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Implementation of Cryptography for Database Security in a QR Code and Web-Based Student Attendance System

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Abstract

Non-formal education such as TPQ plays an important role in shaping the character and religious understanding of the younger generation. However, the use of a manual attendance system at TPQ Assayuti is prone to errors, delays in reporting, and a lack of transparency for parents, thereby hindering management accountability. This study aims to develop a web-based attendance system for students with QR Code integration as a more efficient, accurate, and real-time attendance recording solution. The method used is the Waterfall approach, which includes needs analysis, design, implementation, testing, and evaluation. The system enables automatic attendance recording using QR Codes and provides integrated daily reporting features. The implementation results show improved recording efficiency, minimal data errors, ease of monitoring attendance through a responsive dashboard, and positive user feedback regarding ease of use. These findings confirm that the integration of QR codes and web applications effectively supports the digitization of TPQ administration, improves data accuracy, and can serve as a model for the application of information technology in similar religious educational institutions.

Keywords: Student Attendance, QR Code, Web-Based Application, TPQ Assayuti, Digitalization of Educational Administration.

1. Introduction

Non-formal education such as the Al-Qur'an Education Park (TPQ) plays a crucial role in shaping the character and religious understanding of the younger generation. TPQ Assayuti, as one of the Al-Qur'an education institutions in Cilacap Regency, faces challenges in administrative management, particularly in the attendance system for students, which still relies on manual methods (attendance books). This conventional method is prone to recording errors, data tampering, delayed reporting, and inefficiency in attendance recapitulation. As a result, administrators struggle to monitor student attendance in real-time, while parents do not receive transparent information about their children's participation. In the digital age, such technological lag has the potential to hinder accountability and the quality of educational services. Additionally, data security is a critical aspect in developing information systems, especially those involving user personal data. In QR Code and web-based student attendance systems, the database stores sensitive information such as student identities, attendance data, and admin accounts, which are vulnerable to security threats like hacking, data manipulation, or unauthorized access. These threats can have serious consequences, such as information leaks and data integrity breaches. Therefore, a reliable data security mechanism is needed to protect the database from such threats. One solution that can be implemented is the use of cryptography technology that can encrypt data so that it cannot be easily read or manipulated by unauthorized parties. The implementation of cryptography in databases is expected to maintain the confidentiality, integrity, and authenticity of data stored in QR Code and web-based attendance systems. With the increasing need for the digitization of educational administration in religious institutions such as TPQ, security aspects are crucial so that the application of information technology is not only efficient but also safe. This research was conducted to design and implement cryptographic methods in the database of the QR Code and web-based student attendance system, aiming to create an effective system while ensuring the security of user data.

This issue needs to be addressed urgently because attendance accuracy is a vital indicator for learning evaluation, teaching policy determination, and accountability to parents/guardians. Previous studies have shown that manual attendance systems in non-formal educational institutions often cause human error and consume administrative time [1]. The integration of technologies such as QR codes and web applications is considered a solution to

improve efficiency, transparency, and accuracy [2]. Therefore, this study aims to design a QR code-based attendance system for TPQ Assayuti students integrated with a web application, equipped with database security mechanisms using cryptographic methods.

The problem-solving plan includes three main stages: (1) needs analysis through observation and interviews with TPQ Assayuti administrators, (2) system development using a prototyping approach with web-based application technology (PHP/Laravel) and the generation of unique QR Codes for each student, and (3) system testing including black-box testing and measurement of data processing time. The system is designed so that teachers can scan students' QR codes via smartphone, while attendance data is stored in the database and converted into daily reports automatically sent to parents via email or messaging apps.

A review of the literature strengthens the foundation of the research. The current infrastructure of Islamic boarding schools clearly requires the use of digital technology. [3] The increasing availability of information technology to everyone at any time and from anywhere, supported by adequate information technology, promotes work efficiency in various fields, particularly in Islamic boarding schools. [4] demonstrates that a web-based QR Code attendance system in secondary schools reduces the time required for data compilation from 30 minutes to 5 minutes per day. Meanwhile, [5] emphasizes that the integration of web and mobile applications in a QR Code-based attendance system can reduce data errors by up to 95%. In the context of TPQ, study [1] highlights the success of a similar implementation in increasing parental participation through automatic reports. However, previous research has been limited to formal education, so the development of an integrated system for TPQ as a non-formal institution is an innovation that addresses this gap. Thus, this research is expected to provide scientific and practical contributions to the management of technology-based non-formal education, while also serving as a replicable model for other TPQs.

[6] Having an information system that can manage large amounts of data that we process and generate information quickly, accurately, and more efficiently than doing it manually. [7] This technology not only simplifies administrative processes but also enables faster and more accurate access to information. The existence of an academic information system is crucial in improving the quality of education by providing relevant information to stakeholders, such as students, teachers, parents, and administrators.



Figure 1 Example of a QR Code

A QR Code has two main operations that form the basis of its functionality: generating a QR Code (Generate) and reading a QR Code (Scan). The Generate operation allows users to create a QR Code by entering the desired information, such as text or a URL. This process produces a QR Code image that can be distributed and shared with other users. Meanwhile, the scan operation enables devices to read or decode the information contained within the QR Code using a camera or specialized scanner. The combination of these two operations creates a dynamic ecosystem where QR codes can be used as an efficient tool for information exchange, digital payments, or quick and easy access to specific content. Thus, the ability to generate and read QR codes forms the foundation of various modern technological applications. The implementation and management of attendance systems within an organization often face a number of common issues. One of these is the need for accurate and effective attendance tracking. Manual processes are often prone to human error, which can affect the accuracy of attendance data. Errors such as recording or prediction errors can occur, which can hinder the accuracy of information regarding the attendance of employees or members of the organization. In addition, the difficulty of maintaining attendance records on a regular basis is a challenge in itself

2. Research Methods

Education is a process that consists of individuals, societies, and communities, both materially and spiritually, which can play a role in determining the characteristics of humans and societies. Meanwhile, Ki Hadjar emphasizes that education is an effort to guide all the natural strengths that exist as human beings and members of society so that they can achieve the highest level of safety and happiness [8]. The Al-Qur'an Education Park (TPQ) in the formation of good character in children in Indonesia. Through a systematic analysis of current literature, this study reveals the strategic position of TPQ as a non-formal religious educational institution that not only focuses on teaching the Qur'an but also plays a crucial role in instilling Islamic values and character development. Factors influencing the effectiveness of TPQ are identified, including teacher quality, curriculum, family and community support, and program consistency. This study proposes a conceptual model for TPQ development that emphasizes a holistic approach, encompassing an integrative curriculum, teacher competency development, active learning methods, a comprehensive evaluation system, and tripartite education partnerships. Key challenges in TPQ development include quality standardization, resource limitations, adaptation to social changes, and synergy with formal education [9].

[10] A system is a collection of interconnected, interrelated, and involved components in an activity or goal. Meanwhile, information is written content that has been collected from reputable sources and distributed in a manner most appropriate to the needs of the audience. Information must also serve the recipient well and have different functions in terms of decision making.

An attendance tracking system is a crucial factor for an organization, institution, or company, as it relates to discipline. Therefore, a specialized system is needed to record attendance and absences so that work activities can be tracked in real time and effectively. There are various methods to achieve an effective attendance information system, one of which is using computer technology, specifically through a web-based attendance application [11]. One potential solution is the use of a QR Code-based attendance system, which can simplify the attendance recording process by simply scanning the code associated with the student or teacher. This system has the potential to improve time efficiency, reduce recording errors, and simplify attendance data management. A QR Code is a two-dimensional image that can quickly present various types of information [12].

This web-based attendance application was developed using PHP, CSS, and JavaScript programming languages, and is supported by a MySQL database. The system utilizes a QR Code scanning feature, whereby lecturers display a QR Code which is then scanned to automatically record attendance through the system [13]. An attendance system is a mechanism for recording attendance that is commonly used in educational institutions, organizations, and companies. With the advancement of technology, attendance systems have undergone a transformation from manual methods to digital systems. One form of innovation in digital attendance systems is the use of Quick Response (QR) Code technology [14]. Attendance systems are important in daily life, especially in places such as schools, universities, factories, offices, and hospitals. It is hoped that using the QR code method in this student attendance system will simplify the attendance process. Each student only needs to scan their ID card on the QR Code scanner configured to track arrival times [15].

A QR code is a two-dimensional matrix image that has the ability to store data within it. QR codes are an evolution of barcodes. Barcodes are symbols used to identify real objects, consisting of black and white bars and spaces that are easily recognized by computers. QR codes were created to provide quick access to information and obtain quick responses. Initially, QR Codes were used to track vehicle components in the manufacturing process, but they are now used commercially, particularly in mobile devices [16].

Cryptography is a method used to ensure the confidentiality of information or databases. Cryptography is the science and art of encoding text or confidential information using mathematical techniques. In this case, files that can be encrypted include text documents, image files, audio files, and video files in digital format. In text messages, the content of document files, or document files, maintaining the confidentiality of their data requires encryption and decryption techniques that are not easily or difficult to break. The process of securing text messages, document file contents, or document files can be done by encrypting the text messages, document file contents, or document files using a specific algorithm method that makes the information data unreadable or incomprehensible to others. One such method is the Advanced Encryption Standard (AES) algorithm [17].

Cryptography is the art and science of hiding important and confidential information so that it cannot be accessed by unauthorized persons. In cryptography, confidential messages are referred to as plaintext, while messages that have been obscured or hidden are referred to as ciphertext [18].

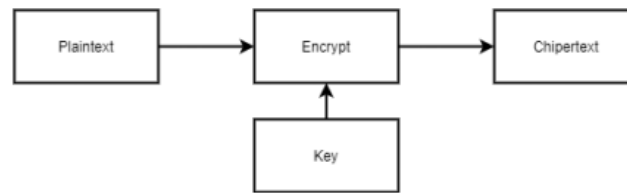


Figure 2 Encryption Process

This research methodology applies the sequential Waterfall method for the development of a QR Code-based attendance system at TPQ Assayuti, which took place over a period of 4 months. The stages began with (1) Requirements Analysis through observation, interviews with 2 teachers/administrators, and 2 students, resulting in an SRS document; (2) System Design, including flowcharts, UML, database, and interface mockups; (3) Implementation using the Laravel 10 technology stack and MySQL for the development of backend and frontend modules; (4) Functional testing with black-box testing, and (5) Implementation & Evaluation through user training, collection of time efficiency data. The main materials include historical attendance data, while the supporting tools consist of a local server and smartphones.

3. Results and Discussions

3.1. Results

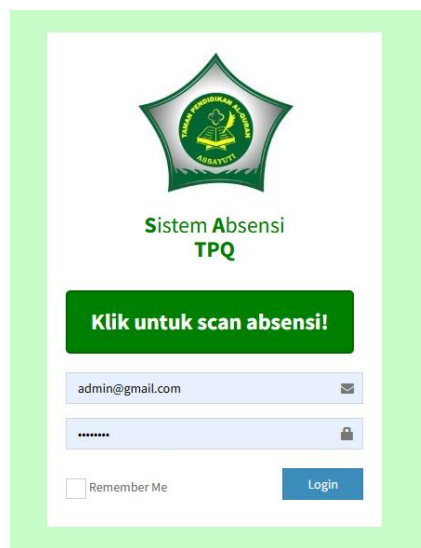


Figure 3 Attendance System Login

The image above shows the login page interface of the TPQ Attendance System, which is designed as a web-based system with QR code scanning integration. At the top is the official TPQ Assayuti logo, which serves as the visual identity of the system. Below it is a green button labeled “Click to scan attendance!” which functions as a quick access to scan the QR code of the students. Next, there are input fields for entering the email address and password for users with admin or system operator access rights, accompanied by supporting icons to facilitate identification of each field’s function. The “Remember Me” button allows the system to save the user’s credentials to simplify future logins, while the blue Login button is used to enter the system. This simple and responsive interface design aims to make it easier for users, both teachers and TPQ administrators, to access the main features of the attendance system quickly, efficiently, and in an integrated manner.

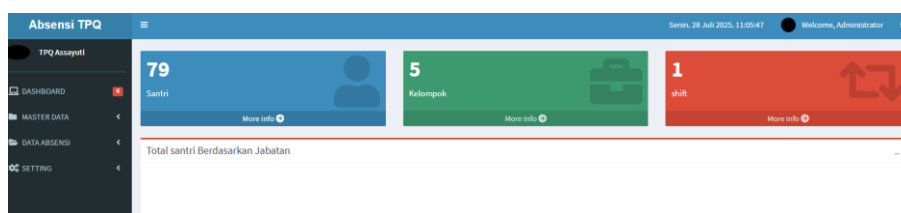


Figure 4 Dashboard

The image above shows the main dashboard of the TPQ Assayuti web-based attendance system. This dashboard displays a summary of key data in real time to facilitate monitoring by TPQ administrators or managers. At the top, there is information about the logged-in user account along with the system time and date. Three main information boxes are displayed horizontally, each showing the number of students (79 people) in blue, the number of study groups (5 groups) in green, and the number of administrators (1 person) in red. On the left side, there is a navigation panel containing main menus such as Dashboard, Student Data, Group Data, Attendance System, and Settings, making it easy for users to access the features they need.

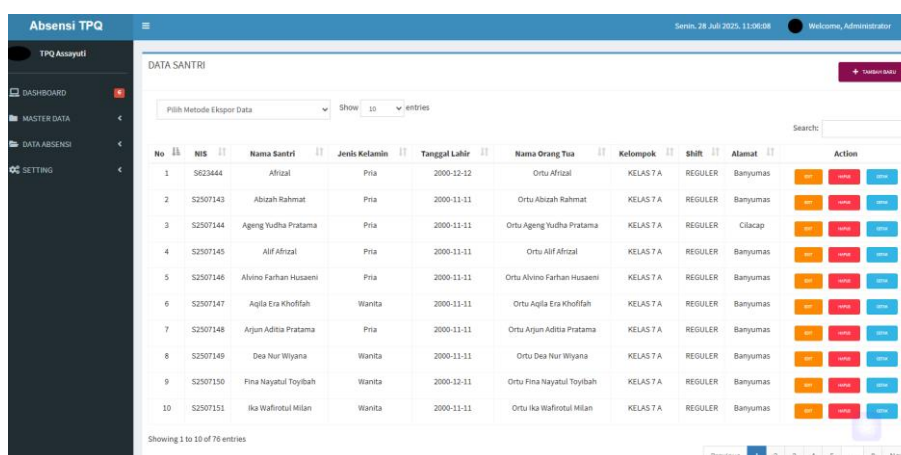


Figure 5 Student Data Page

This figure shows the Student Data page on the Assayuti TPQ web-based attendance system. This page is used to display and manage complete information about students enrolled at the TPQ. The data table includes several important columns such as Student ID Number (NIS), Student Name, Gender, Date of Birth, Parent Name, Group, and Address. Additionally, there is an Action column on the right side that provides specific buttons for actions such as editing, deleting, or viewing detailed student information. The search feature (search bar) at the top right makes it easy for users to quickly find student data based on specific keywords. The system also includes data filtering options based on group and settings for the number of data displayed per page, making it easier for administrators to manage large amounts of data. This interface is designed to be simple yet functional, streamlining administrative processes and integration with the QR Code-based attendance system.

No	NIP	Nama Ustad/ustadzah	Jenis Kelamin	Tanggal Lahir	Shift	Alamat	Action
1	P2507009	RIDWAN, S.Pd	Pria	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
2	P2507010	JUDIN, S.Pd	Pria	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
3	P2507011	JAMALUDIN	Pria	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
4	P2507012	DESTAR INDRAP, S.Pd	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
5	P2507013	IMAM SIRRO MALISI, S.Pd	Pria	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
6	P2507014	ARWATI, S.Pd	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
7	P2507015	KUSMIATI, SE	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
8	P2507016	SITI NURHIDAYATI, S.Pd	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
9	P2507017	DWI AMIT SETIAUTAMI, S.Pd	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]
10	P2507018	SETTI MUSLITANING, S.Si	Wanita	1111-11-11	REGULER	Banyumas	[Edit] [Delete] [View]

Figure 6 Teacher Data Page

This figure shows the Teacher Data page on the Assayuti TPQ web-based attendance system. This page is used to display and manage information related to teachers registered at TPQ. The data table on this page includes important columns such as NIP (Teacher ID Number), Teacher Name/Title, Gender, Date of Birth, Status (Regular/Non-Regular), and Address. On the right side of the table, there is an Action column containing buttons to edit, delete, or view detailed teacher information. The search bar at the top facilitates quick searches for teacher data based on specific keywords. Additionally, the data filter feature and the ability to set the number of entries displayed provide flexibility for administrators in managing teacher data according to their needs. This interface is designed to be simple, responsive, and easy to use, thereby supporting the effectiveness of integrated teacher data management with the overall attendance system.

No	Rekap User	Action
1	Pengajar	[Process] [Remove]
2	Santri	[Process] [Remove]

Figure 7 Attendance Summary Page

This image displays the Attendance Summary page in the TPQ Assayuti web-based attendance system. This page serves to display a summary of attendance data grouped into two main categories: Teachers and Students. The table displayed includes columns for Number, User Relationship (user category), and Action, which provides buttons for performing summary processes or printing attendance reports. The blue “Process” button is used to view or process attendance data in detail, while the “Remove” button is used to delete unnecessary summaries. With its simple and structured interface design, this page facilitates administrators in managing and monitoring attendance data comprehensively and supports the creation of daily, weekly, or monthly attendance reports for both user categories.

Furthermore, the implementation of a QR Code and web-based attendance system for students, equipped with a database security mechanism using cryptography methods, has been successfully implemented. This system was designed using a web-based framework with MySQL database support, encrypted using the AES (Advanced Encryption Standard) cryptography algorithm. All sensitive data, such as admin account information, student data, and attendance records, are stored in encrypted form, making them inaccessible or unalterable without a valid decryption key.

Security testing was conducted to ensure that the cryptographic implementation in the QR Code and web-based student attendance system database could protect data from attack threats. Two testing methods were used: SQL Injection attack simulation and brute force attack on the admin login account.

In the SQL Injection test, experiments were conducted by inserting malicious SQL commands into the login input field, such as ' OR '1'='1 and other data manipulation commands. The test results showed that the system successfully rejected all of these invalid requests. Login data is encrypted using the AES algorithm, and input validation on the server side prevents the execution of malicious queries, thereby preventing data leaks and illegal access to the database.

Meanwhile, in the brute force attack test, experiments were conducted by repeatedly sending password combinations using a penetration testing application. The system successfully detected suspicious repeated login attempts and automatically blocked the account temporarily after three failed attempts. The encrypted password hashing mechanism made this attack unable to bypass authentication.

Test results show that the data encryption and decryption process runs optimally without significantly affecting system performance. The attendance recording process via QR Code scanning can be done in real-time, with data stored directly in an encrypted database. The admin dashboard allows accurate monitoring of daily attendance, while also providing security notifications when unauthorized access attempts occur.

3.2. Discussions

The implementation of the web-based attendance system for TPQ Assayuti students, integrated with QR codes, has demonstrated improved efficiency in the attendance recording process compared to manual methods. This system enables attendance tracking to be conducted quickly, accurately, and in real-time, while minimizing human error in data entry. The integrated attendance summary feature makes it easier for administrators to monitor attendance data for both students and teachers, while also generating daily reports that can be accessed at any time. Additionally, the simple and responsive interface makes it easy for users to operate, whether they are administrators or teachers. This finding aligns with previous research confirming that the use of QR Codes in web-based attendance systems can enhance administrative effectiveness and support the digitalization of data management in religious-based educational institutions.

Furthermore, security testing using SQL Injection and brute force attack simulations showed that data remained protected because the cryptography implementation successfully prevented information leaks. Thus, the system not only improves attendance recording efficiency but also ensures database security and integrity. These results prove that the integration of QR Code technology with cryptography mechanisms is effective in supporting the safe and reliable digitalization of religious-based educational administration

4. Conclusion

Based on the research results, it can be concluded that the implementation of the Assayuti TPQ Student Attendance System, which is web-based and integrated with QR codes and daily attendance reports, has successfully improved efficiency, accuracy, and transparency in the attendance recording process. This system addresses the issues of manual attendance administration, which was previously time-consuming and prone to errors, and provides ease for administrators in monitoring attendance data in real-time. These findings are consistent with previous literature emphasizing the importance of digitalization in supporting data management in religious-based educational institutions. The contribution of this research lies in the application of QR Code technology integrated with a web-based system specifically tailored for the TPQ context, thereby serving as a reference for the development of similar systems in comparable institutions.

As a suggestion, further research could develop additional features such as automatic attendance notifications to guardians via SMS or WhatsApp, integration with academic information systems, and improved data security to prevent QR code misuse. In addition, testing the system with a larger number of users and over a longer period of time is also recommended in order to evaluate the overall performance of the system. With continuous development, this system is expected to become an effective model for the application of information technology in supporting the digitization of pesantren or TPQ-based educational administration

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