

EVALUATION OF FINGERPRINT-BASED FERTILIZER STORAGE IN OIL PALM PLANTATION

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Abstract

Fertilizer management represents the most substantial expense in oil palm plantations. The purchase of fertilizers alone constitutes 85% or more of the total production cost. Poor fertilizer management will result in the misapplication and loss of fertilizer, resulting in a substantial financial loss for the company. Consequently, the current method for managing the fertilizer warehouse, which still relies on padlocks, is inefficient. Hence, fingerprint-based access has been developed to automatically authenticate registered users and unlock the store's barrier. The present study aims to evaluate the functionality of the developed fingerprint-based access system for entering a fertilizer store and to conduct user acceptance testing to ensure that storekeepers or estate managers will benefit from using the system. This research was carried out at Felda Bera Selatan 5 and 7, in Bera, Pahang, Malaysia. The results of the functionality and user acceptance generated positive responses. Multiple users concur that the project could significantly enhance estate security in the future. The study offers numerous benefits to those who need it the most, especially storekeepers and estate managers. The ability to monitor the inflow and outflow of fertilizer from the store is the most significant advantage for storekeepers and property managers. The application of this technology will also bolster the fertilizer warehouse's protection against theft.

Keywords: Arduino, fertilizer, fingerprint, security

Introduction

According to a study conducted by Awalludin *et al.* (2015), the oil palm industry in Malaysia has rapidly developed within the estate business. In relation to that, the growing number of palm trees contributes to increased fertilizer application. Oil palm trees require a sufficient amount of fertilizer to obtain nutrients and produce high-quality organic products. Fertilizer, a substance used to increase soil fertility, should be applied to the oil palm plant in order to increase yield. Nutrient levels in the soil significantly affect yield quality, with higher nutrient levels leading to greater yields. Conversely, excessive application can result in water, soil, and air pollution (Savci, 2012). Mismanagement of fertilizer can lead to substantial losses for companies.

Fertilizers management entails a critical emphasis in all aspects, particularly in security. Fertilizer management also represents the most expensive field cost item in well-managed oil palm plantations in Malaysia (Goh *et al.*, 2005). Poor fertilizer management can lead to misuse and loss of fertilizer, resulting in a significant financial loss for the company. Currently, most estates still rely on logbooks to record the fertilizer quantities before updating it on computers. Nevertheless, this approach is inefficient, as those in charge may forget or

experience delays in updating the information. As a result, during audits, various issues arise, such as discrepancies in the recorded quantities of fertilizer entering and leaving the store. This poses challenges for both the storekeepers and the estates in accurately accounting for the fertilizer.

Theft has been a major issue on the plantations (Ajambang *et al.*, 2016). For instance, according to Badrul Hizar (2017), a project manager has been detained in order to help the Federal Government's Rice Paddy Scheme (SBPKP) fraud investigation involving RM2.54 million. Meanwhile, Nazialita (2018) reported that three men were arrested for theft of herbicides and fertilizers valued at RM33,755. These incidents underscore the higher risks associated with improper fertilizer handling. Additionally, it demonstrates the importance of effective fertilizer management to prevent such losses from occurring. Therefore, addressing fertilizer shortages should not be taken lightly.

The aims of this study are to evaluate the functionality of the developed fingerprint-based access system for entering a fertilizer store and to conduct user acceptance testing to ensure that storekeepers or estate managers can benefit from using the system.

Materials and Methods

This study was conducted at Felda Bera Selatan 5 and 7, Bera, Pahang. The selection of this location was based on its utilisation of the current security method, which involves using padlocks to lock the store, and the entry of individuals into the store is manually recorded.

Hardware and Software Specifications

Hardware and software specifications are an essential step that must be carefully considered. Without the use of appropriate hardware and software, the development process might not function properly, potentially being hindered by constraints in software and hardware capabilities. The hardware and software prerequisites for this research are outlined in **Table 1**. **Figure 1** illustrates the prototype project.

Table 1 Hardware and Software Specifications

Hardware/Software	Specifications
Microcontroller	Arduino UNO
Prototype and Program Development	Arduino IDE 1.8.9
Fingerprint Reading	Optical Fingerprint Module Sensor (AS608)
Data Collection	Micro SD Card Module

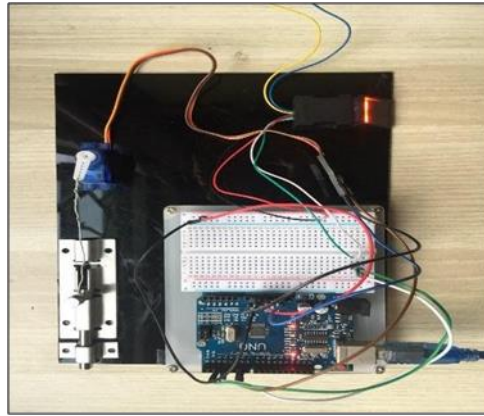


Figure 1 Prototype of fingerprint-based access

Results and Discussion

The purpose of functionality testing is to ensure that the system operates without errors, maintains accuracy, and runs smoothly. This test only required a ‘yes’ or ‘no’ response from the user. Thus, the objectives of the project and the questions itself are congruent.

Table 2 displays the functionality results for the complete hardware prototype. During the fingerprint matching procedure, only a 10% error rate was detected in the functionality test. For the overall functionality test, 90% of users were able to pass without making an error. Errors occurred due to incomplete finger placement on the fingerprint reader. Notably, the enrolment procedure requires attention. To successfully enrol, users need to scan their finger twice and the images must match. This issue can be resolved by updating the fingerprint reader.

Table 2 System functionality testing results

Hardware component	Function (%)
Fingerprint Reader	
• Enrolling	100
• User ID	100
• Scanning process	100
• Scan finger	90
• Unlock barrier	100
• Lock barrier	100
Overall Functionality	90

User Acceptance Evaluation Testing

Table 3 shows the results of a user acceptance survey conducted to assess the acceptance of a proposed smart security access system. The testing was conducted within the estate

community, comprised of ten (10) individuals, including the estate manager, assistant manager, supervisor, storekeeper, clerk, and workers indirectly involved in the security of the fertilizer store. The respondents were asked to rate their agreement with several statements about the system, using a Likert scale ranging from "Strongly Disagree" to "Strongly Agree." **Table 3** indicates the frequency (F) and percentage (%) of responses for each rating category, as well as the total score and mean score for each statement.

Table 3 User acceptance survey of the developed SMART Security Access

Statement	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Total Score	Mean Score	Acceptance
	F	%	F	%	F	%	F	%	F	%			
Does the SMART security access look modern?							5	50	5	50	45	4.5	Positive
Does the SMART security access work similarly as the current security method at fertilizer store?							5	50	5	50	45	4.5	Positive
Is the SMART security access flexible to replace the current security method?							5	50	5	50	45	4.5	Positive
Would you recommend the SMART security access to the estate?							4	40	6	60	46	4.6	Positive
How likely are you to use the SMART security access?							4	40	6	60	46	4.6	Positive
How satisfied are you with the SMART security access?							4	40	6	60	46	4.6	Positive

Would you prefer to use the SMART security access if this system has been implemented?	4	40	6	60	46	4.6	Positive
Are you willing to use the SMART security access in the future?	4	40	6	60	46	4.6	Positive
Overall mean score						4.56	Positive

Based on the findings, the majority of respondents favoured the SMART security access system. For all statements, the overall percentage of "Agree" and "Strongly Agree" responses consistently remained high, ranging from 45% to 60%. This indicates that the participants generally agreed on the positive aspects of the proposed system. The mean scores for each statement also reflect this positive attitude, ranging from 4.5 to 4.6 on a scale of 1 to 5.

The initial three statements assess the perceived modernity of the smart security access system and its comparability to existing security methods. The significant percentage of 'Agree' and 'Strongly Agree' responses (ranging from 50% to 100%) and the positive mean scores indicate that users perceive the system as modern and comparable to current security methods at fertilizer stores.

Subsequently, the following three statements pertain to user recommendations, satisfaction, and preference concerning the smart security access system. The majority of respondents responded positively, with a substantial percentage of 'Agree' and 'Strongly Agree' responses (between 40% and 60%) and favorable mean scores (4.6). This suggests that users are inclined to recommend, use, and be content with the proposed system. They also expressed a preference for adopting the smart security access system if it were implemented. Ultimately, the cumulative mean score for all statements was computed as 4.56, underscoring the favorable acceptance of the proposed smart security access system.

Conclusion

In conclusion, the results of the user acceptance survey showed that the majority of respondents are interested in the proposed SMART security access system. The system is thought to be modern, comparable to current security methods, adaptable, and highly recommended. The respondents also indicated a strong desire to use the system, satisfaction with its features, and a preference for its implementation. The most significant benefit of the proposed system is its capability to track individuals and restrict access to the store, providing enhanced security measures.

Ethics Statement

The research does not require research ethics approval.

Authors' Contribution

“Writing – Original draft preparation: Muhammad Alfah Fahmi Ahmad Fauzi; Literature Review: Muhammad Alfah Fahmi Ahmad Fauzi; Methodology: Muhammad Alfah Fahmi Ahmad Fauzi; Writing – Review and editing: Siti Mariam Shamsi.”

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Conflict of interests

The authors declare that there are no conflicts of interest with this paper.

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