OSES Connect: A Centralized Attendance Management System for Ortiz-Saranay Elementary School

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OSES Connect: A Centralized Attendance Management System for Ortiz-Saranay Elementary School

by

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In partial fulfillment of the requirements for the degree of
Bachelor of Science in Computer Science

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Date Signed

ABSTRACT

A low-cost web-based attendance management system, OSES Connect, was developed for Ortiz-Saranay Elementary School (OSES) to address the labor-intensive and error-prone nature of their existing physical form-based attendance tracking processes for students and teachers. The system digitized the attendance process using Quick Response (QR) codes and incorporated a Markov Chain model to predict absenteeism. OSES Connect improved parental monitoring by providing parents with email and Short Message Service (SMS) notifications about their children's attendance. Additionally, it generates comprehensive reports, augmenting the manual use of physical forms to manage attendance data efficiently. The system's usability and effectiveness were evaluated using the System Usability Scale, and it received an overall usability rating of 84.844 from 16 teacher respondents, indicating a high level of user satisfaction.

ACKNOWLEDGEMENTS

I extend my sincerest gratitude and deepest appreciation to my adviser, Mylah Rystie U. Anacleto, whose unwavering support, encouragement, and continuous guidance were instrumental in the completion of this research. Her expertise and insights have been invaluable assets to this project.

Sincere gratitude also goes to the Ortiz-Saranay Elementary School, especially Principal Ma. Victoria C. Topinio, for their profound belief in this work. This research would not have been possible without the unparalleled support of the school's teachers, who have shown great dedication and commitment.

Finally, I sincerely thank my family, friends, and colleagues, who have provided me with unfailing support and continuous encouragement throughout my years of study and through the process of writing this research. This accomplishment would not have been possible without them. Thank you.

TABLE OF CONTENTS

I. INTRODUCTION

A. Background of the Study

Attendance is crucial for students' regular class participation [1] and significantly influences their mental and social development [2]. Inconsistent attendance can lead to poor academic performance and even premature school leaving. Therefore, it is imperative that schools closely monitor student attendance. However, traditional attendance methods persist today, such as calling names or signing on paper. Public elementary and secondary schools in the Philippines, including Ortiz-Saranay Elementary School, use School Forms (SFs) for operations as per the Department of Education (DepEd) Order No. 4, s. 2014. The School Form 2 (SF2) is used to record student attendance [3]. Additionally, teachers must record their daily attendance using the Daily Time Record (DTR), as outlined in the Civil Service Commission (CSC) policy, CSC Memorandum Circular No. 21, s. 1991 [4]. These manual methods of recording and tracking attendance are labor-intensive, prone to errors, and time-consuming.

Despite the challenges of traditional attendance methods, there are innovative solutions available, such as biometrics [5], RFID [6], and face recognition [7]. However, these can be costly and require high-end technology [8]. Utilizing Quick Response (QR) codes offers a cost-effective and easy-to-implement alternative.

Another key aspect of attendance management is parental involvement. Parents may only be aware of their children's school attendance once report cards are distributed at the end of the year. Enhancing parental involvement in school can address this issue of limited awareness, as it has been found to influence student attendance and performance directly. When parents are more engaged in school activities, such as monitoring their child's attendance, it reduces the incidence of student absenteeism [9]. Therefore, increased parental monitoring or supervision could improve student attendance and performance. Not only does this help improve the child's attendance record [10], but it also offers reassurance to the parents.

The implementation of a centralized, web-based attendance management system mitigated these challenges. This system enabled teachers to record student attendance through an intuitive interface, with the optional use of QR codes, and it notified parents of their children's attendance. Additionally, it offered the school a more manageable approach to handling attendance data and generating administrative reports.

Furthermore, predicting absenteeism could be a powerful tool for school administrators and teachers, but most traditional systems lacked this capability. The proposed system included a feature for predicting absenteeism, allowing for more effective resource planning and potential intervention to prevent negative impacts on student performance.

B. Statement of the Problem

Ortiz-Saranay Elementary School (OSES), a public primary school, still employs a manual attendance system, where teachers take student attendance by using a physical school form that is accomplished daily. Moreover, the teachers manually log their attendance using a Daily Time Record (DTR) sheet. These manual processes can accumulate piles of attendance sheets, making the attendance data challenging to manage in the long run. Furthermore, these traditional systems do not offer predictive capabilities, making it difficult for administrators and teachers to anticipate and plan for absenteeism.

The school can employ various attendance management systems. However, these systems can be costly and resource-intensive to implement. Additionally, parents often have limited access to their children's attendance records. This lack of transparency can contribute to poor student attendance, which, in turn, can negatively impact the child's academic performance.

C. Objectives of the Study

The general objective of this study is to develop a cost-effective, web-based attendance management system for Ortiz-Saranay Elementary School. This system seeks to digitize the current manual and error-prone attendance tracking processes. Specifically, the study aims to:

1) Design a centralized database for student and teacher attendance records.
2) Implement QR code-based attendance tracking.
3) Establish automated parental notifications via email and Short Message Service (SMS).
4) Develop a reporting module to generate reports (Daily Time Record and School Form 2).
5) Incorporate a Markov Chain model for absenteeism prediction.

D. Significance of the Study

Ortiz-Saranay Elementary School benefited from OSES Connect, as this cost-effective solution seamlessly managed teacher and student attendance data. The system was able to use Quick Response (QR) codes, reducing the need for personal gadgets for attendance tracking. It also facilitated the generation of administrative reports, lessening the dependence on physical forms. A key feature of OSES Connect was its capacity to keep parents informed about their children's attendance through email and Short Message Service (SMS) notifications. This increased transparency encouraged students to attend their classes regularly, as parents were able to monitor and discuss attendance habits with their children more effectively.

Moreover, OSES Connect incorporated a predictive analytics feature using Markov Chains to anticipate potential absenteeism. This feature served as an early intervention tool, enabling data-driven decision-making processes to identify students and teachers at high risk of absenteeism. The integration of predictive analytics into attendance management systems was a largely unexplored area, making this application particularly valuable.

Furthermore, integrating an identity and access management system within this application further strengthened security measures for the school administration. Lastly, OSES Connect was accessible via web browsers on desktops or mobile devices, guaranteeing reliability and accessibility for all registered and authorized users.

E. Scope and Limitations

The web-based attendance management system was developed specifically for Ortiz-Saranay Elementary School. Accessible via the Internet, this system was designed to centralize all attendance-related processes for students from kindergarten to the sixth grade and the school teachers. Access to the system's features is restricted to authorized and registered school administrators and teachers. Users needed a computer or mobile device, a reliable internet connection, a web browser, and a functional camera to utilize the system. For attendance tracking, students and teachers could use Quick Response (QR) codes, which the system could scan. The system generated these QR codes for the school administration to print out. Moreover, the system employed KeyCloak for identity and access management. However, the process of deploying KeyCloak falls outside the scope of this study.

II. REVIEW OF RELATED LITERATURE

There have been many developments in modern attendance management over the years. Many of them have been developed to address the problems of traditional attendance management systems. These automated systems have gained widespread popularity across various fields, particularly in academic settings, due to their improvement in data accuracy. They can also reduce the common errors in traditional systems [11]. Many educational institutions use radio frequency identification (RFID) systems to record attendance by detecting the students' RFID tags [6]. RFID readers detect students' RFID cards, which lessens the time needed to record attendance.

Another feasible system is the biometric-based attendance system, which uses smart devices to identify students' fingerprints and record their attendance [5] [12]. This system eliminates the need for students to bring their RFID cards from the RFID-based system. Other attendance recording systems utilize other biometric factors, like facial recognition [13] and iris recognition [14]. These biometric-based systems offer enhanced security compared to RFID-based systems since they are based on unique biometric characteristics, which are difficult to forge or duplicate.

However, Ramanan et al. [8] noted that implementing biometric and RFID-based systems can be costly due to the need for hardware purchases. On the other hand, other automated attendance management systems use Bluetooth technology. For instance, Lodha et al. [15] proposed a system that uses Bluetooth smart technology to automate the attendance management of students in lectures. The system consists of electronic tags embedded in student ID cards, which can be detected by an Android application via Bluetooth Low Energy. The system records the attendance data in a database and provides various features such as grading, reporting, and notifying parents. The system claims to have several benefits, such as low power consumption, high data transfer rate, small chip size, low cost, and simple implementation.

Meanwhile, other systems use Quick Response (QR) codes to record attendance. QR codes were made by a team led by Masahiro Hara from the Japanese company Denso Wave in 1994 [16]. These are two-dimensional barcodes that a camera can scan to retrieve information and contain as much as three kilobytes of data. These codes are cheap, readable by smartphones, and can store data with a total size of 7,089 numeric characters or 4,269 alphanumeric characters.

Many modern attendance management systems have been adopting QR codes to record attendance. For instance, Imanullah and Reswan [17] designed a secure attendance system using randomized QR code scanning on a local network. Users scan a QR code, which changes every 10 seconds, through an Android application. This action sends identifier data to the server, marking their attendance. On the other hand, Nuhi et al. [18] developed a web-based smart attendance system using QR codes, which requires the professors and students to scan their assigned QR codes to mark their attendance before or during each lecture.

Meanwhile, Ramanan et al. [8] developed a smart attendance system that uses encrypted QR codes sent to students based on their locations to prevent proxy attendance. The system employs a multi-server architecture with a load balancer to handle high traffic. It also compares the performance of four load balancing algorithms to optimize efficiency. The system ensures data reliability through digital reports and regular backups. These studies show that QR codes are becoming a common way to check attendance, offering a more streamlined process.

In the Philippines, many attendance management systems use QR codes. For instance, Ebin et al. [19] developed a smart and low-cost student attendance acquisition and monitoring system at Eastern Visayas State University. The system was designed to scan QR codes embedded on student identification cards, process the data using Raspberry Pi, and then store and display the attendance data on a web server. The system also employs a dedicated QR code scanner for reading the QR codes. Moreover, the study mentioned that the parents of the students can also monitor their children's attendance online. Overall, it was concluded that the system was highly efficient and had a strong potential to improve the attendance monitoring process. The study strongly recommends using a camera over a dedicated QR code scanner to reduce the system's cost and potentially integrate a facial recognition feature. In a related development, Agripa and Astillero [20] developed a QR-based employee attendance system at a university in Castilla, Sorsogon. The system was designed to record the employees' attendance by scanning the QR codes generated using the employee's information. The study concluded that the developed system offers a user-friendly, efficient, cost-effective method for monitoring employee attendance. The study further suggests incorporating additional features, such as enhanced maintenance, user privileges, and increased flexibility in report generation.

Although attendance management systems offer features and benefits, these may not be sufficient to ensure the regular presence of students. The involvement of parents is also crucial in ensuring that students attend their classes. A study by Grepon and Cepada [9] found that while parents of middle school students in Northern Mindanao, Philippines, were highly engaged at home, their involvement at school was only moderate. The study defined "moderate" parental involvement at school as a relatively infrequent level of activities such as attending school meetings, monitoring their child's attendance, and communicating with teachers about their child's performance and learning needs. The data revealed that the parents' average involvement in school activities reached only the "Once in a While" level, in contrast to their "Greatly Involved" engagement at home. This limited involvement contributed to student absenteeism, meaning students missed less school when their parents kept track of their attendance. Additionally, the study highlighted the challenges parents face in monitoring their children's attendance.

Given the significance of parental involvement in reducing student absenteeism, numerous attendance management systems have been striving to ensure that parents receive notifications regarding their children's attendance. For example, Lodha et al. [15] developed a Bluetooth smart-based attendance management system to inform parents about their children's attendance. Similarly, Islam et al. [21] devised an email and Short Message Service (SMS) system to notify parents about their children's attendance. Galgo [22] also conducted a study to assess the efficacy of Scan Attendance Manager, an application that employs QR codes for monitoring student attendance. One of its features is that it sends an SMS to the parents of the students to notify them about their children's attendance.

Despite the advancements in attendance management systems, there are still areas for enhancing these systems. For instance, applying predictive analytics can be a potential avenue for improvement. One study by Salazar et al. [23] explored different machine learning models to predict whether patients would attend their scheduled medical appointments. This is a similar problem to predicting school absenteeism, as both involve predicting whether an individual will attend a scheduled event. While Salazar et al. did not use Markov Chains in their study, the concept of predictive analytics they employed is similar. Markov Chains are mathematical models that predict future states based on current states [24]. This concept has been applied in various fields, such as weather forecasting, stock market analysis, and the spread of diseases. All of these promising applications make Markov Chains a suitable tool for predicting school absenteeism.

From the studies discussed earlier, it's clear that a school attendance management system is necessary to handle attendance data efficiently. Moreover, QR codes offer an alternative to attendance management systems due to their cost-effectiveness and ease of implementation. However, more research needs to be done to focus on developing an attendance management system specifically designed for public primary schools in the Philippines. Additionally, many referenced studies assume every student has devices for recording attendance, which may only be true in some public primary schools nationwide.

Moreover, the exploration of integrating predictive analytics techniques, specifically Markov Chains, into attendance management systems could be a promising area for future advancements in predicting student absenteeism. While machine learning models, like the ones studied by Salazar et al., are powerful, they often require massive amounts of data and serious computing power. On the other hand, Markov Chains, which can predict future states based on current ones, could be a valuable tool for predicting student absenteeism. However, more exploration is needed on applying Markov Chains to predict student absenteeism. As such, this proposed work could bridge these gaps in developing attendance management systems in the Philippines.

III. MATERIALS AND METHODS

A. System Requirements

This research project involved the development of a web-based attendance management system called OSES Connect, aimed at digitizing and enhancing the attendance tracking process at Ortiz-Saranay Elementary School. The web application was built using Angular version 16.2.12, a widely used open-source framework for creating dynamic and interactive single-page web applications [25]. The front-end development included Tailwind CSS, a utility-first CSS framework for rapidly building custom user interfaces (UI) [26]. Additionally, PrimeNG was used in the web application, especially for displaying tables and graphs, as it offers rich UI components for Angular [27].

For the back-end development, Java version 17 and Spring Boot framework version 3.1.5 were used. Spring Boot is renowned for its features that enable creating enterprise-level applications compatible with Java Virtual Machine (JVM) [28]. Furthermore, the system utilized a PostgreSQL database instance provided by Supabase. Supabase is a cloud-based database service offering tools such as authentication, real-time subscriptions, storage, and other beneficial features [29].

The front-end application was hosted on Vercel, a cloud platform that allows for automatic redeployment of front-end applications whenever codebase changes occur [30]. Similarly, the back-end application was hosted on Render, which also supports the automatic redeployment of applications [31]. A Docker container was utilized to deploy the back-end application. A Docker container is a self-contained package that includes all the components to run an application, such as code, runtime environment, system tools, libraries, and configurations [32].

A key component of the web application's architecture was using GraphQL to interact with and retrieve data from the system. GraphQL was intended to minimize the number of API requests made to the system by the front-end application [33]. Nonetheless, it does not imply that RESTful APIs were not utilized in the system.

Moreover, Cloudinary, a cloud-based service that provides an end-to-end image and video management solution, was used for handling image-related operations [34]. Additionally, KeyCloak was employed and securely deployed on a Google Cloud Platform Virtual Machine (GCP VM) for identity and access management.

Lastly, considering the high costs of traditional Short Message Service (SMS) gateways, the system has been designed to incorporate an open-source API called httpSMS. This provides a cost-effective alternative, enabling the system to send SMS notifications directly to parents. However, a limitation of this approach is that it requires the httpSMS Android application to be installed on a phone used for sending SMS. Additionally, for the SMS notifications to be processed correctly, the phone must have a reliable internet connection or good data service at all times [35].

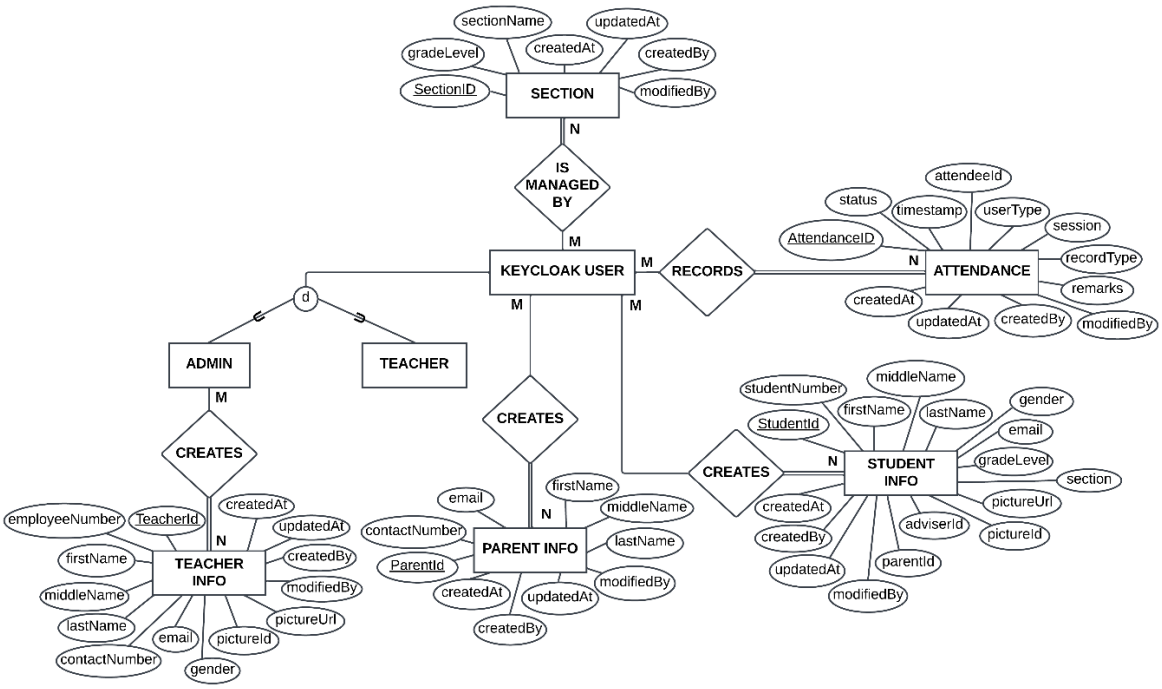


Fig. 1. Part 1 of the entity relationship diagram (ERD) for the OSES Connect database.

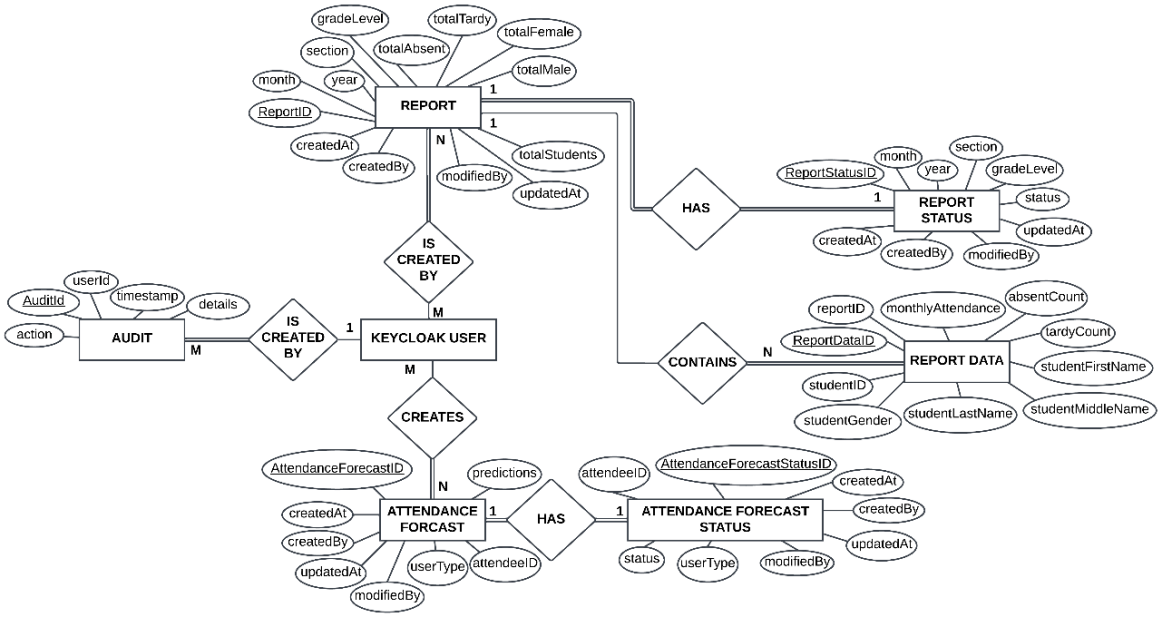


Fig. 2. Part 2 of the entity relationship diagram (ERD) for the OSES Connect database.

B. User Types and Privileges

Figures 1 and 2 present the two parts of the entity-relationship diagram (ERD) that illustrate the relationships within the OSES Connect system. Expanding on this, OSES Connect offers two types of users, each with unique permissions and abilities: administrators and teachers. Administrators have full access to the system and can perform all available functions. They can create, view, update, and delete profile information for teachers, students, and students' parents.

Administrators can also manage sections, which is essential for organizing students within the system. Furthermore, administrators can manage attendance information for teachers and students and create an attendance forecast to predict the likelihood of absenteeism. However, the prediction of teacher absenteeism is a privilege reserved solely for administrators. Administrators can also access an audit trail that logs all user actions within the system.

While teachers have more limited privileges, they play a vital role in the system. They can manage profile information only for students and parents and handle student attendance data through the attendance management system. Teachers can also manage sections and create an attendance forecast only for students. They do not have access to the audit trail or the ability to predict teacher absenteeism. Lastly, administrators and teachers can view and generate reports based on specific types of attendance information.

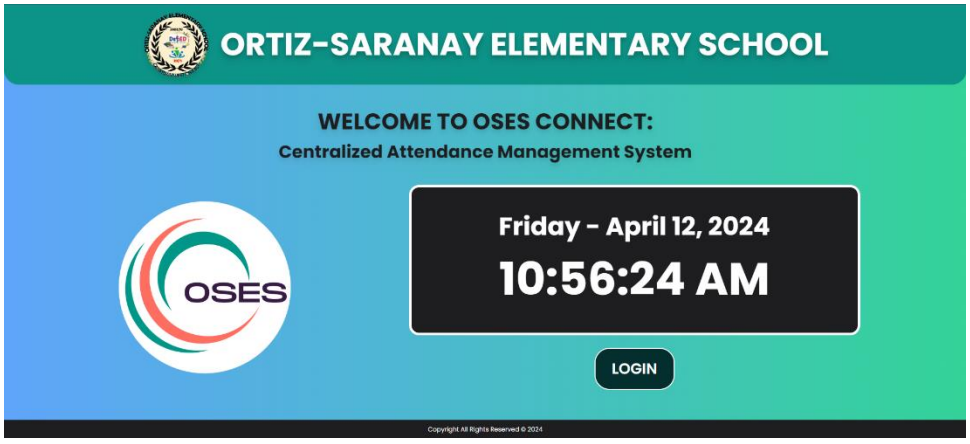


Fig. 3. OSES Connect landing page.

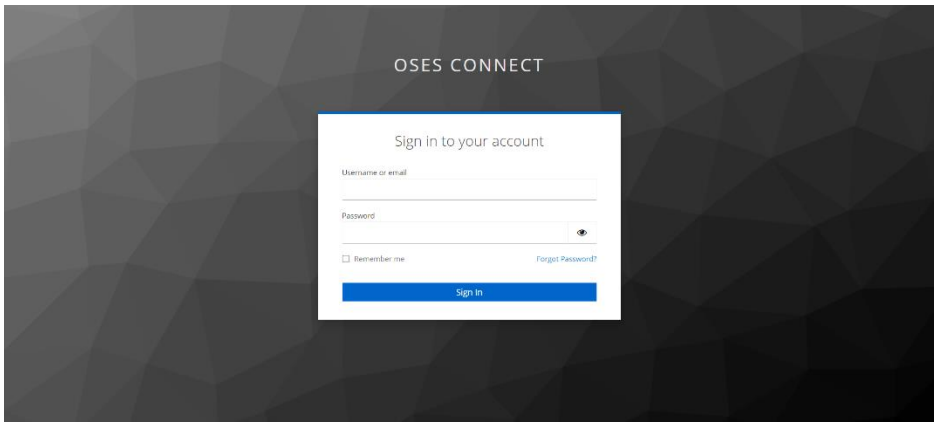


Fig. 4. KeyCloak login page for OSES Connect.

C. Systems Features and Flow

1) ***Login Process***: Upon accessing the website, the landing page welcomes the user with the school's logo, name, and current date and time (Fig. 3). The only button on this page is the login button, which takes the user to the KeyCloak login page (Fig. 4). Administrators can customize this page using the KeyCloak server based on their preferences. Users need to enter their username and password to access the system features. The school administration provides these credentials. For convenience, there is a "Remember Me" option that, when checked, allows the system to remember the user's login details for future visits.

Users who forget their password can click the "Forgot Password" link. This will trigger a password reset process, typically involving the user receiving an email with instructions on resetting their password. If the login details are wrong, the login page shows an error message. After a successful login, users go to a homepage that matches their role. The ID token from the KeyCloak server determines its role. Administrators go to an administrator homepage (Fig. 5), while teachers see a homepage tailored to their role (Fig. 6).

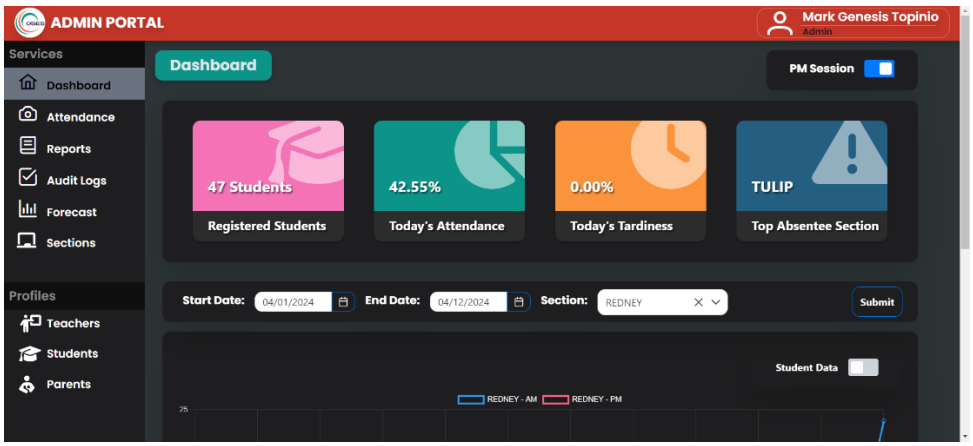


Fig. 5. Administrator Dashboard Page.

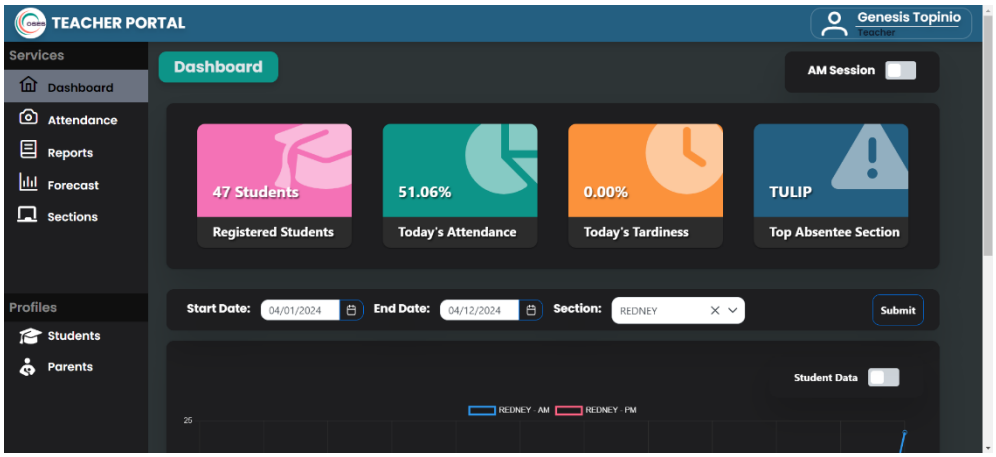


Fig. 6. Teacher Dashboard Page.

2) ***Dashboard***: After a successful login, users land on the Dashboard page (Fig. 5), which provides a summary of analytics tied to student or teacher attendance data. The top section of the page presents the total count of students registered in the system, the percentage of students present for the current half-day session (either AM or PM), and the percentage of students who were tardy for this same half-day session.

Below these statistics, a line graph illustrates the daily attendance of students or teachers over a specific period, extending up to the present day. A switch button is provided alongside this graph, allowing users to alternate the displayed data between students (Fig. 5) and teachers.

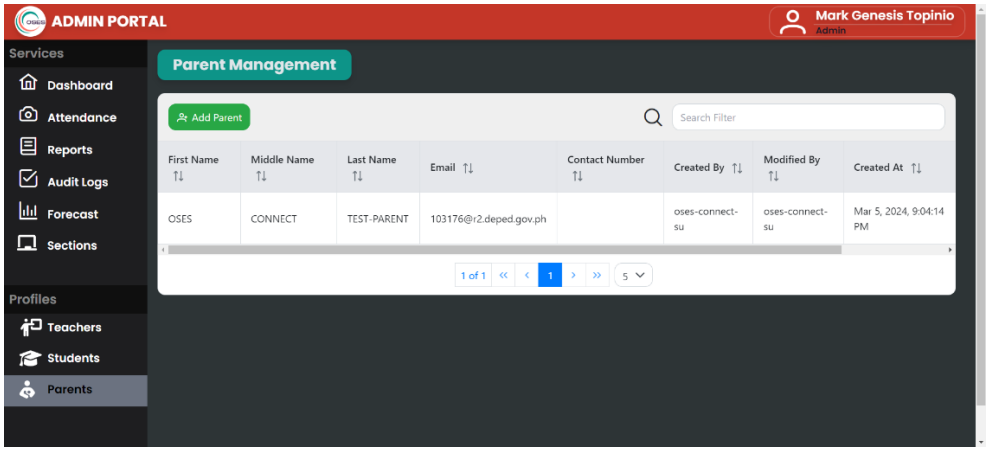


Fig. 7. Parent Profile Information Management Page.

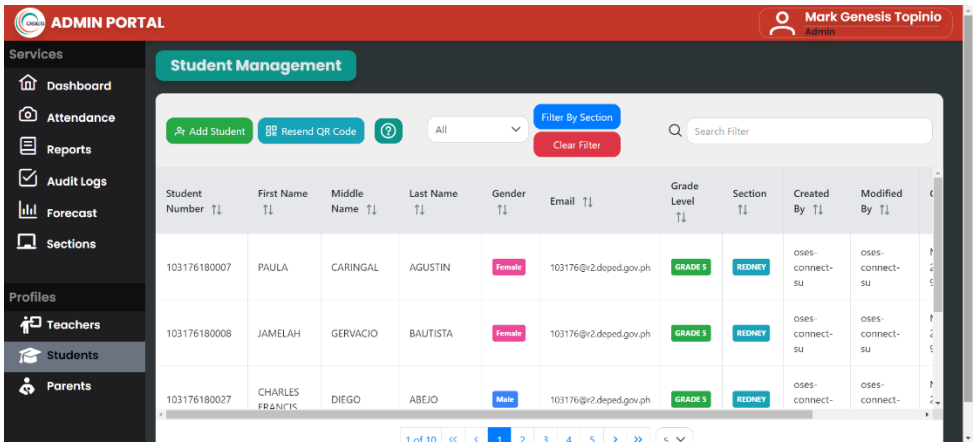


Fig. 8. Student Profile Information Management Page.

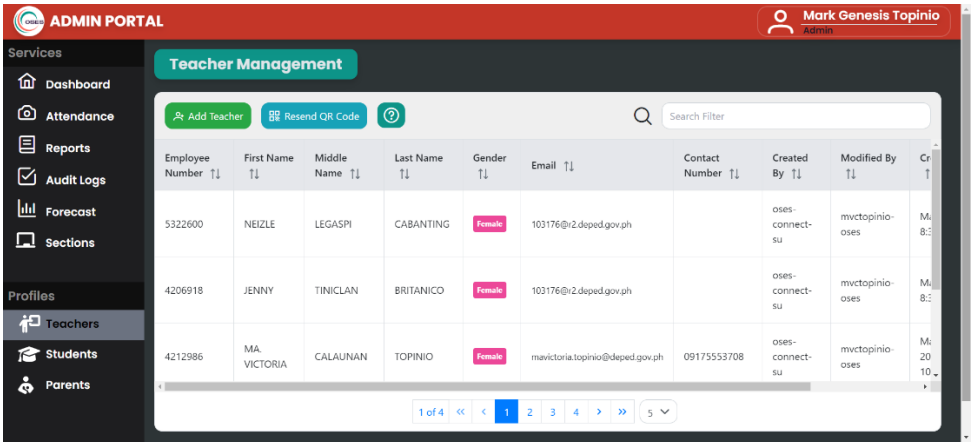


Fig. 9. Teacher Profile Information Management Page.

3) ***Profile Information Management***: The attendance management system maintains records of teachers, students, and parents involved in the system. The profile information management feature facilitates creating, viewing, updating, and deleting these individuals' records. Administrators have exclusive access to manage teachers' profile information (Fig. 9). However, both administrators and teachers can manage student and parent profile information (Figs. 7 and 8).

Each teacher and student is assigned a unique ID when their profile information is created. This ID and the individual's name and email are encrypted using the Advanced Encryption Standard (AES) encryption algorithm. The system generates a QR code from this encrypted data for the attendance management system. If an email address is provided, the system sends the QR code to it. The QR code is updated and resent whenever the teacher's or student's profile information changes.

Users can utilize the search bar and column sorting to locate specific profile information. The system allows parents to view their children's details. In the student profile information management, the table can be filtered by section using a dropdown list of sections. Teachers and students can resend the QR codes of selected entities from the table. They can send it either to the entity's official email address or to a specific alternative email address.

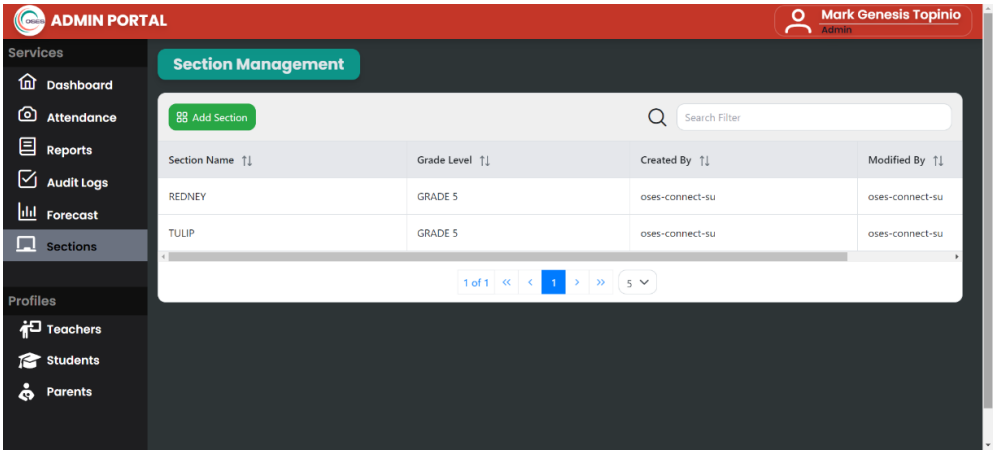


Fig. 10. Section Management Page.

4) ***Section Management***: A key feature of the system is section management. This feature enables administrators and teachers to view, add, edit, or delete sections using the Sections page (Fig. 10). Creating a section requires entering a section name and a grade level.

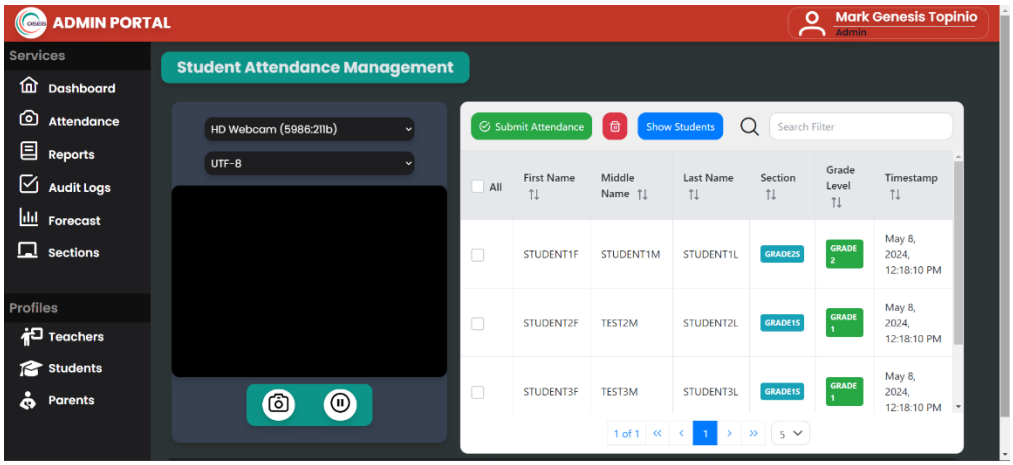


Fig. 11. Student Attendance Management Page.

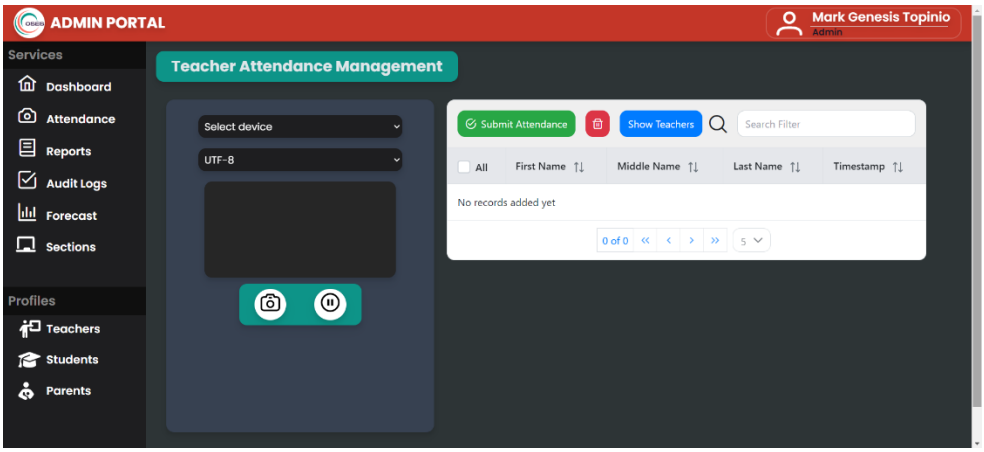


Fig. 12. Teacher Attendance Management Page.

5) ***Attendance Management***: The attendance management system is designed to record and manage students' and teachers' attendance. Both administrators and teachers can access the student attendance management system on the Attendance page (Fig. 11). However, only administrators can access the teacher attendance management system (Fig. 12). The server automatically populates the Attendance database table with placeholder values daily, setting all attendance entries for the day to a default status of "Absent" until updated.

The system employs the QR code generated by the profile information management system to identify users. Upon scanning the QR code with the device's camera and decrypting the information, the application displays the user's picture and name, provided the profile information exists. The system then prompts the attendance recorder to verify the user's identity using the displayed picture. Once the user is verified, the application presents the user's information in a table. The table displays the decoded information, the date, and the attendance time.

It's important to note that the process for recording attendance differs slightly for teachers and students. Teachers must select "Time In" or "Time Out" before viewing the attendance information table. However, student attendance defaults to the "Time In" record type.

Once attendance is recorded, the system can prompt the user to confirm attendance. Upon confirmation, the system records the list of user IDs, the attendance details, and the session type (either "AM" or "PM"). The "Time Out" record type applies only to teachers. The system includes a "remarks" field for the attendance information, accessible on the Reports page, allowing users to note any circumstances related to their attendance.

After the recording phase, the back-end server analyzes the attendance information. The attendance statuses for students and teachers during morning and afternoon sessions vary based on their arrival time. If a student or teacher arrives by 7:45 AM or by 1:15 PM, their attendance status is marked as "Present." Those arriving between 7:46 AM and 8:00 AM or from 1:16 PM to 1:30 PM are marked as "Tardy." Any student or teacher arriving after 8:00 AM or 1:30 PM is marked as "Absent."

The system emails the parent with the student's attendance information. If the parent has provided a mobile number, they also receive a Short Message Service (SMS) notification with the same information. If the parent's email is unavailable, the system sends the email

directly to the student. This email contains the student's attendance information and is sent only to the registered email address of the student or parent. Additionally, the attendance recorder can update the attendance status to "Excused" on the Reports page for students and teachers with a valid reason for absence.

The attendance recorder also has the flexibility to stage the attendance in the attendance staging table by selecting 'Show Students' or 'Show Teachers', depending on the module. This action displays a filterable list of students or teachers that the user can batch-select and stage into the attendance staging table. If necessary, the user can batch-delete the selected staged attendance data by ticking the checkboxes and clicking the trash bin icon from the table. This provides more flexibility in recording attendance in the system.

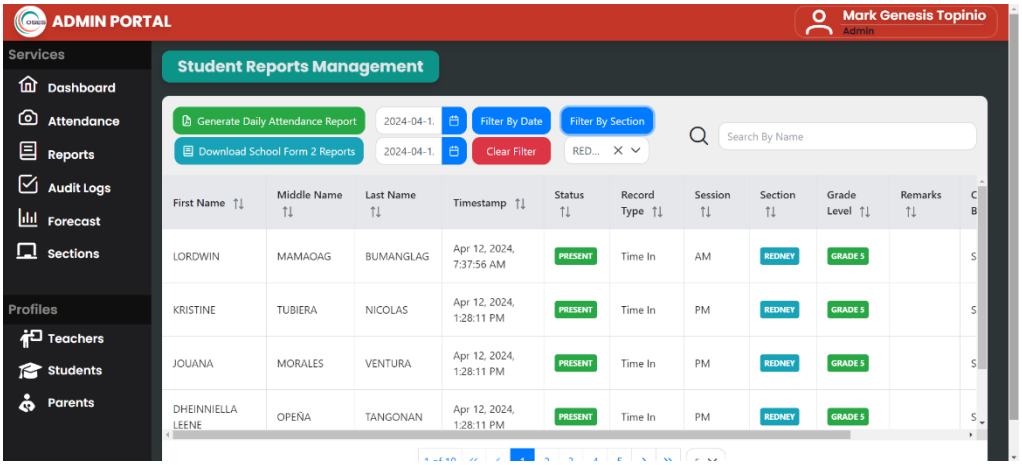


Fig. 13. Student Reports Management Page.

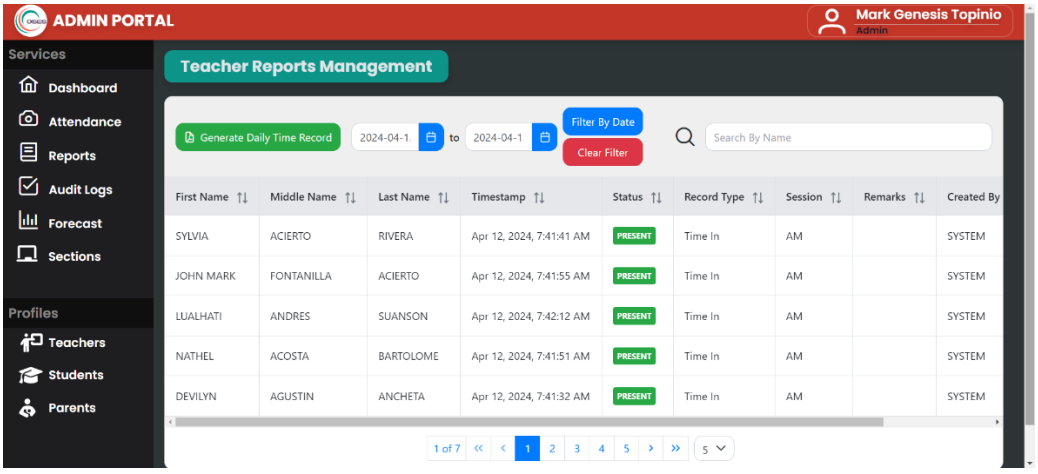
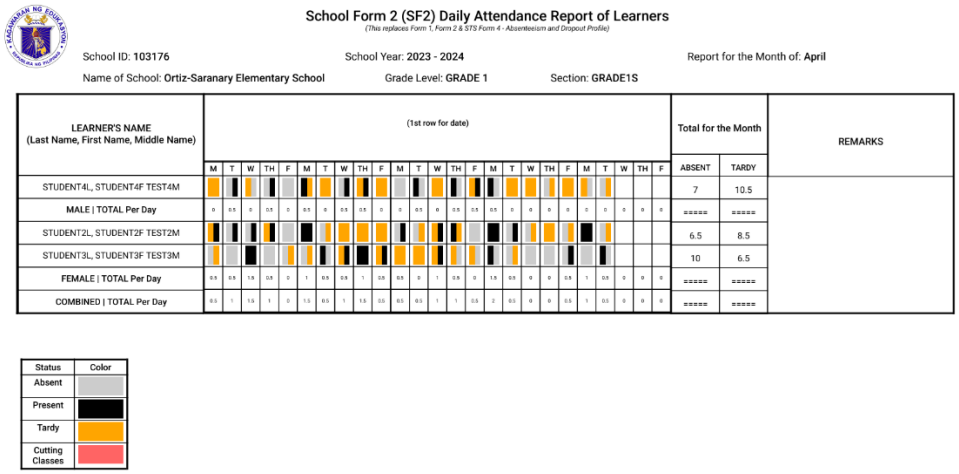


Fig. 14. Teacher Reports Management Page.



School Form 2 (SF2) Daily Attendance Report of Learners

(This replaces Form 1, Form 2 & STS Form 4 - Absenteeism and Dropout Profile)

School ID: **103176** School Year: **2023 - 2024** Report for the Month of: **April**

Name of School: **Ortiz-Saranay Elementary School** Grade Level: **GRADE 1** Section: **GRADE1S**

LEARNER'S NAME (Last Name, First Name, Middle Name)	(1st row for date)																							Total for the Month		REMARKS
	M	T	W	TH	F	M	T	W	TH	F	M	T	W	TH	F	M	T	W	TH	F	M	T	W	TH	F	ABSENT	TARDY	
STUDENT4L, STUDENT4F TEST4M																										7	10.5	
MALE | TOTAL Per Day	0	0.5	0	0.5	0	0.5	0	0.5	0.5	0	0	0.5	0	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	=====	=====	
STUDENT2L, STUDENT2F TEST2M																										6.5	8.5	
STUDENT3L, STUDENT3F TEST3M																										10	6.5	
FEMALE | TOTAL Per Day	0.5	0.5	1.5	0.5	0	1	0.5	0.5	1	0.5	0.5	0	1	0.5	0	1.5	0.5	0	0	0.5	1	0.5	0	0	0	=====	=====	
COMBINED | TOTAL Per Day	0.5	1	1.5	1	0	1.5	0.5	1	1.5	0.5	0.5	0.5	1	1	0.5	2	0.5	0	0	0.5	1	0.5	0	0	0	=====	=====	

Status	Color
Absent	
Present	
Tardy	
Cutting Classes	

Fig. 15. Example of a School Form 2 (SF2) Report generated by the system using dummy data.

6) ***Reports Generation***: One of the system's features is its ability to generate reports. Users can create reports such as the Daily Time Record (DTR) and School Form 2 (SF2) using the attendance information recorded in the system. This feature is accessible on the Reports page (Figs. 13 and 14), available to administrators and teachers. However, only administrators can view the teacher attendance information.

Upon accessing the Reports page, users encounter a paginated table. This table's data can be filtered using start and end date filters, allowing users to view attendance information from specific periods. Users can also update the attendance information directly in the table.

Users can select a specific teacher from a dropdown list and specify the reporting month for the generation of the DTR. The DTR generation is instantaneous. Similarly, for the generation of SF2, users can select a specific section from a dropdown list and specify the reporting month. However, generating SF2 reports may take some time due to the large amount of processed data. Users are prompted to wait for a while after initiating the report generation. To check if the SF2 report generation is complete, users can click the "Download School Form 2" button from the table to check if the report is downloadable.

The reports will be generated in PDF (Portable Document Format). An example of an SF2 output generated by the system is shown in Figure 15.

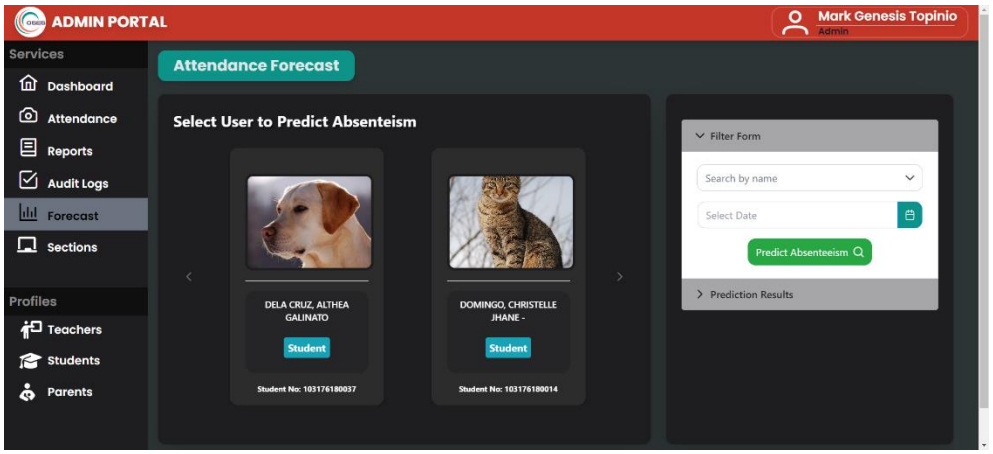


Fig. 16. Attendance Forecast Page.

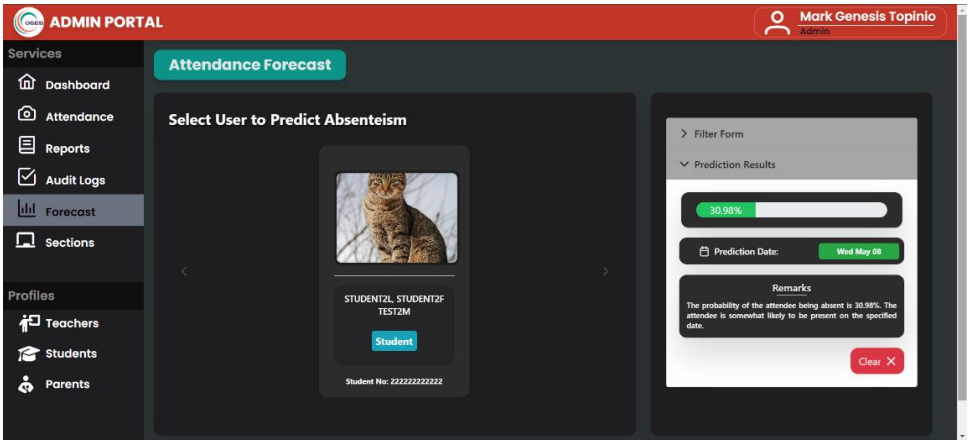


Fig. 17. Attendance Forecast Example Result.

7) ***Attendance Forecast***: The system allows administrators and teachers to predict absenteeism for teachers and students within the school. However, only administrators have the privilege to request and generate the probability of teachers' absence.

Upon accessing the Forecast page (Fig. 16), users are presented with a carousel of users for whom predictions can be made, depending on the user's role. Administrators will see teachers and students in the carousel, while teachers will only see students. Users can select a teacher or student to predict, and the filter form will update accordingly. Alternatively, users can search for a specific student or teacher in the filter form.

After selecting a student or teacher, users must also specify a date for the prediction. Users can make predictions for the next seven working days, including the current day when the feature is accessed. However, the prediction excludes weekends. This feature is only accessible during weekdays to ensure accurate predictions, as the computation relies on the regularity of the school week.

After completing the filter form, users can click the "Predict Absenteeism" button to generate the absenteeism probability. If the computed probability is unavailable, the system will display a pending status and prompt the user to check later. Users can click the "Predict Absenteeism" button again to refresh the status.

Once the computed probability is available, it will be displayed as a percentage in a progress bar (Fig. 17). The color of the progress bar will vary based on the prediction value: blue for less than 0.25, green for between 0.25 and 0.5, orange for between 0.5 and 0.75, and red for greater than 0.75. The prediction results section will display a severity status ranging from 'Low Risk' to 'Very High Risk,' along with remarks and suggested actions based on the computed probability. Users can clear the filter form and prediction results section by clicking the "Clear" button.

The absenteeism probability computation is based on historical attendance data and uses a Markov Chain model. The model's transition states are the attendance statuses (i.e., present or absent). For simplicity, a 'Present' state is a day recorded as 'Present' or 'Tardy' for either the morning or afternoon session. If a student or teacher has attended either the morning or afternoon session, the system will consider the student or teacher as 'Present' for that day. However, this interpretation does not affect the Attendance Management System's data. An 'Absent' state is a day recorded as 'Absent' for both sessions.

To build the Markov Chain model, the system computes transition probabilities, which are the probabilities of transitioning from one state to another. It then recursively computes the absenteeism probability using the transition probabilities derived from the historical attendance data. However, predictions are limited to the next seven working days to prevent computational overhead. The algorithm for computing the absenteeism probability was initially validated against the well-known 'Sunny and Rainy' example scenario, a standard use case for Markov Chain models. The algorithm underwent rigorous unit testing, and the output precisely matched the expected results of this scenario.

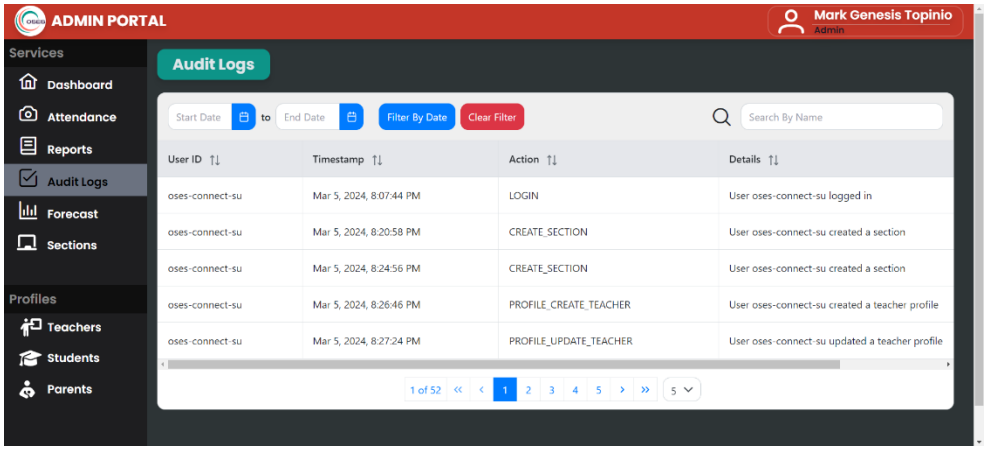


Fig. 18. Audit Logs Page for Administrators.

8) ***Audit Trail***: The system also includes an audit trail accessible via the administrators' Audit Logs page (Fig. 18). This feature enables administrators to view a log of all user actions within the system. The audit trail is presented in a paginated table, allowing for easy viewing and filtering of specific audit logs. The information displayed in the audit trail includes the date and time of each action, along with details about the action taken. The audit trail is generated whenever users interact with features such as the attendance management system, profile information management, or report generation.

D. User Testability

The System Usability Scale (SUS) was used to evaluate the fully deployed system. The SUS is a recognized and dependable tool for assessing the perceived usability of a system, product, or service. The SUS questionnaire consists of ten statements, each rated on a five-point scale from 'Strongly Agree' to 'Strongly Disagree.'

The respondents, including the administrators and teachers of Ortiz-Saranay Elementary School, had been given access to the system for testing. A section comprising 24 students was selected for the student attendance testing, with the adviser responsible for recording their attendance before the morning and afternoon sessions. The teachers' attendance testing was conducted in the administrator's office, where teachers could use their QR codes or search their names in the system to record their attendance. This process mirrored student attendance recording.

After using the system, the respondents were asked to answer the SUS questionnaire, which was administered using Google Forms.

IV. RESULTS AND DISCUSSION

The deployment and evaluation of the system at https://oses-connect.vercel.app/ have been successful. The application's average usability score is 84.844, as determined by the feedback from 16 users, mainly teachers from Ortiz-Saranay Elementary School. This score signifies a strong user satisfaction level and high system usability. Table I presents the frequency distribution of the responses on the System Usability Scale, labelled SD for Strongly Disagree, D for Disagree, N for Neutral, A for Agree, SA for Strongly Agree, and T for Total Responses.

In addition to the usability scale, the survey included an open-ended question for users to provide feedback on the system. The feedback was largely favorable, with users commending the system's convenience and effectiveness in streamlining attendance-checking processes. Users noted that the system simplifies the attendance checking process and significantly improves the school system. Encouraged by the positive feedback and the system's effectiveness, the school principal plans to adapt the system for attendance tracking in the next school year.

STATEMENTS	SD	D	N	A	SA	T
1. I think that I would like to use this system frequently	0	0	0	2	14	16
2. I found this system unnecessarily complex	11	2	0	1	2	16
3. I thought this system was easy to use	0	1	0	4	11	16
4. I think that I would need the support of a technical person to be able to use this system	7	0	4	2	3	16
5. I found the various functions in this system were well integrated	0	0	0	3	13	16
6. I thought there was too much inconsistency in this system	12	3	1	0	0	16
7. I would imagine that most people would learn to use this system very quickly	0	0	1	2	13	16
8. I found this system very cumbersome to use	13	2	0	1	0	16
9. I felt very confident using this system	0	0	0	3	13	16
10. I needed to learn a lot of things before I could get going with this system	5	3	2	2	4	16

TABLE I. Frequency distribution of the responses on the System Usability Scale.

V. CONCLUSION

The centralized attendance management system, OSES Connect, has been successfully implemented, deployed, and tested for Ortiz-Saranay Elementary School. The system achieved an impressive average usability score of 84.844 out of 100, indicating a high level of user satisfaction and usability as evaluated by 16 users, primarily teachers from the school.

OSES Connect not only streamlines attendance recording but also enables comprehensive tracking of both teacher and student attendance. A significant advantage of the system is its ability to generate Daily Time Record (DTR) and School Form 2 (SF2) reports automatically, eliminating the need for manual report generation by teachers. Furthermore, the notification feature keeps parents informed about their children's attendance, promoting increased parental involvement in monitoring their child's school attendance.

Moreover, the attendance forecast feature serves as an early warning system, allowing for proactive measures to address potential attendance issues among teachers and students. By predicting the likelihood of absenteeism, the school can implement preventive strategies and interventions to mitigate attendance-related challenges.

VI. RECOMMENDATIONS

To further enhance the study, it is recommended to make the user interface more responsive to different kinds of devices, especially mobile devices. For the image-saving feature in teacher and student profiles, an added functionality to crop images before saving the picture is suggested to enhance the user experience.

Additionally, the system could benefit from implementing batch processes for various operations. For instance, incorporating a batch process to generate attendance forecasts for a specified group of students and teachers, rather than processing them individually, could improve efficiency and scalability. Furthermore, batch processes could be implemented for assigning parents to multiple students at once, making it easier to manage this task.

Finally, the Markov Chain model used in this study could be improved by increasing the state space, thereby providing higher precision in the computation. For instance, incorporating additional states like ‘TARDY’ and ‘EXCUSED’ could lead to more accurate predictions.

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