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IoT Inventory Parcel System – Pagoh Residential Students College

Muhammad Izz Dzikri Mohd Faisal[1], Ahmad Syahidan Ahamad Azahari[1], Muhd Amirussyahmy Haneis Mohd Noor Salleh[1], Juliana Mohamed[1]*, Mohamad Fazirul Rafiq Afandi[1]

1 Department of Information Technology, Centre for Diploma Studies
Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author: julianaju@uthm.edu.my
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Abstract

Parcel delivery is a common issue that happens in residential students' colleges. A common issue they face is parcel loss and failed delivery attempts that cause a lot of trouble to students. This project aims to help Pagoh Residential Students with the parcel management problem. An innovative, automated system called the Internet of Things (IoT) Inventory Parcel Management System was created to improve supply chain and logistics operations, inventory, parcel security and efficiency. Recently, IoT technology has been applied in various fields. The project is built with an app that can help to partly prevent theft. Within that, authentication is applied in this project to secure the parcel in the box. Users need to fill in the authentication with the OTP address from the app to open the box. By using the IoT system it will efficiently, parcel theft expenses are decreased, and customer satisfaction is raised with a user-friendly interface. When a parcel is delivered, the data is stored in the database app. In conclusion, we are hoping with this system will help the Pagoh Residential College in parcel management.

1. Introduction

The growing issue of package theft in residential institutions calls for a creative and practical response. Using cutting-edge Internet of Things (IoT) technology, the suggested Inventory Parcel System is made to fully handle this problem. With IoT systems and safe authentication, this project aims to improve security and parcel management procedures.

The Internet of Things system provides security to guarantee that all the data stored and sent to the system is protected from unauthorised access. This to make ensure integrity of the parcel management process and protect confidential data associated with package deliveries require a high level of security [1]. This project started from 19 April 2024 to 16 June 2024 with important technologies such as Servo Remote Control (RC) Planes and Arduinno also box to store the parcel [1]. Through this project will hope to help students since the project applies IoT technology. In addition, this technology has various functionalities, including linking with any device such as a mobile phone and designing IoT device functionalities. From these considerations, our system may improve the total economics of the parcel delivery system [2].

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1.1 Project Background

IoT Inventory Parcel System is more focused on ways to construct interaction with tangible gadgets. This method is known as "tangible interaction", that give strong physical interactions with digital technologies. Tangible interaction can close the gap between the real and virtual world by integrating tangible things that users can move, touch and manipulate [3].

Tangible interaction very powerful in an IoT system. Currently, as we can see, in a smart home where tangible items such as a light switch, security lock or thermostat knob it will communicate directly with the digital management system of the house. Users can use smart gadgets naturally and instantaneously by utilising tactile controls that reduce cognitive strain associated with abstract digital interfaces such as screens and buttons [4].

To summarise, the project implemented a tangible interaction that will make parcel management smart as a system. This method makes digital functions more natural, interesting and meaningful for users by allowing physical things to govern digital ones. Also, IoT technology is more appropriate and usable [1].

1.2 Problem Statement

Regarding the common issue in residential colleges, unclaimed parcels have increased significantly in recent days, causing financial losses and creating a sense of insecurity in the students. Furthermore, this growing number of unclaimed parcels has emerged as a critical situation. The store is not disorganised, and ineffective is consequences of students forgetting to pick up their packages even have been delivered. This not only makes it difficult for other students to find their parcel but also for the administration to keep things tidy and safe. This case necessitates a prompt and practical solution to protect student property [5].

Another challenge is facing, parcel theft that causes insecurity among students. This problem leads to monetary losses since students financial is hard. Students experience anxiety and financial hardship when their parcels are lost since there are not enough security implements while; unclaimed packages are not ineffective, and possible to lost is high. Inadequate notice is not enough, and hectic student schedules, made worse by inadequate storage options, are contributing reasons. To solve this problem, the administration needs strong system management to increase security and streamline notification procedures to effectively arrange the storage to guarantee the security of the parcels [6].

Parcel management is important to make sure the flow of packages and students' property is secure. With the two problems above, this project implements secure parcel boxes to reduce parcel theft and ensure the protection of deliveries. These boxes feature strong security, such as tamper-resistant designs and secure installation, that prevent theft and safeguard parcels until they are retrieved by authorised recipients. By providing secure boxes, the system enhances efficiency in parcel management to protect from weather damage; it can be accessed by authorised recipients with authentication. This approach not only minimises parcel theft but contributes to a more organised delivery process in residential colleges or any other setting where parcel security is paramount [7].

1.3 Literature Review

Internet of Things (IoT) is one of the terms in information technology. IoT will turn physical objects into virtual entities in the future. It seeks to bring everything from our environment under one structure that enables us to not only control objects around us but also be informed about their current states [8]. Within this, the main aim of this project is to present an overview of the Internet of Things, its architectures and its essential technologies. This field has changed as a result of the confluence of several technologies such as machine learning, ubiquitous computing, commodity sensors and increasingly embedded systems. IoT is possible as earlier domains to embedded systems, wireless sensor networks or control systems (smart home) and automation both separately and together. This technology is most commonly associated with "smart home" products in the consumer market. These products include lighting fixtures, thermostats, cameras, home security systems and other appliances [9].

The delivery of shipping and express containers, parcels, or high-value main is single shipment is referred to as parcel management. For comparison, the trucking service providers are less offer and commonly offered by postal technology, express, and personal delivery companies. In the world today is digital, and E-commerce is widespread. Logistics centres frequently struggle to meet staff expectations due to the overload of parcel delivery [10]. Parcel Management provides integration of the shipping process through a carrier's process from the warehouse operations to fulfilment order and shipping, blending together as one process. This process reduces costs and improves control to provide better customer services are accomplished by streamlining the process of domestic and international shipping manifestation, shipping label and report printing and shipment tracking. With features such as carriers and integrators, it will accommodate both process to packages shipping. Second, manifestation, because the aim is to facilitate the carrier manifestation process through automated

interfaces with the carrier or integrator by determining all necessary information based on the process-carrier, service level, accessorial, etc. [10].

In other words, IoT parcel management presents a transformative system in the logistics and supply chain industry, utilising interconnected devices and sensors to enhance the processes of parcel management. These technologies help with sorting processes in warehouses and provide precise indirectly reducing human error. This is to ensure every package that delivered optimises storage space and minimises the risks of theft. IoT technologies provide end-to-end visibility throughout the supply chain from the supplier to the final customer. This is to identify delays, pickups, or issues proactively and ensure a smoother delivery process. Within that, the technology offers robust solutions to enhance it. The authentication security allows authorised customers to pick up the parcels [1], [2].

2. Methodology

The use of a hybrid approach in this project is consistent and compatible with the project requirements and procedures for achieving the objectives. This methodology is chosen after a thorough examination of each activity and the steps taken during the phases. The IoT Inventory Parcel System employs a hybrid methodology that allows for iterative improvement, resulting in better refinement and continuous improvement of the system. Each phase of the hybrid methodology is repeated in cycles of planning, design, develop, and evaluate the project using an iterative approach through user testing. This methodology allows the project to maximise the system's adaptability, adapt to the project's changing needs, and, most significantly, promote gradual improvements in system functionality and performance. In each iteration of the methodological process, feedback from stakeholders, the most important of which is the inventory manager, is used, as well as previous studies that have demonstrated the importance of iterative and combined forms for more detailed project requirements by prioritising improvements and discovering features. The agile loop of this iterative methodology can identify and rectify issues that arise during the process phase, ultimately leading to a more accurate solution for prioritising users in this system. Fig. 1 depicts the Hybrid methodology.

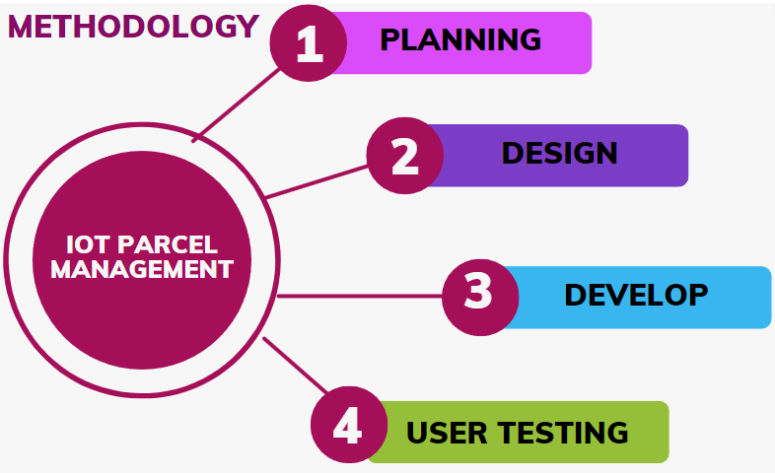

Fig. 1 *Hybrid methodology*

2.1 Planning

This phase to identify the requirements of this project, where the foundation for the entire system is established. It involves a series of strategic and tactical steps designed to ensure successful implementation and operation of this project. The steps include requirement analysis to identify the objectives, technology and infrastructure planning to choose appropriate IoT devices, and security to ensure a comprehensive security strategy to protect IoT devices, data, and communication networks.

2.2 Design

In the design phase of the IoT Parcel Management project, need to think carefully about the architectural concept, system functionality and user interface. The most critical is designing the box in which the parcel is to be stored because it needs to be designed in line with the user's needs. It prioritises the security of user data by utilising highly secure software (Arduino IDR) and functions. The security of user data is prioritised with the use of highly secure software and functions to protect the privacy of system users. This phase is part of a hybrid methodology to make sure the design reaches all aspects. The design of model projects and the interface is designed to be user-friendly.

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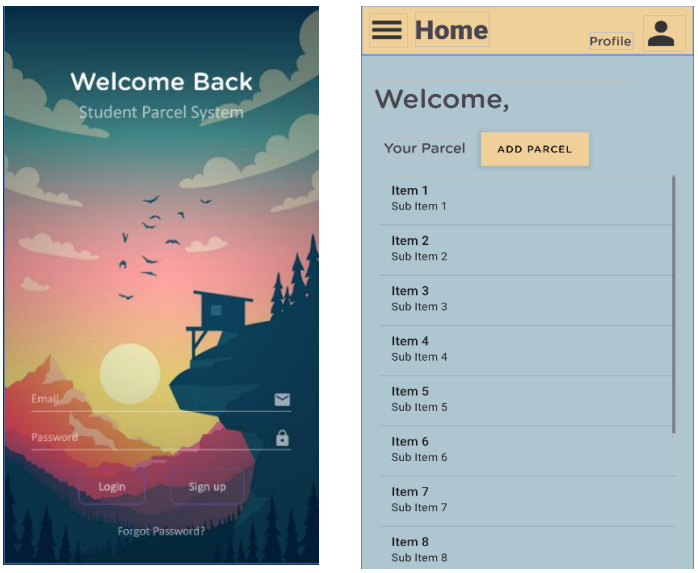
Based on Fig. 2, the IoT Parcel Management project designed an app to enhance the management of the parcel. Fig. 2 (a) shows the interface of log in, the main page of the app. He/she should sign up first before they can log in to the app and manage their own parcels. Fig. 2 (b) interprets to the homepage interface where the list of parcels shows here, whenever he/she will be having it. If they didn't have any parcels, the list of parcels would disappear.



(a) **(b)**

Fig. 2 *Figure description (a) Log In Interface; (b) Homepage Interface*

2.3 Develop

This phase develops and implements the functional design that implements. This involves writing the code using Java to control functional buttons in the apps, while using XML to create user-friendly interfaces aligned with the design phase. It also uses Arduino IDE and C++ to control Arduino maker in the apps. Extensive testing ensured the system meets the high standards set during the design phase.

2.4 User Testing

The testing phase ensured the project met its objectives. It involved testing the code functionality, database to handle user data security and user interface for ease of use. For usability testing with a survey, it shows 89.5% of respondents would recommend this app indirectly, which ensures a user-friendly experience.

3. Results and Discussion

A total of 19 selected respondents were allowed to test the IoT Parcel Management System to ensure that this app is practical and effective for enhancing parcel management.

Table 1 *Percentage of respondents by gender*

Gender	Percentage
Male	52.6%
Female	47.4%

The majority of respondents referred from Table 1 are UTHM students who stay in residential college; 52.6% are male, and 47.4% are female. They were given a Google Form link to give feedback about this system. The questionnaire uses a Linear Scale to measure the assessment according to the questions provided.

Table 2 *User percentage assessment*

Questions	Highly Dissatisfied	Dissatisfied	Neutral	Satisfied	Highly Satisfied
This application is easy	5.3%	0%	15.8%	52.6%	21.1%

to use					
This application suitable for general use	5.3%	0%	21.1%	36.8%	31.6%
Attractive application user interface	0.0%	5.3%	15.8%	42.1%	31.6%
Mobile application is easy to use	0%	0%	26.3%	31.6%	36.8%
The application displays information immediately	0%	0%	10.5%	47.4%	36.8%
Does this application help improve problem-solving in parcel management	0%	0%	5.3%	47.4%	42.1%

Table 2 presents the user percentage assessment of the developed mobile application based on several usability and user satisfaction criteria. Overall, the findings indicate that the application received positive feedback from users, with the majority of respondents selecting either "Satisfied" or "Highly Satisfied" for most evaluation items.

For the statement "This application is easy to use," 52.6% of respondents were satisfied, while 21.1% were highly satisfied. Only 5.3% of users reported being highly dissatisfied, indicating that the application generally provides a user-friendly experience.

Similarly, for the statement "This application is suitable for general use," 36.8% of respondents were satisfied, and 31.6% were highly satisfied. However, 21.1% of respondents selected neutral, suggesting that some users may still require improvements in terms of accessibility or functionality for broader public usage.

In terms of interface design, the item "Attractive application user interface" showed encouraging results, where 42.1% of respondents were satisfied, and 31.6% were highly satisfied. Only 5.3% expressed dissatisfaction, demonstrating that the visual appearance and interface design were positively accepted by most users.

The statement "Mobile application is easy to use" also recorded positive responses, with 31.6% satisfied and 36.8% highly satisfied. Meanwhile, 26.3% of respondents remained neutral, which may indicate that some users experienced minor difficulties during interaction or navigation.

For the item "The application displays information immediately," 47.4% of respondents were satisfied and 36.8% were highly satisfied. This finding suggests that the application performs efficiently in presenting information and provides a responsive user experience.

Lastly, the statement "Does this application help improve problem solving in parcel management?" obtained the highest positive feedback, where 47.4% of respondents were satisfied, and 42.1% were highly satisfied, with only 5.3% selecting neutral. This demonstrates that the application effectively assists users in managing parcel-related problems and fulfils its intended functional objectives.

Overall, the assessment results indicate that the developed application achieved a high level of user acceptance in terms of usability, interface attractiveness, responsiveness, and functionality. The dominance of positive responses reflects that the application has good potential for practical implementation and user adoption in parcel management activities.

4. Conclusion

The IoT Parcel Management System is created to help the parcel management flow, especially at residential colleges. This helps the administration sort parcels indirectly easy for students to pick up their packages from the parcel hub. Apart from that, parcel stolen case hope decreases periodically because it involves property that is valuable to students. This project successfully solves residential problems such as parcel theft, unclaimed parcels, and parcel flow management; also, majority respondents interested in the interface.

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Conflict of Interest

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

Author Contribution

The authors confirm their contributions to the paper as follows: ***study conception and design:*** *Muhammad Izz Dzikri Mohd Faisal;* ***data collection:*** *Ahmad Syahidan Ahamad Azahari;* ***draft manuscript preparation:*** *Muhd Amirussyahmy Hanies Mohd Noor Salleh. Juliana Mohamed and Mohamad Fazirul Rafiq Afandi. All authors reviewed the results and approved the final version of the manuscript.*

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