SECURITY OF QR CODE ATTENDANCE USING ADVANCED ENCRYPTION STANDARD METHOD AND LOCATION VALIDATION WITH INTERNATIONAL MOBILE EQUIPMENT IDENTITY (IMEI) VERIFICATION

THESIS

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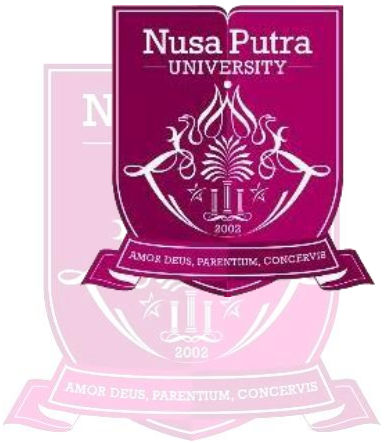

MASTER PROGRAM IN COMPUTER SCIENCE
NUSA PUTRA UNIVERSITY
SUKABUMI
2023

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THESIS

Submitted in Partial Fullfilllment of the Requirements
for the Degree of Master in the field of
Computer Science

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DECLARATION

TITLE	:	**SECURITY OF QR CODE ATTENDANCE USING ADVANCED ENCRYPTION STANDARD METHOD AND LOCATION VALIDATION WITH INTERNATIONAL MOBILE EQUIPMENT IDENTITY (IMEI) VERIFICATION**
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"I herebly declare that this thesis is the genuine result of my own work, except for the quotations and summaries, each of of which I have duly attributed to its source. Should any other party subsequently claim authorship of this thesis, accompanied by sufficient evidence, I am willing to accept the consequ ences".

Sukabumi , 02 February 2024

Rof ul Zamal Santosa

THESIS CONFIRMATION

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This thesis has been examined and defended before the Thesis Examination Board on Thesis Defense Session held on December 2023. In our opinion, this thesis is adequate in terms of quality for the purpose of coferring the Master of Computers Science (M.Kom) degree.

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ABSTRACT

Attendance is an important process in managing the presence of individuals in a system or organization. In the digital era, QR Codes have become a popular method of doing things verification presence . However, QR security is still a major concern, because QR Codes can easily be reverse-engineered or counterfeited and validation of the location and devices used is needed so that the security and accuracy of attendance activities run as they should. To overcome this problem, this research proposes a QR Code presence security system using the Advanced Encryption Standard (AES) method and location validation and International Mobile Equipment Identity (IMEI) . The AES method is used to encrypt QR Code data before the user scans it, while location validation and IMEI are used to verify the location and device of the person concerned. This research describes the system workflow using activity diagrams and implements a QR Code attendace security system using computer technology. Trials and evaluations were carried out to test the effectiveness and safety as well as validation of the proposed system. The research results show that the proposed system is able to increase the security of QR Code attendace and can carry out location validation, while IMEI can only be used as validation on a maximum Android system version 9.

Keywords: Security, Attendance, QR Code , Advanced Encryption Standard (AES) , IMEI , Encryption, Location Verification, Activity Diagram .

ACKNOWLEDGE

With profound gratitude, I would like to present this preface as an expression of thanks to all those who have provided support and assistance throughout the completion of this thesis. The process of writing this thesis would not have been successful without the invaluable contributions of various individuals and entities who willingly offered guidance, advice, and encouragement.

First and foremost, I would like to express my immeasurable gratitude to my academic advisor, who has provided exceptional guidance and support throughout the research journey. Thank you for the patience, knowledge, and time devoted to guiding me towards the achievement of this academic goal. The guidance provided has offered me valuable insights and enriched my understanding in the field I have researched.

I would also like to extend my gratitude to colleagues and friends who have made significant contributions to this research. Your discussions, critical thinking, and valuable input have helped me develop ideas and enhance the quality of this thesis. Our collaboration has opened new doors for deeper understanding and diverse perspectives.

Not to be forgotten, I extend my thanks to my family and loved ones who have always provided unconditional support. The words of encouragement and motivation you have given have consistently propelled me to remain enthusiastic in facing the challenges that arose. Thank you for being the pillars of strength throughout this journey.

In conclusion, I would like to express sincere appreciation to all those who have assisted and supported me in completing this thesis. Every form of assistance, whether large or small, has been the key to the success of achieving this milestone. My hope is that this research can bring benefit and positive contributions to the field I have studied.

Thank you once again to everyone involved; without you, the completion of this thesis would not have been possible. May the relationships we have built through this process continue to thrive and provide enduring benefits in the future.

Sukabumi , 02 February 2024

Rof'ul Zamal Santosa

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CHAPTER I
INTRODUCTION

1.1 Contextual Background

The use of digital systems to assist in solving business problems continues to evolve. One implementation is the utilization of digital systems in attendance tracking. Employee attendance is a crucial recurring activity, directly related to Key Performance Indicators (KPIs) and, in some companies, used as a component in payroll calculation. Therefore, meticulous, prompt, and accurate recording of employee attendance is essential (Al et al., 2006).

Current attendance management systems utilized by companies still possess weaknesses that can compromise the security and accuracy of employee attendance data. These weaknesses include the absence of encryption in QR Codes, allowing unauthorized parties to manipulate and easily access them. Additionally, there is no location validation for employees attending at each branch of the company, leading to uncertainty about whether employees at different branches are attending in designated locations. Furthermore, there is a lack of restrictions on the equipment or devices used for attendance, creating security vulnerabilities, potential fraud, and uncertainty for employees during attendance.

The integrity of attendance records is crucial, as any compromise could result in the manipulation or deletion of original data. One solution to mitigate the risk of attacks on attendance information is to encrypt the QR Code data, producing ciphertext from the original plaintext value. This security method is referred to as cryptography. Cryptography can be applied to QR Codes. In addition to the security factor of QR Codes, the certainty of employee presence in the company is also a consideration for the company's KPI, as some companies calculate salaries based on employee attendance. Device restrictions are also necessary, as many crimes are currently committed by targeting users of mobile devices, especially smartphones. Location information from attendance is crucial for companies with multiple branches, ensuring that employees attend at predetermined locations.

QR Code is an advancement from the barcode, capable of storing more information both horizontally and vertically. According to Saranya's research, QR

Codes can store a larger amount of data in a smaller space, provide reliable error correction at higher speeds, and have faster response times. Secure authentication is achieved using data-hiding algorithms with QR Codes (Saranya et al., 2016).

In previous research, Mittra and Rakesh investigated the desktop application of QR Codes for data security and authentication. This system used AES encryption. As QR Codes can be customized or formatted according to the company's preferences by applying colors, embedding a logo image, or label, it will help organizations communicate information in a more emphasized and distinguished manner than others. A secure QR Code will assist companies in securely exchanging information, achieving the dual goal of secure and ambiguous data exchange. It will also help companies implement solutions for compressed, cost-effective, secure, and hidden information exchange (Mittra & Rakesh, 2016).

In a study by Agung, Sony, and Latifah titled “Presensi karyawan berbasis aplikasi mobile dengan filter jaringan intranet dan IMEI” it was concluded that implementing an employee attendance system through an intranet network involving IMEI (International Mobile Equipment Identity) reading and local network restrictions could run smoothly. This would facilitate employees in attendance, simplify attendance management in institutions, and be applicable to various campuses with different demographic characteristics. Attendance summaries between the main campus and regional campuses could be managed through a VPN network installed on each router, making it highly efficient in monitoring and evaluating employee performance. Test results showed that the access time to load JSON data from the mobile application was around 0.83 milliseconds, indicating that the application could be implemented smoothly without significant obstacles (Filter Jaringan Intranet Dan Imei et al., 2020).

In another study by Ariq, Ananda, and Teguh titled “Pengembangan dan evaluasi sistem presensi pegawai dengan data geolocation menggunakan metode prototipe” it was concluded that the prototype method was successfully used to develop an employee attendance system. Blackbox testing results showed that all six existing features were used successfully. However, the performance evaluation of the employee attendance system using Google Lighthouse showed that the system's performance was still relatively low in terms of performance, with an

average score of only 41.5. Only the login feature obtained a relatively high test result, possibly due to the simplicity of the login page (Wardhana et al., 2022).

Based on the aforementioned reasons, this research aims to develop an attendance system using QR Codes with AES encryption to help maintain the confidentiality, authenticity, and security of attendance data. Additionally, location validation is implemented to ensure that employees of the company attend at designated locations or branches specified by the company. Furthermore, device access for attendance is restricted by utilizing IMEI validation, ensuring that only authorized devices have access.

1.2 Research Questions

With the aforementioned contextual background, the formulation of research problems for this study can be outlined as follows:

a) How can the implementation of the Advanced Encryption Standard (AES) method enhance the security and integrity of data in the QR Code attendance system?
b) Can the mechanism of location validation effectively ensure the authenticity of QR Code attendance and how can its implementation be integrated into the attendance system?
c) How can the International Mobile Equipment Identity (IMEI) be utilized as a device authentication tool to enhance the security of the QR Code attendance system?
d) To what extent can the effectiveness of the security system developed with the AES method, location validation, and IMEI utilization address potential threats to the integrity and security of QR Code attendance?
e) Are there any specific challenges or obstacles encountered in the implementation and use of the QR Code attendance security system with the AES method, location validation, and IMEI?
f) What are the implications of the research results for the overall improvement of QR Code attendance security, and how can recommendations be provided for further development in the context of information security?

1.3 Scope of Research

To design a system by addressing the functions of attendance in this research, the limitations are defined by the following factors:

a) This research is limited to the security of attendance using QR Code and does not encompass other attendance methods
b) .Focus on the implementation of the Advanced Encryption Standard (AES) as the primary encryption technique, without considering other methods
c) The limitation of location validation considers the geographic position of the user and does not discuss other aspects such as network or time zone
d) The utilization of the International Mobile Equipment Identity (IMEI) is limited to device authentication as a part of the security system, without include other IMEI aspects
e) The research does not encompass the evaluation of security related to external factors such as network infrastructure security or externally originated attacks.
f) This research is focused on the development of QR Code attendance security system at the application or specific platform level and does not consider implementation on a larger infrastructure scale.
g) System performance evaluation primarily focuses on security aspects during attendance usage, not on other functions that may be related.

1.4 Objectives of Research

The objectives of this research are as follows:

a) Integrating Advanced Encryption Standard (AES) method into QR Code attendance system to enhance the security and data integrity.
b) Developing a capable location validation mechanism to verifying the authenticity of QR Code attendance by ensuring that the attendance is conducted from an authorized location.
c) Exploring the potential utilization of the International Mobile Equipment Identity (IMEI) as a device authentication tool to ensure that attendance is conducted from a legitimate device.

d) Analyze challenges that may arise during development and implementation, as well as identify future opportunities for the development of a more secure and efficient QR Code attendance system.
e) Provide specific recommendations for further improvements in the security of the QR Code attendance system, including security updates and functional enhancements.

1.5 Benefits of Research

The benefits that can be obtained from this research are:

a) Contributing significantly to the improvement of attendance security by integrating Advanced Encryption Standard (AES) method to protect attendance data from potential security threats.
b) Providing a location validation mechanism that effectively preventing unauthorized attendance or fraudulent activities within the QR Code attendance system.
c) Utilizing the International Mobile Equipment Identity (IMEI) for device authentication can enhance security by ensuring that attendance is conducted from a legitimate and trustworthy device.
d) Provide additional protection for user data involved in the attendance system, reducing the risk of information leakage and data misuse.
e) Assist organizations or institutions in meeting higher security standards in attendance management and user information.
f) By implementing advanced security methods, this research can enhance the reliability and integrity of the QR Code attendance system.
g) With improved security, users can have greater confidence in the QR Code attendance system, thereby increasing the adoption and utilization of the technology.
h) Provide a foundation for the development of an integrated system that is more secure and efficient by leveraging a combination of advanced security methods.
i) To contribute to the literature on information security research, especially in the context of attendance security using QR Codes and IMEI technology integration.

j) Provide recommendations for further improvements that can serve as a basis for further research and the development of attendance security technology.

1.6 Writing Structure

The writing structure provides an overview and description of the research arrangement broadly covering several chapters, including:

CHAPTER I INTRODUCTION

Comprising contextual background, research questions, scope of research, objective of research, benefits of research, and writing structure.

CHAPTER II LITERATURE REVIEW

Containing literature reviews, references, and sources related to the research issues, including studies on systems and security systems, attendance, QR Code, AES algorithm, cryptography, IMEI, PHP, UML, and other relevant theories as the foundation of the writing.

CHAPTER III RESEARCH METHOD

Explaining the methods or steps used in writing. Describing the methods used in writing, design, implementation, and testing of the built system.

CHAPTER IV RESULTS AND DISCUSSION

In this chapter, it elaborates on the implementation, testing, and analysis during the research.

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the conclusions obtained from creating and testing the system developed in the research along with suggestions that can be used as input for further development.

This chapter contains conclusions obtained from the creation and testing of the system developed in the research, accompanied by recommendations that can be considered input for further development.

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CHAPTER V
CONCLUSIONS AND FUTURE WORK

5.1 Conclusions

In this thesis, research and implementation of security of QR Code attendancemusing advanced encryption standard method and location validation with International Mobile Equipment Identity (IMEI), have been conducted. The objective of this research is to provide security and accuracy to attendance records. Based on the research findings and implementation, important conclusions can be drawn as follows:

a) The system demonstrates that QR Codes have been encrypted using the Advanced Encryption Standard (AES) method, making them unreadable directly. This signifies the adoption of high-security measures in the storage and exchange of data through QR Codes.

b) Testing is conducted to ensure that access to the device is restricted to specific devices through IMEI validation. The testing process involves the use of different data, and if the device is not registered, the response "Device not registered, please contact admin" will appear. However, it should be noted that IMEI validation is only applicable for Android versions 9 and below. For Android versions 10 and above, developers face challenges as Android does not grant permission to app developers to access IMEI, considering the data sensitive. Therefore, validation for Android versions 10 and above is performed using device id, which is randomly assigned by the device. This decision is believed to be related to the strict policy of Android developers, allowing IMEI access only to device manufacturers, with stricter supervision.

c) Location validation can be accurately performed. An error response appears if attendance is conducted at a location that does not match the specified one. This indicates that the system has tight control over the attendance location to ensure the accuracy and reliability of data.

d) Clear information related to attendance, including being on time, late, and leaving early, is communicated through the user. This provides insights into the performance of the respective clients.

5.2 Future Work

As security technology continues to evolve, it is crucial to conduct further research on encryption algorithms, such as the Advanced Encryption Standard (AES), to enhance the security level of QR Code attendance systems. The selection of more sophisticated encryption algorithms or exploration of new variants of AES could be a progressive step in addressing emerging security threats.

The development of multi-factor security systems is another area of research that can provide additional layers of security by integrating factors such as biometrics or multi-factor authentication. Optimizing the performance of attendance applications is also critical to ensure swift responsiveness and efficient resource usage, thereby supporting more effective utilization.

Blockchain technology offers higher levels of security and reliability, and its implementation in QR Code attendance logging is an exciting avenue for future work. Conducting case studies in real-world environments will provide practical insights into the effectiveness of QR Code attendance security solutions on a larger scale.

Improving user-friendly interfaces in mobile attendance applications is also crucial to increase end-user adoption. Continuous study of new attack vectors and identification of potential security threats are essential steps in maintaining the security of QR Code attendance systems.

Furthermore, evaluating sustainable business models for QR Code attendance security solutions is also important. Collaborations with industries and stakeholders can aid in obtaining the necessary input, feedback, and support to enhance the implementation and acceptance of these solutions across various sectors. This future work is expected to pave the way for further development and improved security in the context of QR Code-based attendance.

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