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Predictive Analysis Application for Academic Student Advancement in Secondary Education Institutions

Peejay C. Vargas*

Abstract: The study developed a Predictive Analysis Application for Academic Student Advancement at Dr. Josefa Jara Martinez High School (DJJMHS) to manage school forms and data records centrally. This system offers real-time attendance tracking, academic progress reports, prediction, visualization, staff performance monitoring, and report generation. It ensures secure network connections and improved security measures while presenting all functions through a user-friendly interface. Developed using HTML5, CSS3, JavaScript, and Python-MySQL, the system facilitates the issuance and processing of various school forms. Through two testing cycles, it demonstrated functionality and reliability, receiving a "Very Good" rating from 30 respondents. This indicates accurate and dependable access to end-users' data and services through the system.

Keywords: Information Systems, Decision Support Systems, Data Mining, Student progression, Predictive analysis

1. Introduction

The growth in the use of online transactions has been rapidly increasing over the years [1]. The Department of Education (DepEd) reported and welcomed 28 million new students for the school year 2022-2023 [2]. Over time, the high school's paper-based recordkeeping has developed intrinsic problems, including being difficult to access, requiring a lot of time to update, not being secure, and being unable to be shared between locations (inaccessibility). Unfortunate events such as a fire breakout or water damage could result in the irreversible loss of important documents and data, whose knock-on consequences might be unpredictable. This means that each student's data must be deliberately recorded in accordance with the fundamental educational procedures and forms. Interviews with many stakeholders in public high schools, including administrators, teachers, parents, and students, revealed that these stakeholders shared common issues with academic records, including laborious manual

* Senior High School Department, Dr. Josefa Jara Martinez High School, Quezon City, Metro Manila, Philippines
Email: peejay.vargas@deped.gov.ph

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reporting, inaccurate records, issues with record keeping, and maintenance issues. These difficulties cause lengthy wait times for the parent or student and have an impact on record distribution.

The warning of the Novel Corona Virus 19 pandemic has made it necessary for academic settings to have access to information by using online resources. The Philippine Department of Education has ordered the use of technology platforms in the delivery of instruction [3]. This presents a challenge for public schools to adapt to the new learning modality in terms of record-keeping and reporting. Students are on a home-based learning modality, and thus, academic record management is expected to be available in a non-contact-based process with the students, following the health protocols provided for by the Department of Health (DOH) and the COVID-19 Inter-Agency Task Force for the Management of Emerging Infectious Diseases (IATF). The pandemic has brought delays in the processing of academic records and the turn-over of important reports to DepEd. Premises considered; a well-designed educational record management system is imperative to mitigate risk through compliance with DepEd standards, minimize loss of information, and provide system and user logs for auditing [4].

An educational institution should have a Knowledge Management (KM) portal for systems to act as centralized digital filing cabinets. The appropriate KM portal should contain relevant knowledge that enriches and helps the staff carry out their work. In this case, academic record-keeping is the main functionality of the developed application [5]. The capacity to connect all saved forms and documents to all school stakeholders is made possible by existing academic record management systems, which help institutions meet the growing demand for up-to-date information in school systems, especially public school systems. This project provides an opportunity for government-compliant educational record-keeping processes for academic records. The system establishes an efficient, and accessible process for recording, storing, and retrieving educational data to improve data accuracy and accessibility in the educational sector.

2. Related Studies

Today's era marked that school-based technology is already a necessity, and every nation found the need to invest in it, resulting in significant progress towards the digital device [4]. Academic institutions employ a record management system that is beneficial for faster internal official correspondence and is safer, more transparent, and less costly [6][7]. However, Dr. Josefa Jara Martinez High School is a public school that uses manual records management and record-keeping processes. To address opportunities for improvement, this paper designs a system for the said school.

2.1 Educational Data Management System (EDMS) Architecture

The electronic document management system architecture is provided by a number of studies. The document management architecture used in this study is shown in Figure 1. This architecture consists of three modules: document storage, document management, and document retrieval and sharing. System users create internal papers, which are scanned into the system from hardcopied official documents. Records can be preserved and saved. Reports from system logs will show the audit path of documents. Two servers are designated for document storage. The absence of cloud storage provisions in this study is due to the institution's low budget allocation. Users can write, search, send, edit, report, attach, route, and approve documents in the document retrieval and sharing component.

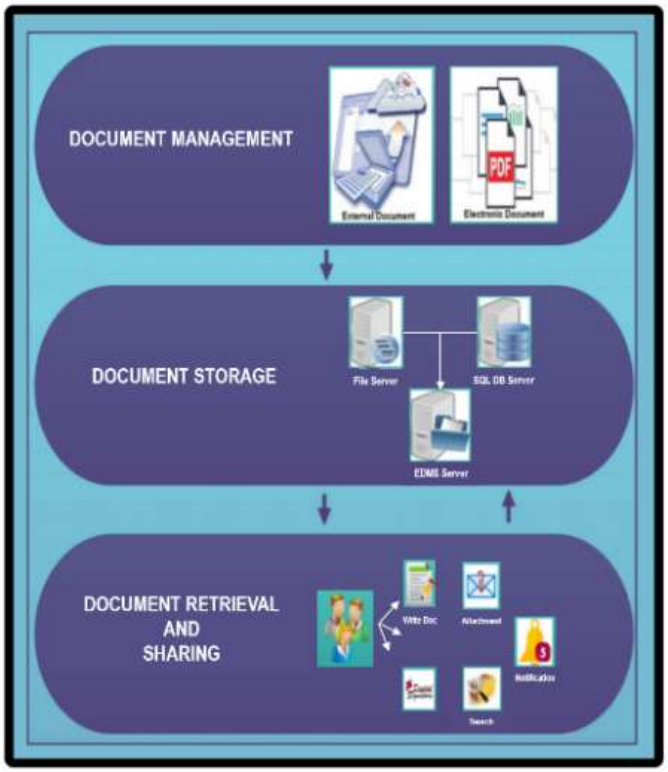

Figure 1. EDMS Architecture

In the Philippines, there are no available off-the-shelf EDMS for education. All the existing systems found in the works of literature use K-12 international standards. The standards of the Philippine Department of Education are different from these systems. This study develops an application that is compliant with the public-school standards of the country. This kind of improvement with the use of information technology helped the school with document management. The Registrar of DJJMHS examines whether the storage of school forms on the server is safer and easier to access. To this end, a system also provides the user who runs a transaction with a personal computer, laptop, and an applicable gadget like a tablet or cellphone. It is also presented as a comparison of generated graph results to analyze existing data analytics on visualization performance per course. This functionality design helps the administrator and teachers to decide appropriate academic-related interventions with the collection of data: enrollment every school year, male and female enrolled, enrollment per grade level, Junior High School male and female, Senior High School male and female, passed academic grade per year grade level, failed academic grade per year grade level, passed academic grade per section, failed academic grade per section, passed and failed every school year, and class performance per faculty. Content 360 is a flexible K-12 education solution that improves efficiency, streamlines management, and boosts productivity at all levels of the educational system. The features streamline student admission and reporting. Report cards, college transcripts, attendance, and financial assistance paperwork are just a few of the forms, and data should be kept accurately, carefully, and confidentially. Students, school managers, and management teams have historically relied heavily on papers [8].

2.2 Knowledge Management

The processes of the school are based on knowledge and the stakeholders. They need to understand how important information is to them and how knowledge is used. By allowing a cloud-based platform, a knowledge management (KM) portal enhances knowledge in the enterprise to exchange, distribute, create, document, and understand processes. Using the KM portal in an organization will reduce job

mistakes, encourage efficient outcomes, enhance decision-making, increase communication, and boost student quality in the workplace and educational setting [5]. An educational institution should have a KM portal for systems to act as centralized digital filing cabinets. The required KM portal should contain applicable information that will enrich and assist employees in carrying out their work [5][9]. In this case, academic record-keeping is the main functionality of the developed application.

2.3 Data Mining

Databases, data centers, the Internet, other knowledge archives, or dynamically streamed data across the system are all possible data sources. Data transformation and data consolidation in data warehousing are commonly conducted before the data collection process [10].

The identification and management of outliers ensures more accurate modeling and analysis in data-driven decision-making processes. Data is clustered using a statistical method known as discriminant analysis to categorize fresh observations into already-defined groups. It models each response class independently and estimates likelihood using the Bayes theorem. These models can be quadratic or linear in nature, and they improve data mining approaches [6].

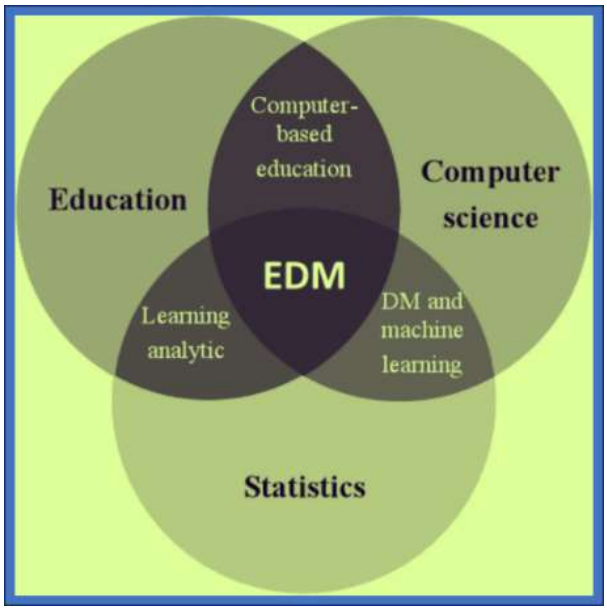

Figure 2. EDM Areas

The goal of Educational Data Mining (EDM) is to find hidden patterns and create predictive models that may be used to provide relevant information in educational contexts. To determine whether students are at risk of failing the semester evaluation early on, it is necessary to predict the academic progress of the students. This can be utilized to deduce important patterns that will help us comprehend how children learn. The need for education data mining is expanding quickly, along with the number of student records [11]. Administrative data could be very helpful in addressing various types of educational difficulties. In order to ease educational challenges, professionals must recognize the impact of big data in education. Modern cultures require training in creative thinking abilities in order to keep up with technological advancements, knowledge growth, and the constant flow of information [12]. It's all about devising tools for analyzing the precise types of knowledge that emerge from educational settings and using these approaches to better understand what students learn in such contexts [13]. Figure 2 summarizes the areas involved in educational data mining. EDM can analyze the data generated by any learning system and concentrate on various aspects, taking into account underlying demographic and

motivational data containing multiple levels of hierarchy, contexts, granularity levels, and historical data. It is referred to as interdisciplinary data mining for education because it can include social network research, educational psychology, cognitive psychology, and psychometrics.

3. Methods

3.1 Conceptual Framework

Figure 3 reflects the conceptual representation of the system. The developed system can be accessed using the institution's intranet. The management system is hosted over the intranet and will be available to any device as long as it is connected to an intranet-capable device. The academic record management runs over the local host to provide rapid deployment and easy access.

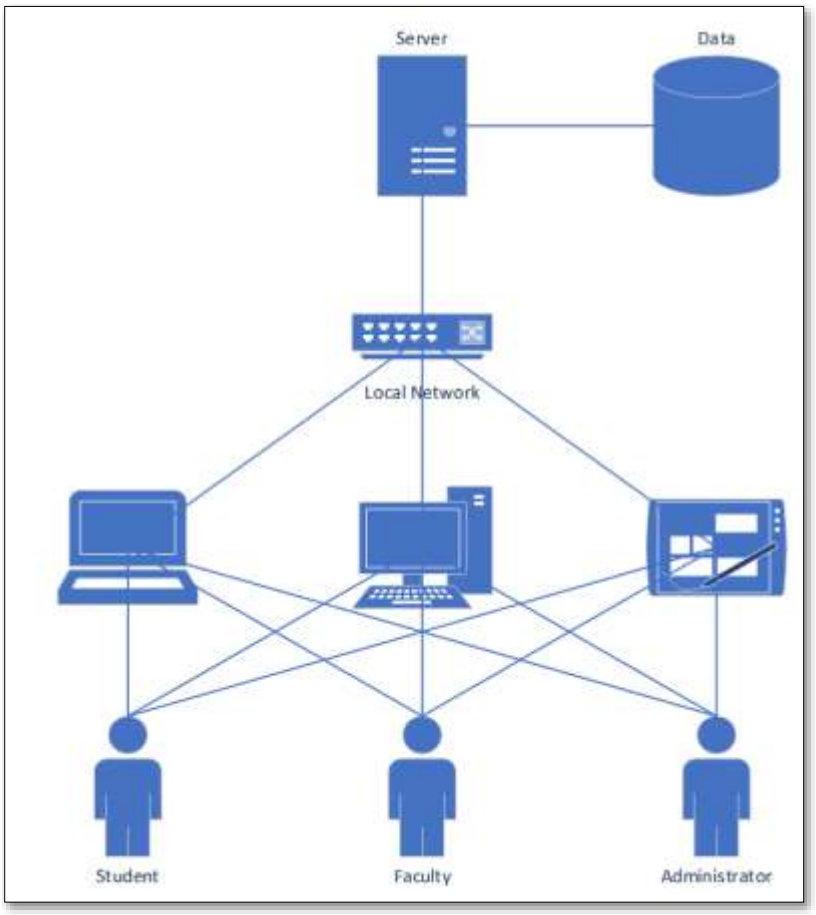

Figure 3. Conceptual Framework

3.2 Software Development

This study employed the Waterfall Software Development Model.

3.2.1 Server Architecture

The system employed a three-tier architecture to create the server. The design allowed the server to play two roles: a database server for the back end, which used MySQL, and an application server for the front end, which used Django, JavaScript, HTML5, and CSS3. The three-tier server architecture also illustrates how the Transactional Management System (TMS) managed multiple users to access the

database and the file manager for the application simultaneously. It further shows that the end user will only see the interface of the system.

3.2.2 Use Case

Considering the user requirements analysis output, this study designs the application following the use case diagram depicted in Figure 4. The entities describe the user's interaction with the system. The diagram shows the Student, Teacher, and Administrator/Registrar as the actors. It shows which parts of the system the user can only access. The system user type consists of Administrator/Registrar, Teacher, and Student. The System Administrator can access all security, technological, and ethical modules and has unique configuration settings and a user management account. Using the dashboard and timesheet modules, the Administrator can track system output, manage requests, manage custodian accounts, and display and print reports, including all school forms.

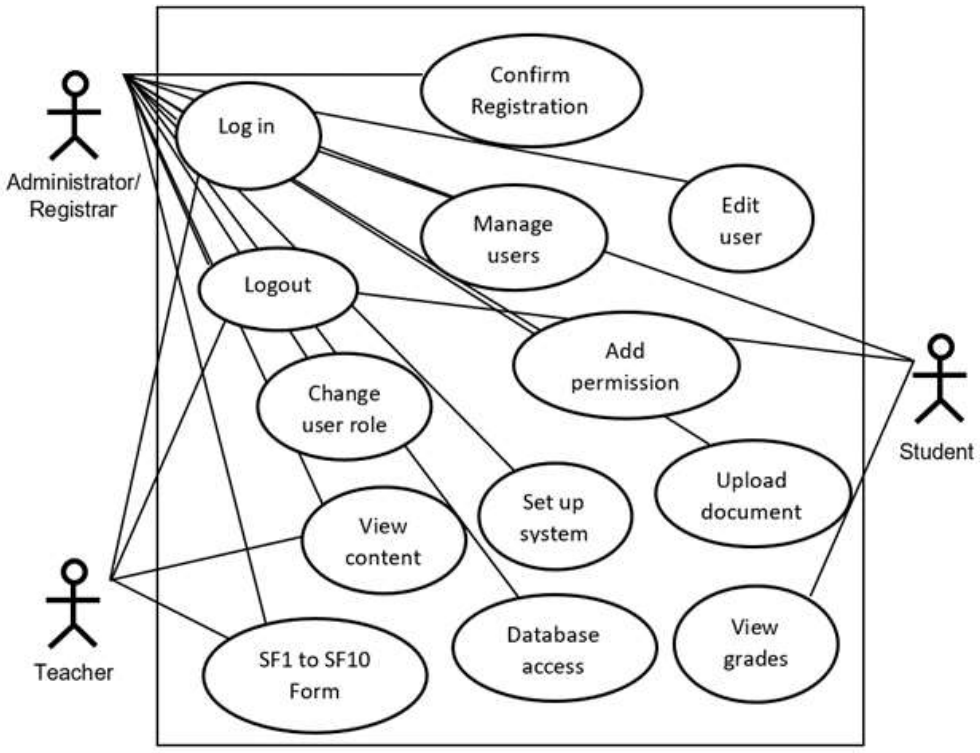

Figure 4. Application Use Case

The Administrator of the system has all possible permissions and can access any functions. Like, confirm registration to the system (*e.g.*, allow a new user to access the TMS). The Administrator can add a new subject to the list of subjects; add new subject categories to the categories. All that it can do is Login, Logout, Confirm Registration, Manage users, Set up the system, View content, Edit user profile, Change user role, Add permission, Upload document, and Database access. One that it can perform on the system is the Enroll Grade level of the validated student. The Administrator can register the teacher and student in the system (*e.g.*, a new teacher and student). The Teacher with four dialogue actions in the system, namely Login, Logout, view grades, and School Form 1 (SF1) to School Form 10 (SF10), can perform various functions like attendance, grades, conduct, and status for the student. The Student can perform tasks like changing the password and view the grade on the system.

3.2.3 User Interface Design

Figures 5 and 6 are examples of User Interface (UI) designed for report generation and visualization.

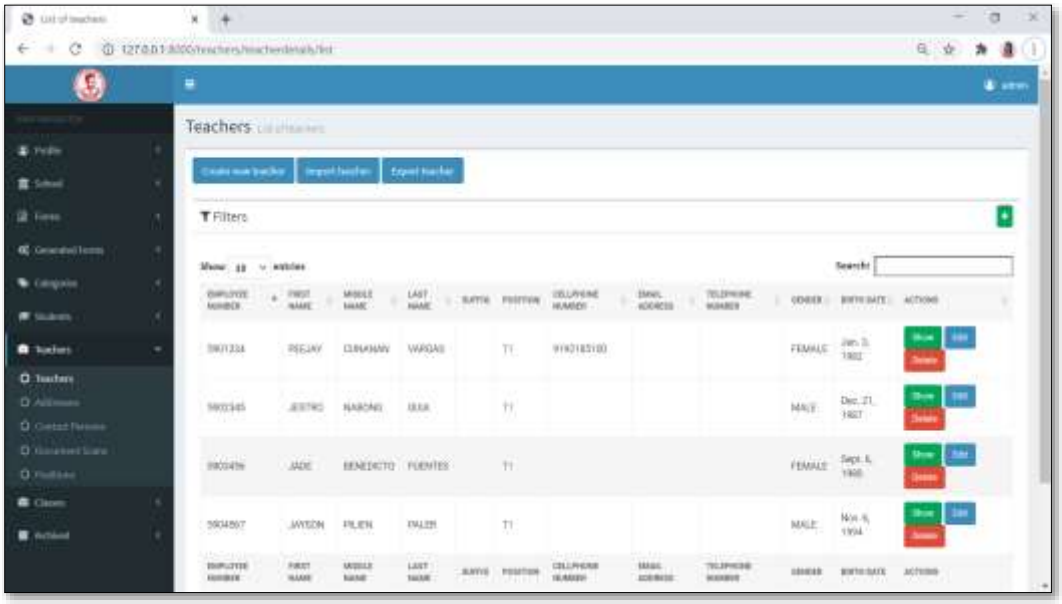

Figure 5. DJJMHS-TMS Teachers Module

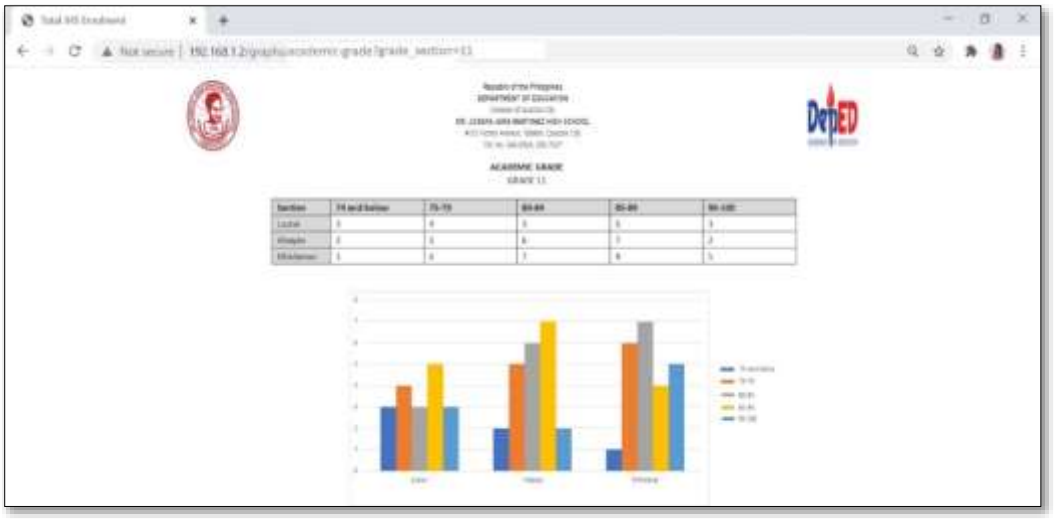

Figure 6. Data Visualization

3.3 Operation and Testing Procedure

In this phase, the system was pilot-tested in the identified school. The phase-in is initiated after the system has been tested and accepted by the user of the respective department of the school. The system was deployed in a live environment. Program testing was conducted in a specified order to verify that the system functions according to specifications. The study used functionality and reliability as the test parameters. The error was fixed in every executed test case.

3.4 Evaluation Procedure

The system was evaluated using the eight quality parameters described in ISO/IEC 25010: functional appropriateness, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

The total number of respondents is thirty (30) and is divided into two groups. The first group of respondents will consist of ten (10) IT professionals or experts aged 22 and above. They must have a background in any computer-related course, preferably a graduate of a bachelor's degree and an IT specialist. The second group of respondents was composed of twenty (20) school officials, personnel, and students (non-IT). All respondents assessed the functionality of the TMS at DJJMHS, as a total of 30 test cases were prepared and executed to test each module.

The weighted arithmetic mean, a statistical technique, was used in the data interpretation. First, to determine the average responses of the five options in each item, namely 5 (excellent), 4 (very good), 3 (good), 2 (fair), and 1 (poor). using a rating scale of 1-5, with 5 being the highest and 1 being the lowest. Then, the data were collected and tabulated to get the weighted mean for each criterion and the grand mean.

4. Results and Discussion

The testing process consisted of two cycles to evaluate the system's compliance with specifications and operational requirements. The 30 test cases were executed to ensure functionality, accuracy, and completeness. Table 1 shows that in the first cycle, 100% of test cases were executed, with 88.2% passing and 11.8% failing. Issues were re-tested and fixed during the second cycle. After resolving these issues in the second cycle, all test cases passed, indicating successful functionality testing. Performance was assessed based on ISO/IEC 25010 quality characteristics, with respondents confirming the system's functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability through weighted mean scores. The Academic Student Progression Predictive Analysis System provides a seamless recording of student information and visualization of reports for predictive analysis generation.

Table 1. Test Execution Summary

Test Execution	Expected Result	Actual Result	
		Cycle 1	Cycle 2
No. of Test Cases Executed	100%	100%	100%
Results of Test Cases			
Passed	100%	88.2%	100%
Failed	0%	11.8%	0%
No. of Test Cases Not Executed	0%	0%	0%

Table 2. Summary of Evaluation Results

Characteristic of Software Product	Weighted Mean	Interpretation
Functional Sustainability	4.07	Very Good
Performance Efficiency	4.26	Very Good
Compatibility	4.35	Very Good
Usability	4.41	Very Good
Reliability	4.08	Very Good
Security	4.05	Very Good
Maintainability	3.94	Very Good
Portability	3.76	Very Good
Overall Mean	**4.12**	**Very Good**

In Table 2, the system is functionally complete, appropriate, and correct when used in a specified state based on the respondents' responses. Utilizing Python for the back-end, and HTML5, CSS, and JavaScript for the front-end, along with a MySQL database, the system has undergone rigorous functional testing across two cycles, demonstrating excellent performance with an overall mean rating of 4.12 according to ISO/IEC 25010 software standards, indicating a "Very Good" descriptive rating across various characteristics.

5. Conclusion

The development of the school-based TMS for DJJMHS has been a success, providing a secure intranet-based system that seamlessly serves multiple departments, including Admission, Registrar, Academics, and Students. The system offers essential features such as statistical reports, computerized enrollment, uploading of student grades, and a user-friendly interface accessible on various devices like cellphones or tablets. There are several recommendations for enhancements to the existing system at DJJMHS. These include integrating additional processes such as Property management, Information Technology Management Services, Online Services for Student quarterly grades, General Services, and Administrative Services. Additionally, the implementation of a notification system to alert students and parents about the availability of grades and announcements. Furthermore, embedding the system on the school website will ensure widespread accessibility and usability. These planned expansions aim to further streamline operations, improve communication, and enhance the overall functionality and accessibility of the system for all stakeholders involved.

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