their lives and conserves energy, especially within their homes. The Smart Electrical Appliances Application aligns with these expectations by offering a user-friendly interface that allows residents to control electrical appliances remotely. Instead of relying on traditional wall switches that require physical access, residents can conveniently operate their appliances through the application, saving time and energy.

1.2 Objectives and Project Scope

To address these energy consumption challenges and promote energy conservation, the Smart Electrical Appliances Application for UTHM Pagoh Residential College has been developed. The main goal of this project is to provide a convenient solution for residents to effectively manage and preserve electrical supply while ensuring their comfort and satisfaction. Moreover, this project aims to encourage residents to adopt more efficient and mindful energy usage practices. The objective of the B405 Smart Hostel Project is to propose a prototype that enables UTHM Pagoh residential college residents to control their household appliances using a mobile application. The project aims to develop an IoT device prototype that allows residents to control appliances through internet and Wi-Fi connectivity, minimizing electricity consumption and wastage. Additionally, the project seeks to provide a user-friendly application that simplifies daily life for the residents. The project scope focuses on room B405 in block A6, serving as an example to address the issue of electricity wastage caused by a lack of awareness and manual control of appliances. By utilizing the application, residents can easily manage their electrical supply, promoting convenience and efficiency.

2. Literature Review

The Internet of Things (IoT) is a rapidly developing technology that aims to maximize existing resources, including the internet and physical technology. It encompasses various applications, such as smart home systems and agriculture equipment. The Smart Electrical Appliances Application for UTHM Pagoh Residential College aims to integrate IoT technology into the smart home system, ensuring efficient living and operation for humans. This project coexists with other technologies that utilize the IoT concept, enhancing the overall efficiency of human life.

The Smart Electrical Appliances Application for UTHM Pagoh Residential College is based on Internet of Things or better known as IoT. This project combines both physical objects and internet together to function as one collaborative unit which defines as an IoT technology. IoT has a lot of functionality and being used in many

industries or fields in the world [3]. In this era of technological growth, the world benefits IoT's existence and used it to make things easier to be done or operated. IoT scenarios are applied to applications with smart devices which users apply them in their daily activities in various fields [4]. However, there were a few systems that had a similar concept to the smart home systems, as referenced in the development of the smart electrical appliances application for UTHM Pagoh residential college. Smart products like Arduino Based Home Automation using IoT, Microcontroller Based Smart Home System with Enhanced Appliance Switching Capacity, and Smart Home Automation and Security System using Arduino and IOT were compared in terms of its description, advantages, and disadvantages for overall review.

Research has been made on some of the existing projects that are related with the Smart Electrical Appliances Application for UTHM Pagoh Residential College. Firstly, Arduino based home automation using IoT [5] which is a home automation system added with security that controls fan, light, television, room heater and other sensors. It is able to detect a variety of gas using gas sensor and possess temperature sensor that can measure temperature and humidity of the room. However, it has delay response from the ESP8266 Wi-Fi module when using the application. Besides that, project, there is Microcontroller Based Smart Home System with Enhanced Appliance Switching Capacity [6] project, which is a low-cost smart home system that offers a variety of uniqueness. This project is able to control up to 208 appliances, possess automatic night light, able to enable the alarm and contact the user in if any emergency occurred. Unfortunately, it has complex structure especially its' wiring management on the prototype. Other than that, there is also Smart Home Automation and Security System using Arduino and IoT [7] which is a home security automation system that controls the home's security sensors for the home's security purposes. It possesses the ability to control flux, fire, and door sensor, able to measure acceleration of the object and possess automatic light control by detecting the brightness of light. Even so, the details of application used is not described.

There are a lot of features that are just the same between the projects and the things that are differentiate them is the performance, functionality, and their own special features. These three projects used a microcontroller technology or function whether it is Arduino Uno or ESP8266 Wi-Fi module that are used to be operated as the main connector that is able to link the internet and the physical components. Arduino Uno and ESP8266 Wi-Fi module are the most important components or hardware that are needed in order to successfully implement the smart home system. For instance, the Arduino based home automation using IoT project that used the ESP8266 Wi-Fi module to support the system connection. Apart from that, in terms of quality or performance, Microcontroller Based Smart Home System with Enhanced Appliance Switching Capacity is the better one. With emphasizing the energy-efficiency as their one of the main concepts, this project possesses a high-quality structure that certainly needed by people. Moreover, Smart Home Automation and Security System using Arduino and IOT project has many interesting features or functionality that will without a doubt attract people's attention since it highlights the security and pleasure for the user. For example, the automatic night light that will ease the user by providing the comfort especially for the eyes. In addition, this project also has good and simple structure, yet it has top-tier features or functionality and operation.

3. Methodology

The selected methodology for this project is the agile methodology that is composed with a total of 6 phases which are carried out to effectively implement this project. These 6 phases will be the main content for this chapter that is aimed to be describing about the project along with the methodology that is used. The project's development process is done by referring and implement those phases which are planning, design, development, testing deployment, and review. Agile methodology is the iterative way for developing the software project for frequent changes, fast delivery and reducing risk [8]. This methodology is chosen since it is suitable for this project since it is required multiple improvements and there is also a period given to complete the project and need to fulfil the required basic standard at the same time. Agile methodologies are in general oriented to the quick obtaining of results, which also means that used of agile methodology can ensure the smoothness of the project development simply and effectively [9]. Fig. 1 shows the 6 different phases of agile methodology.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 200-208

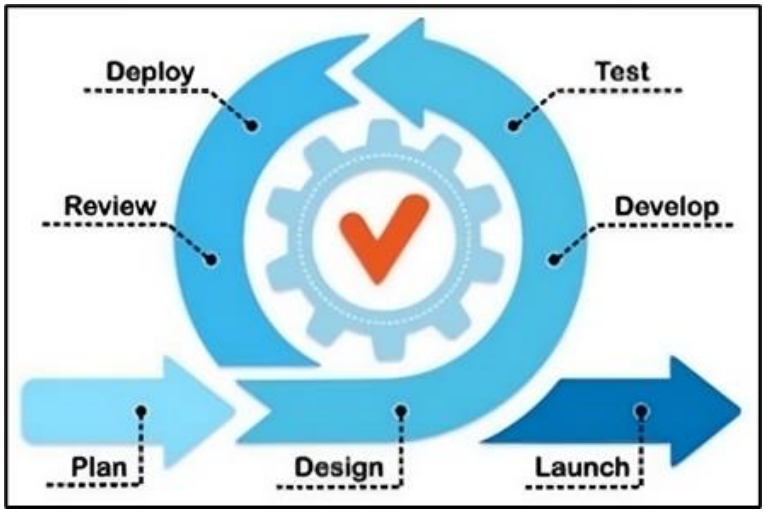

Fig. 1 *Agile methodology*

3.1 Planning

The first phase in Agile methodology is planning phase. One of the primary objectives of the planning phase was to define the project goals and objectives as well as the project's scope. The features, and functionalities of the project will also be identified. This Smart Electrical Appliances Application for UTHM Pagoh Residential College project aims to develop a prototype of an IoT device that allows residents to control the electrical household appliances with internet and Wi-Fi connection. Other than that, to prevent waste and minimize the electricity consumption of residential college and also providing an application that can ease the daily life of the user which is the residents of room B405 at UTHM Pagoh residential college.

After careful consideration, it was determined that the Smart Electrical Appliances Application would be developed specially to allow for remote control of the fans and lights in the B405 room at the UTHM Pagoh Residential College. This intention minimised project scope enables a targeted strategy for addressing the specific energy-saving requirements within this well-defined environment.

3.2 Design

The design phase is an important stage in the Agile methodology, where the project team concentrates on developing the design and architecture of the solution based on the requirements given in the planning phase. This phase involves constructing the design of the IoT system including hardware and software and how they will communicate. In this case we will develop a prototype to illustrate the solution. Hardware that will be used to implement this prototype are Wi-Fi board ESP8266, 8 Channel Isolated 5V Relay Module, light bulb, bulb holder, DC motor, rocket switch, Breadboard, resistor 6.8 ohm, 9V batteries, and jumper wires for connection. Fig. 2 shows the circuit of the prototype.

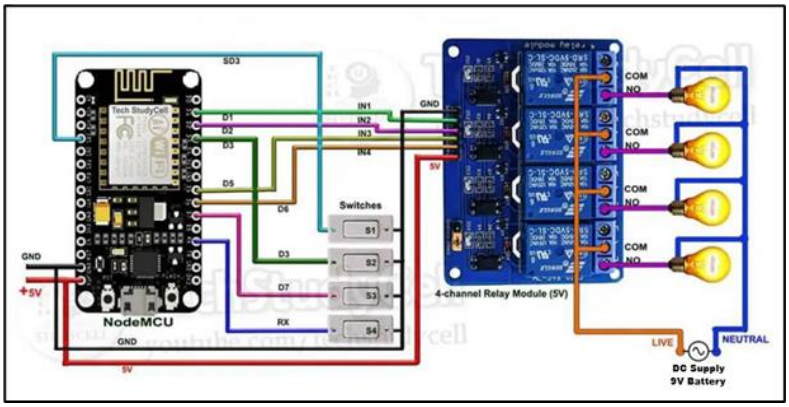

Fig. 2 *Circuit diagram*

The ESP8266 Wi-Fi Board will be used as the main controller of the project, which executes all the codes for this project to run. The codes are implemented on the ESP8266 Wi-Fi board using the Arduino IDE software. The ESP8266 Wi-Fi module then gives instructions to the relay module to turn on and off the electric current. Therefore, the bulbs and DC motors connected to each relay can be turned on and off by user interaction with the

Blynk application. On the other hand, the Blynk application is also connected with Google Assistant to use the voice control feature. It is done by using the IFTT software as their connection medium. Webhooks, which is a feature in IFTT is used to connect with Blynk application by using Blynk's link so that this three software can work together to enable the voice control function. To prevent the bulb from burning due to excessive electric current from the battery, a 6.8-ohm resistor is connected to each bulb. The DC motor does not use a resistor because it works by receiving an electric current and reacting with the amount of current obtained. For example, if a lot of current is obtained, the faster the DC motor rotates, while if it receives a low electric current, the motor will rotate slowly.

3.3 Development

During the development phase, the designers and developers collaborate to create a functional product. They write code for the software components, integrating them with the hardware components. The project focuses on implementing features such as remote control of fans and light through the application interface. The author used Arduino IDE software to program the connection between the ESP8266 Wi-Fi module and the mobile application called "Blynk" using C++ programming language. The interface of the Blynk application, shown in Fig. 3, contained five buttons, each corresponding to the control of four lights (Room A, Room B, Room C, Room D) and one fan. Besides that, Fig. 3 also shows the interface of the IFTT software and Google Assistant that shows the voice instructions or commands to control the electrical appliances. The team works in iterative sprints, with collaboration from testers to identify and resolve any issues. Unit testing ensures the proper functioning of each feature within the overall system.

The author chose ESP8266 over Arduino for the project due to its built-in Wi-Fi module, eliminating the need for external mounting. Wi-Fi was preferred over Bluetooth due to its wider network range. ESP8266 and Arduino were selected as they are cost-effective, reliable, and user-friendly platforms for individual control home automation systems, aligning with the project's focus [10].

Lastly, the development team seeks feedback from the project supervisor, residents of room B405 at UTHM Pagoh residential college, and evaluators. This feedback is carefully analysed, and necessary adjustments and improvements are made to improve the application's functioning and user experience.

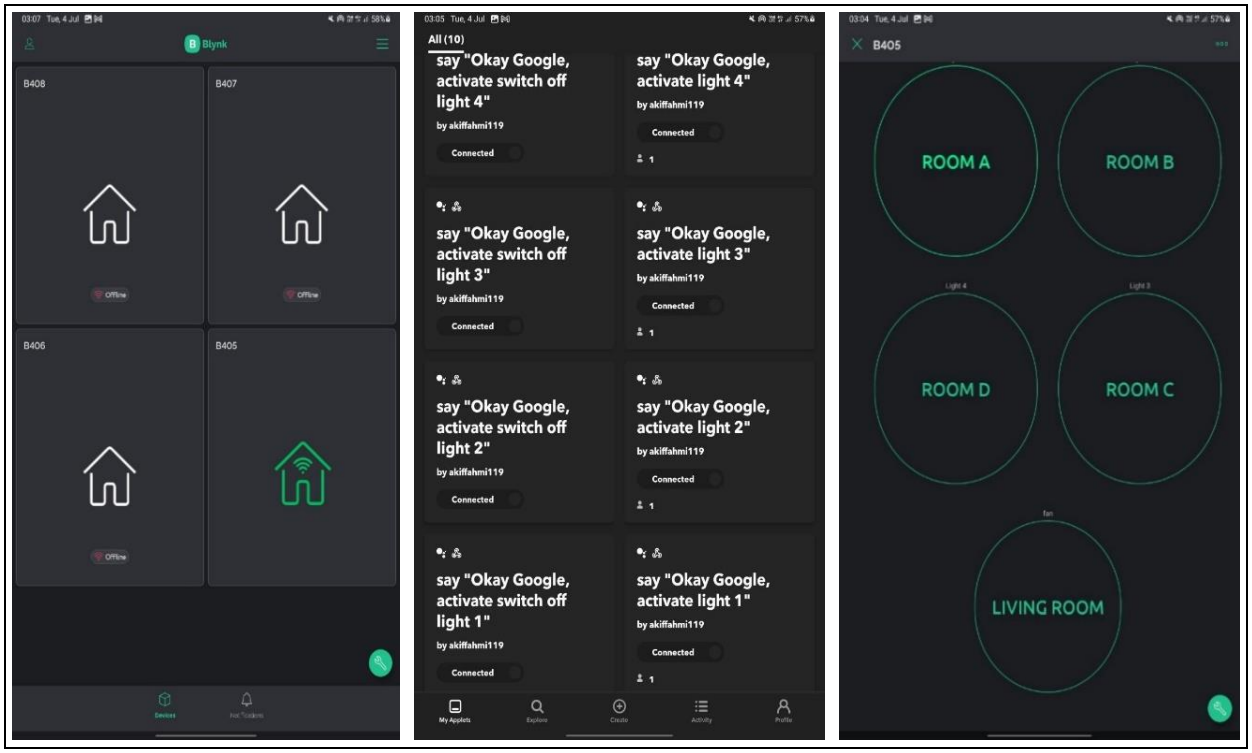

Fig. 3 *Interface of Blynk application and IFTT and Google Assistant*

3.4 Testing

The testing phase is done by referring to Fig. 4. The testing phase is flexible since it does not have a specific level or phase to implement, which is very suitable for this project. This is because the Smart Electrical Appliances Application for UTHM Pagoh Residential College project required many corrections and improvements from time to time, such as the codes that needed to be added or changed at some point while developing the project. To make

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 200-208

sure the project runs well according to the desired need, it needs to be tested repeatedly until it reaches the point where there is no need to enhance or change its structure. When the testing did not meet the requirement such as when the programming for the ESP8266 Wi-Fi module with the light bulbs did not work out, the research will be done first to search its' solution and followed by designing the new output based on research made. After that, the project will once again be developed according to the design and will be test after.

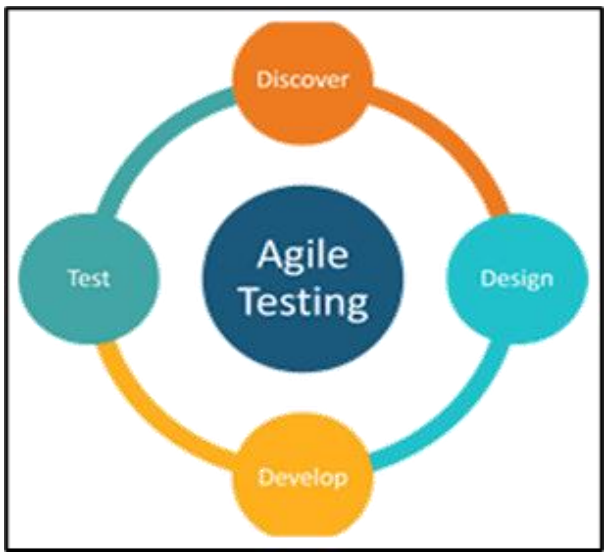

Fig. 4 *Flow of testing phase*

3.5 Deployment

A phase that involves another audience depends on the progress of the project's development, which in this case is the project's supervisor, the residential college management, and the project's evaluator. The project is deployed to them to gain their feedback. The obtained feedback was analysed and adapted to the project so that it could be better than before, such as with feature addition and mistake correction. The enhancement and improvement of the project are mostly advised by the project's supervisor. Apart from that, when the project is entirely completed with success, it is deployed to the project's evaluator and residential college management to gain the final assessment.

3.6 Review

This phase decides what will be in the next project development process or iteration. This project required a lot of improvement since there are many constraints that prevented the project's creation, such as the fact that the codes and components did not work as planned. However, the project is improvised in the next iteration after referring to the feedback and the problems that existed when developing the project.

4. Result and Implementation

This project developed a prototype of the Smart Electrical Appliances Application for Pagoh Residential College as well as the technology that allows it to work. The development phase of this project is the most important and difficult stage since there have been numerous failures and unsuccessful processes to make this product work properly. Fig. 5 (a) shows the design of the prototype and Fig. 5 (b) shows the prototype of the project. The prototype of the project is created according to the design in Fig. 5 (a), which is the sketch model of the interior design of B405 room at UTHM Pagoh residential college. Hardware that are used to complete the circuit are Wi-Fi board ESP8266, 8 Channel Isolated 5V Relay Module, light bulb, bulb holder, DC motor, rocket switch, Breadboard, resistor 6.8 ohm, 9V batteries, and jumper wires for connection.

Fig. 5 *Overview for (a) Design of the prototype; (b) Prototype of the project*

After developing and testing the function of the prototype, the author then conducted a questionnaire using a digital platform called Google Forms to gather feedback about the project from the residents of B405. The questionnaire was designed specifically to address the project's scope, which primarily focuses on the residents of B405. By utilizing Google Forms, the author was able to distribute the questionnaire electronically, allowing the residents to provide their feedback conveniently and efficiently. The questionnaire most likely included questions about the project's functionality, usefulness, and overall impact on the lives of the residents involved. This feedback would provide the author with helpful data to assess the prototype's effectiveness and make any necessary improvements or modifications to better correspond with the demands and preferences of the residents of B405. Fig. 6 and Fig. 7 shows the feedback that were received from users via the Google Form survey created.

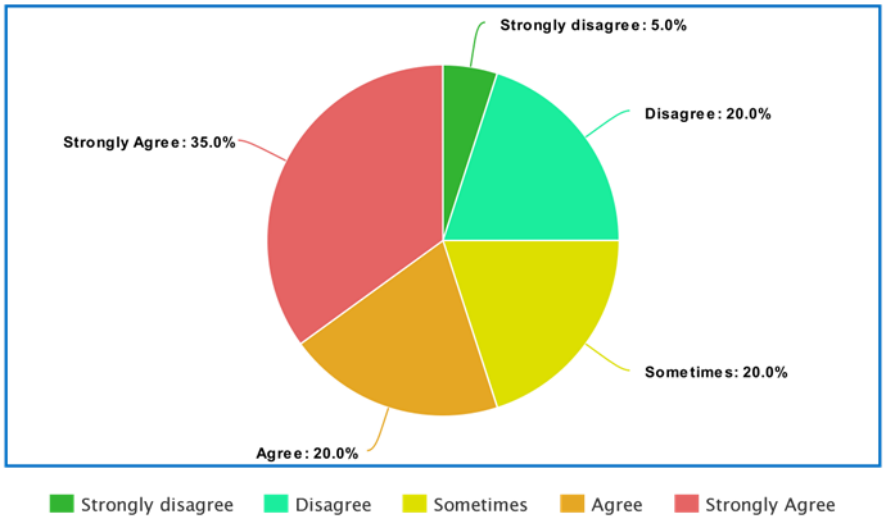

Fig. 6 *Degree to which people forget to turn off the lights*

In Fig. 6, the data highlights a significant trend, many people consistently forget to turn off the lights when leaving the college premises. This observation underscores the existence of an important issue requiring further investigation. An analysis of survey responses reveals that this forgetfulness often results from the demanding nature of college life, including classes, assignments, and extracurricular commitments. This widespread behaviour underscores a significant problem in need of a solution.

In this context, the implementation of the Smart Electrical Appliances Application for UTHM Pagoh Residential College offers a promising solution. This innovative system enhances user convenience by providing a more flexible and user-friendly approach to managing electrical consumption compared to traditional methods. The goal is to simplify the process for residents or students, making it more convenient and reducing the likelihood of neglecting the status of electrical appliances.

Multidisciplinary Applied Research and Innovation Vol. 5 No. 1 (2024) p. 200-208

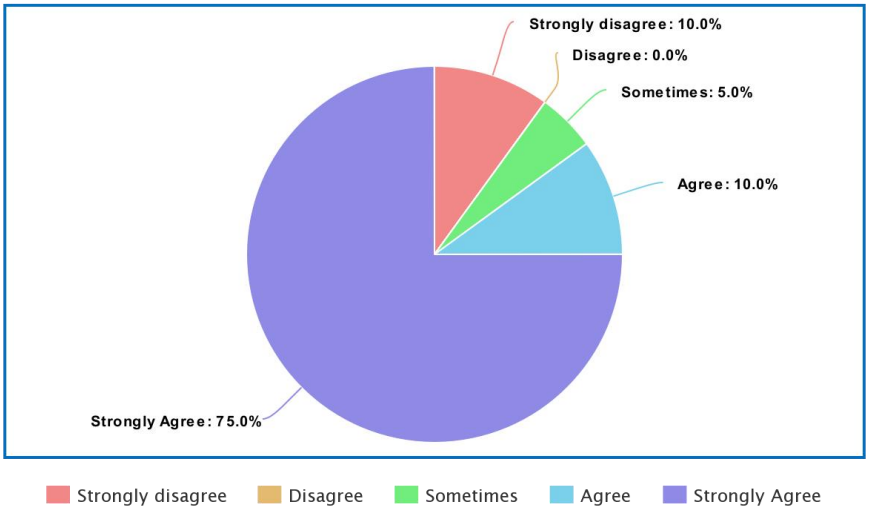

Fig. 7 *Degree of desire in having a system that help save electrical usage*

The data presented in Fig. 7 further reinforces the positive response, as a significant number of users expressed a desire for a system that can help simplify and save electrical usage. From all the responds given via the Google Forms survey, respondents found the system will be highly effective, as it simplifies electrical appliance control via a smartphone with a Wi-Fi connection. This feedback underscores the project's success in achieving its goal of providing an efficient and user-friendly solution for optimizing electricity usage.

For instance, one respondent mentioned, "I benefit greatly from the mobile application for controlling appliances in my college dorms. Sometimes, due to forgetfulness or rush to class, I'd leave appliances on, but now I can easily manage them". This feedback underscores the practicality of such technology in addressing common issues of forgetfulness and time constraints among college students, ultimately contributing to energy conservation and convenience. The respondent positive experience supports the research conclusion that implementing these applications in college dormitories offers a valuable solution to optimize energy usage.

5. Conclusion and Recommendations

The Smart Electrical Appliances Application for UTHM Pagoh Residential College is an innovative IoT project. With a user-friendly mobile app, residents can control appliances remotely and conserve energy effectively. Following an agile methodology, it includes planning, design, development, testing, deployment, and review phases. Residents praised its efficiency in controlling lights and fans, making it a successful solution for energy conservation. The project empowers residents to actively manage electricity usage, promoting a greener lifestyle. A potential future improvement for the project is to add notifications to the application for appliance status awareness. Additionally, incorporating recorded electricity usage and a timer feature would allow residents to monitor usage and automatically turn off appliances when needed, optimizing energy consumption.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design, data collection, draft manuscript:*** *Ammar Muaz Zaidi, Muhammad Akif Fahmi Mohammad Kamal, Mohammad Danish Fitriey Asmawi, Noordiana Kassim @ Kasim;* ***draft manuscript preparation:*** *Ammar Muaz Zaidi, Muhammad Akif Fahmi Mohammad Kamal, Mohammad Danish Fitriey Asmawi, Noordiana Kassim @ Kasim. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] P. M. B. Mansingh and G. Sekar, "Energy efficient home automation system using Li-Fi," *Adv. Eng. Res.*, vol. 49, pp. 197–211, 2022.

[2] K. Janani, S. Harini, B. Abirami, and V. J. Vijayalakshmi, "IOT based home automation using cloud," *12th Int. Conf. Adv. Comput. Control. Telecommun. Technol. ACT 2021*, vol. 2021-August, no. 03, pp. 927–933, 2021.

[3] G. Lampropoulos, K. Siakas, and T. Anastasiadis, "Internet of Things in the Context of Industry 4.0: An Overview," *Int. J. Entrep. Knowl.*, vol. 7, no. 1, pp. 4–19, 2019, doi: 10.2478/ijek-2019-0001.

[4] P. Asghari, A. M. Rahmani, and H. H. S. Javadi, "Internet of Things applications: A systematic review," *Comput. Networks*, vol. 148, pp. 241–261, 2019, doi: 10.1016/j.comnet.2018.12.008.

[5] N. M. Lalit Mohan Satapathy, Samir Kumar Bastia, "Arduino based home automation using Internet of things (IoT)," *Int. J. Pure Appl. Math.*, vol. 118, no. 17, pp. 769–778, 2018.

[6] M. Hasan, M. H. Anik, and S. Islam, "Microcontroller Based Smart Home System with Enhanced Appliance Switching Capacity," *ITT 2018 - Inf. Technol. Trends Emerg. Technol. Artif. Intell.*, no. April 2019, pp. 364–367, 2019, doi: 10.1109/CTIT.2018.8649518.

[7] S. Wadhwani, U. Singh, P. Singh, and S. Dwivedi, "Smart Home Automation and Security System using Arduino and IOT," *Int. Res. J. Eng. Technol.*, pp. 1357–1359, 2018.

[8] F. Hayat, A. U. Rehman, K. S. Arif, K. Wahab, and M. Abbas, "The Influence of Agile Methodology (Scrum) on Software Project Management," *Proc. - 20th IEEE/ACIS Int. Conf. Softw. Eng. Artif. Intell. Netw. Parallel/Distributed Comput. SNPD 2019*, no. December, pp. 145–149, 2019, doi: 10.1109/SNPD.2019.8935813.

[9] A. López-Alcarria, A. Olivares-Vicente, and F. Poza-Vilches, "A systematic review of the use of Agile methodologies in education to foster sustainability competencies," *Sustain.*, vol. 11, no. 10, pp. 1–29, 2019, doi: 10.3390/su11102915.

[10] A. Choudhary, S. Yadu, B. Raj, and R. Jhapte, "Home Automation using IoT by NodeMCU ESP8266," no. 05, pp. 899–901, 2023.