Web-Based Student Result Management System

Thesis · October 2018

CITATIONS
2

READS
123,034

1 author:

Mohammad Lorgat
Catholic University of Mozambique
12 PUBLICATIONS **13** CITATIONS

Web-Based Student Result Management System

Mohammad Gulam Lorgat

Abstract: The technological development and impact of computers and internet on our lives that has been verified over time affected various sectors of activity. And almost every task today is being run through computers. Getting information and quickly turning it into a product that consumers want is the essential key to staying in business and all of this is done nowadays using computers and applications or information systems. And the education system is undeniably the backbone of the society, it focusses at preparing the young talents for the future. However, currently the process of students' result management and declaration at the Catholic University of Mozambique, is performed manually with extensive human intervention, the students' results are generated through a spreadsheet application and then printed on a paper, attached to a wall for declaration and then stored. The current research aims at creating a web-based student result management system, reducing time, effort and improving security. The methodology adopted for the elaboration of the research is based on qualitative study. The research results in the development of a multi-user system, based on web technology with MVC (Model-View-Controller) architectural pattern and developed using Java programming language with Apache Tomcat Server and MySQL Database Management System support.

Keywords: Information System; MVC; Java; Results; Students.

1 Introduction

The impact of computers and internet, on our lives today is probably much more than we really know. Getting information and quickly turning it into a product that consumers want is the essential key to staying in business and all of this is done nowadays using computers and applications or information systems.

And the information systems will continue to change businesses and the way we live. Many corporate leaders are using technology to manage every aspect of their organization, from product creation to customer service.

It has brought evolution in almost every field, it changed the ways of teaching, administration of activities such as e-learning, e-library and online portals where teachers and students communicate, and sharing of information has never been better.

Student result declaration and management are amongst the most important activities within a university or any educational institution, since all other activities depend on it. Hence implementing an information system can be declared a significance result.

The main objective of this research is to enhance and automate the management and declaration of students' results using a computerized system.

1.1 Problem Definition

Currently, the process of declaring and managing the students' results at the Catholic University of Mozambique, is performed manually with extensive human

intervention. The students' results are generated through a spreadsheet application and then printed on a paper, attached to a wall for declaration and then stored.

Despite having an application that generates the result, it is not very effective as the system consumes a lot of time and human resources in performing various tasks, it is costly, it lacks data security and efficiency. And at present, the institution needs an advanced and computerized environment. And once implemented, it will minimize all the problems mentioned.

1.2 Scope

The study aims at developing and implementing a web-based student result management system for the Catholic University of Mozambique, replacing the old manually done paper work and to minimize the security issues and the problems it possesses.

The proposed is a multi-user system, developed using Java programming language with Apache Tomcat Server and MySQL DBMS (Database Management System) support.

The system is confined to and intended for the students. They possess privileges to check their results after he/she is provided with a specific username and password for a secure login. The entire system is managed by a system administrator, who possesses the full control of the system, to read, write and execute the results and to assign privileges to teachers and students. And the teachers have the privilege to assign the students' marks, through which, a result will be generated automatically and each student will have access to their results only, using their respective account.

1.3 Research Significance

The computerization of the current system will have an impact on the way the students access their results and, how it is managed and generated by the institution's employees. The system will make the life much easier for the institution as they will be able to store data much better than how they were able to do earlier.

The students will have a smart management of their results and will be able to keep track of their progress with an ease of access, from anywhere, anytime and any device that has an internet connection, and just by entering their respective credentials provided by the institution. Not only for the students, but for the teachers and the institution's employees managing the system as well. They will be able to keep their data organized and secure.

The system will allow the teachers to grade the students even from home, then automatically perform the grades calculation, and the students could easily access and print them. This avoids the teachers from doing all the work manually, and have a better work quality and management that would reduce time, human effort and errors.

2 Literature Review

According to Freund et al. (2017), nowadays people interact directly with technology in fields such as education, government, finance, retail, entertainment, health care, science, travel, publishing, and manufacturing.

And they also state that, educators and teaching institutions use technology to assist with education. Most equip labs and classrooms with laptops or desktops. Some even provide computers or mobile devices to students. Many require students to have a mobile computer or mobile device to access the school's network or Internet wirelessly, or to access digital-only content provided by a textbook publisher.

And educators may use a Course Management System (CMS), sometimes called a Learning Management System (LMS), which is a software that contains tools for class preparation, distribution, and management. For example, through the course management system, students access course materials, grades, assessments, and a variety of collaboration tools.

Many schools offer distance learning classes, where the delivery of education occurs at one place while the learning occurs at other locations. Distance learning courses provide time, distance, and place advantages for students who live far from a campus or work full time.

Referencing Wallace (2015), the LMS is an information system used to track student progress, and manage educational records. Many offer other features, such as online registration, assessment tools, collaborative technologies, and payment processing. They also offer tools for creating or importing content.

And she also states that, people are so accustomed to social networking and other web applications that it is an easy step to build these tools into an online platform or environment.

And referencing Wundenberg (2015), LMS characterizes a complex, often web based software system which pools multiple task specific subprograms under a shared User Interface (UI).

These subprograms support, for instance:

- Allocation and organization of learning content for different learning scenarios;
- School administration;
- Information management;
- Online school business related communication.

2.1 Learning Management System Features

Dias, Diniz and Hadjileontiadis (2014) state that, LMS Moodle (Modular Object-Oriented Dynamic Learning Environment), a free and open-source platform based on socio constructivist perspectives developed by Dougiamas in 1999, allows users to incorporate various resources and functionalities in a modular structure. Additionally, seen as a Course Management System (CMS), Moodle can be used to manage the students' path, to monitor their performance, to create and distribute content, to organize e-activities, to evaluate, as well as to provide tools for communication, collaboration and interaction between the peers involved in the educational process.

However, it is important to underline that incorporation of a wide range of activities in the LMS per se does not seem sufficient to enhance the teaching learning process. These kind of learning platforms (e.g., Blackboard, Formare, Moodle,

Teleformar, WebCT) should be seen as an opportunity for institutions to develop learning materials, online courses, tests and evaluations, databases and to online monitor students' progress.

Furthermore, Wundenberg (2015) states that, an LMS also has to represent a number of characteristics to satisfy the stakeholders' needs:

- User friendly, intuitive design and self-explanatory functionalities;
- Adequacy for the users' levels of experience and knowledge;
- High system robustness against data-loss or system failure;
- High data security standards;
- Easy accessibility;
- System flexibility for institutions' individual configurations and concept adaptations.

According to Foreman (2018), an LMS differs from other information systems and it has its own features that allows schools and institutions to manage users and courses and administer the system.

- The user management features of an LMS include user account creation, authentication, user profiles, and roles and permissions.
- The course management includes managing lessons and assignments, post a course syllabus, learning goals, and schedule, provide interactive activities such as surveys, quizzes, and polls, upload and download multimedia course materials, conduct web conferences, send instructor-student messages and messages among students and establish student groups.
- The academic features are those that require special permission and, generally, are not accessible to students. They include class rosters and gradebooks, reports, analytics and statistics, and tools for developing courses and lessons in the system.

Moreover, the current research focuses on the section where the professors and students are registered into the system and are enrolled in respective subjects, allowing the professors, to grade the students and monitor their progress. And allows the students to view their own progress or results on each enrolled course.

3 Research Methodology

A research methodology is the elaboration of a clear strategy for gathering evidence, including the specific data collection methods to be used, the kinds of evidence to be collected, and the approach for analysing the evidence (Darian-Smith & McCarthy, 2017). It is the path to solve a research problem. Hence it must be planned according to the objectives of the study.

3.1 Research Design

The research design used in this study is qualitative. Dawson (2015) states that, a qualitative research method is a scientific method of observation, used to gather non-numerical data and that enables to conduct in-depth studies about a broad array of topics. They are more common within the field of information science and involve methods such as case studies and surveys.

3.2 Data Collection Method

Refers to the methods used to obtain and gather all the required data and information for the execution of the current research. The data was collected using both, by primary data collection methods as well as secondary sources.

Primary data are the original data that has been collected specially for the purpose in mind. And data collected from the original source using one or more of the primary data collection methods such as, interviews, observations, surveys, etc. (Darian-Smith & McCarthy, 2017). In the current research most of the information were gathered through primary sources. And the methods that were used to collect the primary data are: on site observation, structured interview and document analysis.

Secondary data is the one that was collected and that has already been analysed by someone else other than the user. This means that huge data sets are already out there, either completely unanalysed or ready to be analysed in new and creative ways. Furthermore, many of these data sets are inexpensive or freely available to researchers. And for an average scholar, doing secondary research on existing data can be more convenient, much faster, and less expensive than trying to do one's own primary research to collect new data (Darian-Smith & McCarthy, 2017). And the secondary data was collected through: books, thesis and internet or Web.

3.3 Data Analysis

The classification and tabulation transform the raw data collected into useful information by organizing and compiling the bits of data into graphically understandable manner, and in the current research, it was done with the help of a UML (Unified Modelling Language) modelling tool, Astah.

3.4 System Development

System development is a set of activities used to build an information system. System development activities often are grouped into larger categories called phases. This collection of phases sometimes is called the system development life cycle (SDLC), each system development phase consists of a series of activities (Freund et al., 2017).

And in the current research, to develop the Web-Based Student Result Management System, the incremental model was employed, which is now the most common approach for the development of application systems and software products.

Incremental development is based on the idea of developing an initial implementation, getting feedback from users and others, and evolving the software through several versions until the required system has been developed. Rarely a complete problem solution is worked out in advance but it moves toward a solution in a series of steps, backtracking when realized that some mistake have been made. By developing the software incrementally, it is cheaper and easier to make changes in the software as it is being developed (Sommerville, 2016).

4 System Analysis

Systems development is mainly done in two phases, namely, system analysis and design. And this chapter focuses on analysing the research data and describing a logical view of the whole process, by modelling the data analysed in the form of diagrams to visualize the design and specifications of the system in an object-oriented manner.

The analysis phase answers the questions of who will use the system, what the system will do, and where and when it will be used. During this phase, the research team investigates any current system(s), identifies opportunities for improvement, and develops a concept for the new system (Dennis, Wixom, & Tegarden, 2015).

Referencing Valacich and George (2017), because analysis is a large and involved process, it is divided into two main activities to make the overall process easier to understand:

• Requirements determination: a factfinding activity.
• Requirements structuring: an activity that creates a thorough and clear description of current business operations and new information processing services.

4.1 Requirements Determination

According to Dennis et al. (2015), the requirements determination turns the very high-level explanation of the business requirements stated in the system request into a more precise list of requirements that can be used as inputs to the rest of analysis. And a requirement is simply a statement of what the system must do or what characteristic it must have. The system requirements are often classified as functional (FR) and non-functional requirements (NFR).

The following are the functional requirements of the current system:

[FR01] – The system will have three types of users: Administrator, Professor and Student.
[FR02] – The system will allow access to users account after authentication.
[FR03] – The system will prepare the students result report.
[FR04] – The system will allow the Administrators to create accounts for professors and students.
[FR05] – The system will allow the Administrators to register new subjects.
[FR06] – The system will allow the Administrators to manage all the professors', students' and subject's records.
[FR07] – The system will allow the Administrators to assign and update students' grades.
[FR08] – The system will allow the Administrators, professors and students to modify their passwords.
[FR09] – The system will allow the Administrators to assign subjects to professors.
[FR10] – The system will allow the Administrators to enrol students in a particular subject.
[FR11] – The system will allow the Administrators to generate results.
[FR12] – The system will enable the students to check their results.
[FR13] – The system will enable the students to print their results reports.
[FR14] – The system will enable the professors to assign grades to students.
[FR15] – The system will allow the professors to generate results

And the following are the non-functional requirements of the current system:
[NFR01] – The system should be developed based on web technology.
[NFR02] – The system should be in Portuguese language.
[NFR03] – The system should be implemented using Java programming language;
[NFR04] – The system should be able to connect and perform operations on DBMS MySQL.
[NFR05] – The system should be able to work on any web browser.
[NFR06] – The system should be available for use 24 hours per day, 365 days per year.
[NFR07] – Only administrators can manage professors' and students' account and subjects' records.
[NFR08] – The system should have a user-friendly UI.
[NFR09] – The system should use Apache Tomcat v8 or higher as the Application Server.
[NFR10] – The system should be executed on JDK v8 or higher.
[NFR11] – The system should support multiple simultaneous users' access at all times.
[NFR12] – The system should have a higher level of security, restricting access to some functionalities according to users' role.

4.2 Requirements Structuring

Valacich and George (2017) state that, "organizing, or structuring, system requirements result in diagrams and descriptions (models) that can be analysed to show deficiencies, inefficiencies, missing elements, and illogical components of the current business operation and information systems".

According to Tilley and Rosenblatt (2017), a use case diagram visually represents the interaction between users and the information system. In a use case diagram, the user becomes an actor, with a specific role that describes how he or she interacts with the system. Systems analysts can draw use case diagrams freehand or use CASE tools that integrate the use cases into the overall system design. An activity diagram resembles a horizontal flowchart that shows the actions and events as they occur. Activity diagrams show the order in which actions take place and identify the outcome. A sequence diagram shows the timing of interactions between objects as they occur. Might be used by systems analysts to show all possible outcomes, or focus on a single scenario. The interaction proceeds from top to bottom along a vertical timeline, while the horizontal arrows represent messages from one object to another.

And the Fig. 1 represents the use case diagram of the system, the Fig. 2, shows an activity diagram detailing one of the essential activities of the system, which is assigning grades to students. And Fig. 3, 4 and 5 show the system sequence diagrams of some essential scenarios.

Figure 1: Use Case Diagram

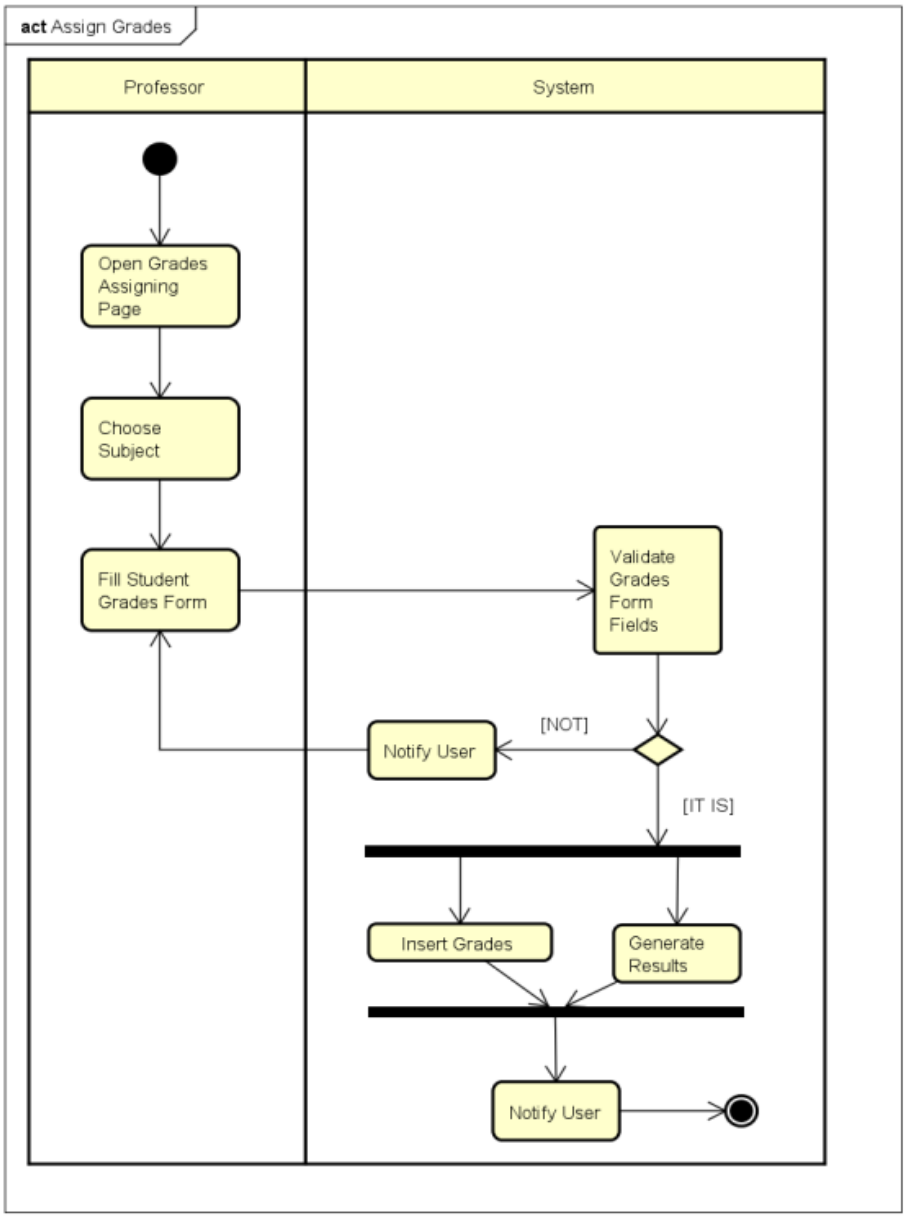

Fig. 2. Activity Diagram – Assign Grades

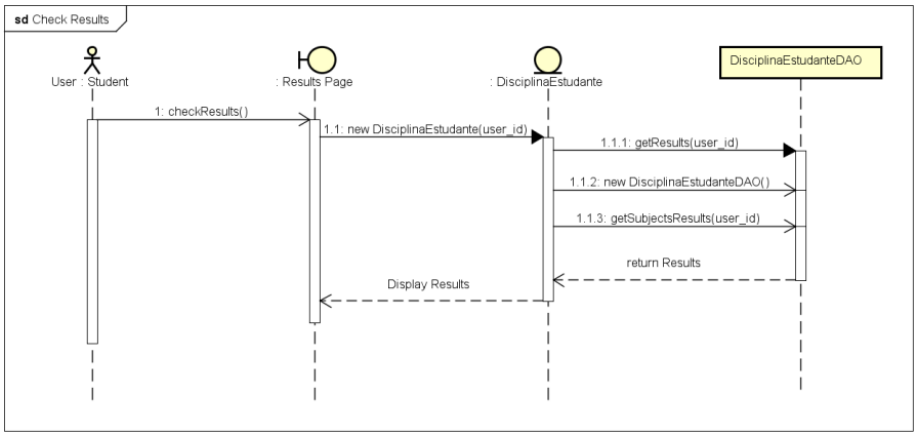

Fig. 3. Sequence Diagram – Check Results

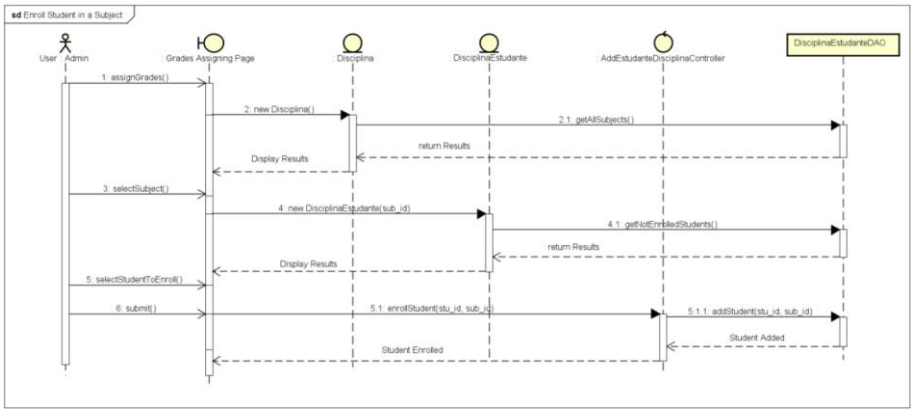

Fig. 4. Sequence Diagram – Enrolling Students in a Subject

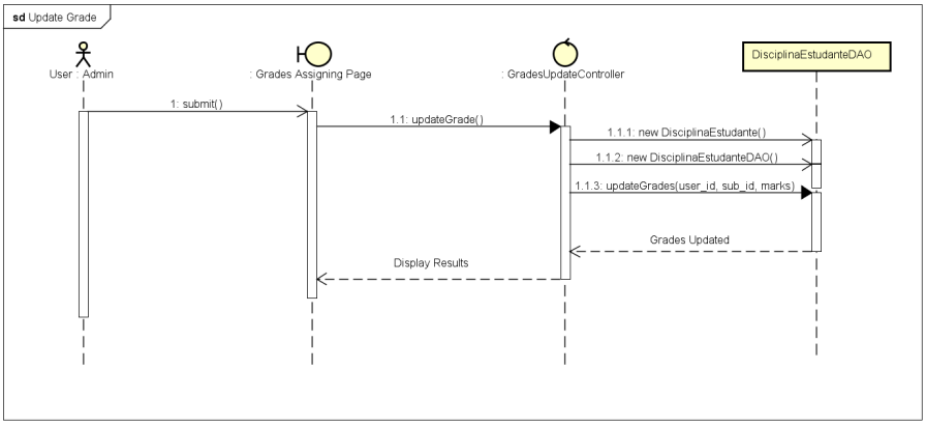

Fig. 5. Sequence Diagram – Update Grade

5 System Design

The purpose of the analysis phase is to figure out what the business needs and right after system analysis, started system design whose purpose is to decide how to build the same system. And according to Dennis et al. (2015), system design is the determination of the overall system architecture, consisting of a set of physical processing components, hardware, software, people, and the communication among them, that will satisfy the system's essential requirements. During the initial part of design, the business requirements for the system are converted into system requirements that describe the technical details for building the system.

5.1 System Physical Architecture

In a client-server architecture, a program is broken up into two different pieces that typically run on two separate computers. A server does most of the heavy lifting and computation; it provides services to its clients across a high-bandwidth network. Clients, on the other hand, mostly just handle user input, display output, and provide communication to the server (Dooley, 2017).

The current system follows the mentioned client-server model, where the system is deployed in a web server, Apache Tomcat, that provides the services, listens and replies the requests sent by a client from a browser.

5.2 Class Diagram

A class diagram shows the static structure of an object-oriented model: the object classes, their internal structure, and the relationships in which they participate (Valacich & George, 2017).

And the Fig. 6, depicts exactly the structure of the system using class diagram.

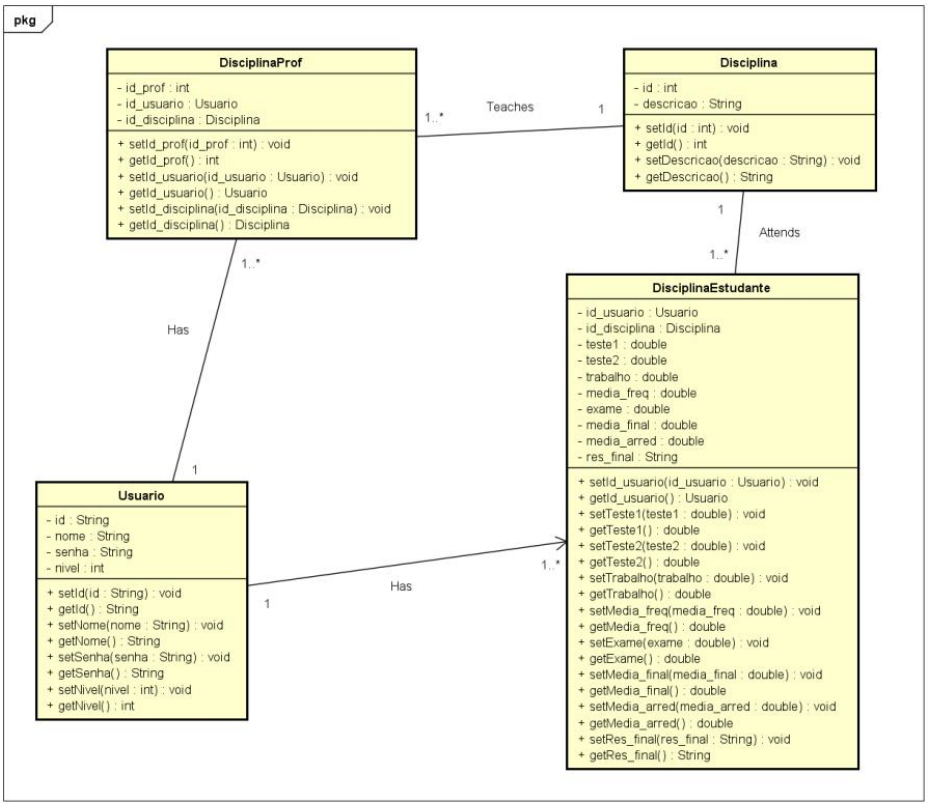

Fig. 6. Class Diagram

5.3 Database Design

From the analysis phase, a logical model of the system was created. And the following particular activity describes the proposed system's data organization, storage and management. Which is to be managed by the DBMS, a system responsible for storing, retrieving and protecting the data. These issues are important as they affect the consistency and quality of the data. The data is structured in files or tables that interact in various ways. Each table contains data about students, professors, users and subjects.

According to Dennis et al. (2015), relational database is the most popular kind of database for application development today. And it is based on collections of tables with each table having a primary key, which is a field or fields whose values are unique for every row of the table and are used to identify each row or record. The tables are related to one another by placing the primary key from one table into the related table as a foreign key. Most relational database management systems (RDBMS) support referential integrity, or the idea of ensuring that values linking the tables together through the primary and foreign keys are valid and correctly synchronized.

5.3.1 Normalization

For the logical database design, a process called normalization was used, which is a way to build a data model that has the properties of simplicity, non-redundancy, and minimal maintenance. And according to Valacich and George (2017), "Normalization is a process for converting complex data structures into simple, stable data structures."

The database of the current system went through the second normal form and third normal form of normalization. A relational table is already in first normal form. Hence the normalization begins with the second normal form. And normal forms beyond third normal form exist, but they rarely are used in business-oriented systems.

Normalization is based on functional dependency, which is a constraint between two attributes in which the value of one attribute is determined by the value of another attribute.

For example: suppose there is a USER table with the following attributes: ID, name, password and level. Here the ID attribute uniquely identifies the name attribute of USER table because if the user id is known, the user's name associated with it can be told.

5.3.1..1 Second Normal Form

Second normal form is satisfied if any one of the following conditions apply:

• The primary key consists of only one attribute (such as the attribute ID in relation USER).

• No nonprimary key attributes exist in the relation.

• Every nonprimary key attribute is functionally dependent on the full set of primary key attributes.

For example, the following table is not in 2NF:

STUDENT (UserID, Name, Password, Level, SubjectID, description)

The functional dependencies in this relation are the following:

UserID – Name, Password, Level

UserID, SubjectID – description

The primary key for this relation is the composite key UserID, SubjectID. Therefore, the nonprimary key attributes Name, Password, and Level are functionally dependent on only UserID but not on SubjectID. STUDENT table has redundancy, which results in problems when the table is updated.

And now to convert a relation to second normal form, the relation is decomposed into new relations using the attributes, called determinants, that determine other attributes; the determinants are the primary keys of these relations. STUDENT table is decomposed into the following two relations:

USER (UserID, Name, Password, Level)

Subject (SubjectID, description)

5.3.1..2 Third Normal Form

And the third normal form (3NF) is satisfied if: It is in second normal form and there are no functional dependencies between two (or more) nonprimary key attributes (a functional dependency between nonprimary key attributes is also called a transitive

dependency). For example: consider the relation PROFESSOR (ProfID, SubjectCode, description)

The following functional dependencies exist in the PROFESSOR relation:

ProfID – ProfID, SubjectCode, description (ProfID is the primary key)

SubjectCode – description (Each subject has a unique description)

It is noticeable that PROFESSOR is in second normal form because the primary key consists of a single attribute (ProfID). However, description is functionally dependent on SubjectCode, and SubjectCode is functionally dependent on ProfID. As a result, there are data maintenance problems in PROFESSOR.

These problems can be avoided by decomposing PROFESSOR into the two relations, based on the two determinants. These relations are the following:

SUBJECT (SubjectCode, description)

PROFESSOR (ProfID, SubjectCode)

5.4 Entity Relationship Diagram

An entity-relationship diagram (ERD) is a model that shows the logical relationships and interaction among system entities. An ERD provides an overall view of the system and a blueprint for creating the physical data structures (Tilley & Rosenblatt, 2017). The following figure displays a logical data representation of the current proposed system. Built with the help of MySQL Workbench, a visual or logical database design tool which provides data modeling, SQL development, and comprehensive administration tools for server configuration, user administration, backup, and much more.

The first step was to identify the entities for the current system during the analysis phase and at this stage a simplified method can be established to depict the relationships between entities. The current system database is composed of four tables representing its respective entities, “disciplina” for subjects, “usuario” for users, “disciplina_prof” for professors and their assigned subjects, and finally “disciplina_estudante” for students and the subjects they are enrolled in. And its composition can be seen in the following figure through the ERD.

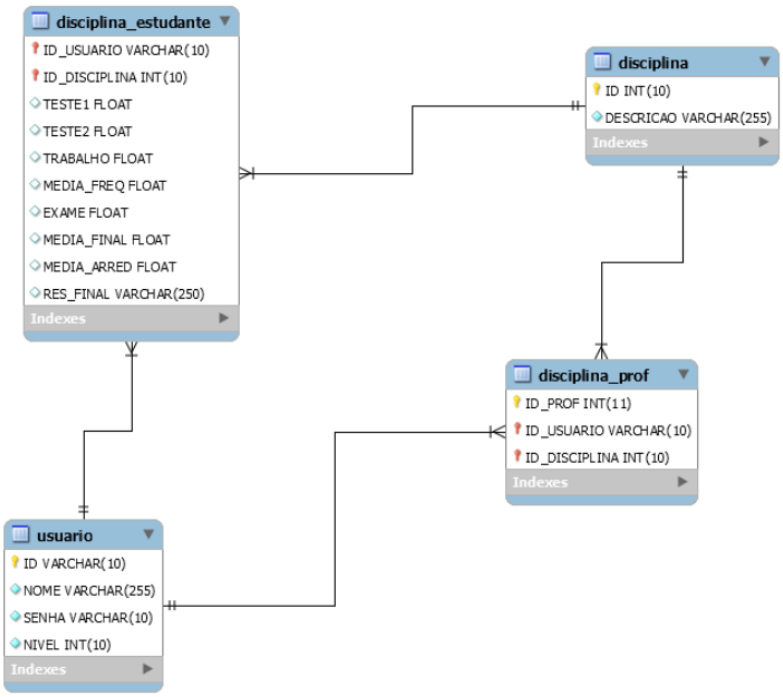

Fig. 7. Entity Relationship Diagram

5.5 User Interface

This phase, generally revolved around creating a friendly user-interface, a platform on which the users could communicate or manage the data and access the information needed. Easy to understand, manageable, reliable, interactive, that establishes a great connection with other layers of the system, manipulating the data without any inner details of it and that performs a certain task accurately.

And the designing of the user-interface involved understanding the task, objectives and experience the target audience possessed. Which was possible through the application of the HTML, CSS and Bootstrap technologies.

Below is the first page of the system, called the login page, where the user is required to be authenticated to access the system. And the system shall open a particular account page or dashboard according to the user level or role.

The Fig. 9 displays the page used to change the password of a user account, by providing the current password of the account and the new password.

The Fig. 10 shows the page where the professor can assign grades to each student on a specific subject. The professor selects a specific subject he is assigned to and the system displays a list of students enrolled in that specific subject with a few fields that allows to assign their respective grades.

The Fig. 11 displays the administrator account section where, students account can be managed.

The Fig. 12 depicts the section where the administrator can assign subjects to professors. The administrator can select the professor from the dropdown options, then the system shall generate a list of subjects that the professor is already assigned to. And can further assign more subjects which is not included in the assigned subjects list, by selecting a particular subject from another dropdown options generated, which only contains, not assigned subjects.

And the Fig. 13 displays the student's page where the results are declared. And possesses a button that permits the student print the same results.

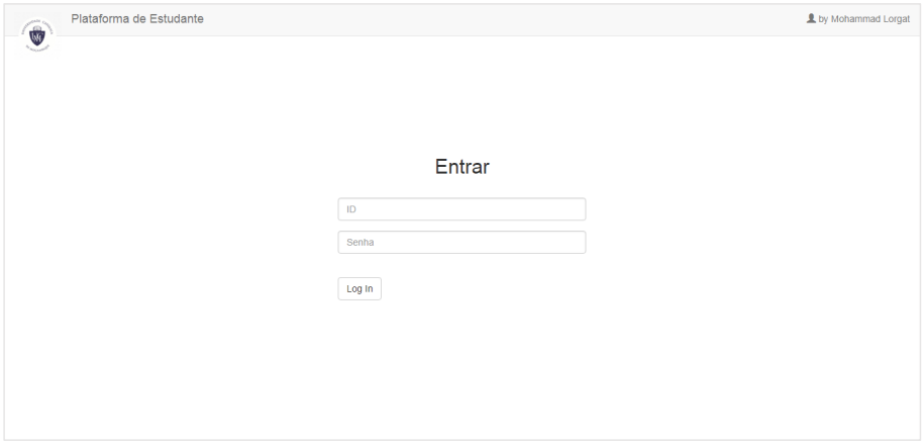

Fig. 8. Login Page

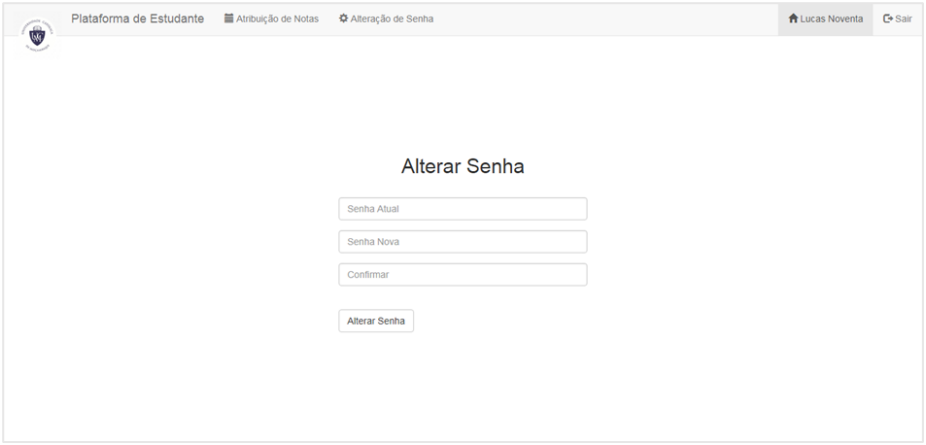

Fig. 9. Alter Password Page

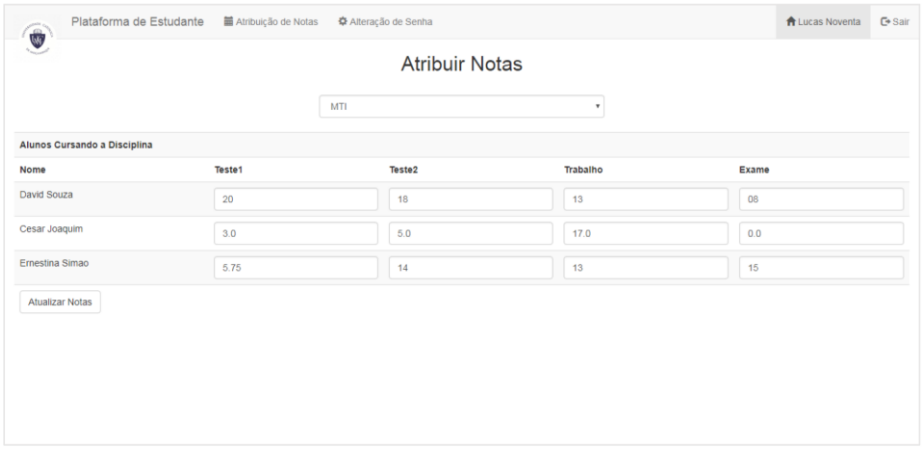

Fig. 10. Grades Assigning Page

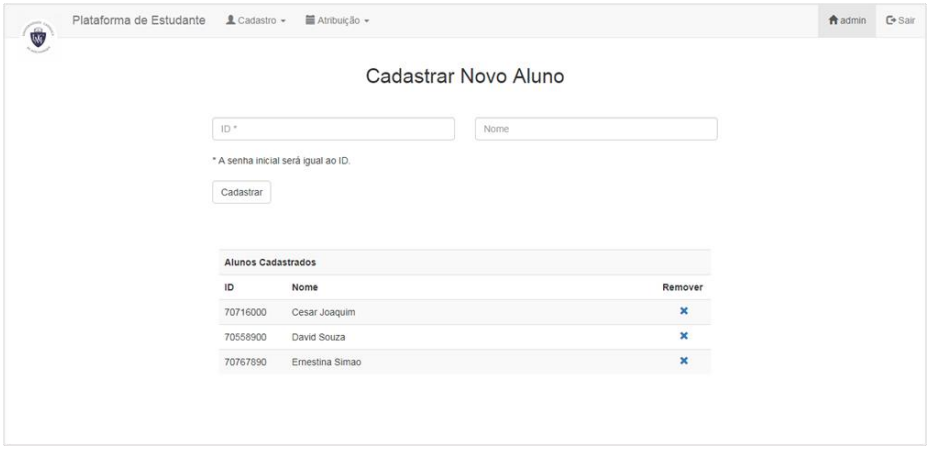

Fig. 11. Students Account Management Page

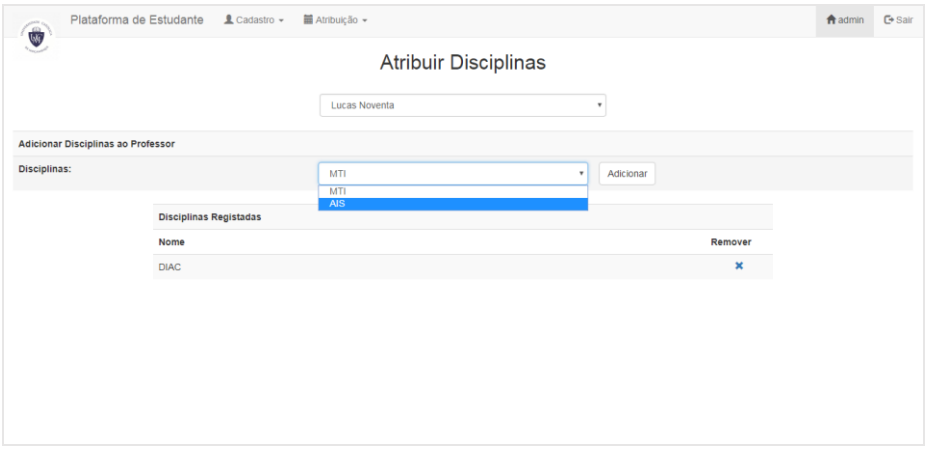

Fig. 12. Subject Assigning Page

Fig. 13. Results Page

6 System Implementation

A development environment refers to the mix of software tools, methods, and physical resources that an IT (Information Technology) team uses to create an information system. It usually is easier to use an IDE (Integrated Development Environment), which uses built-in tools provided by the software vendor (Tilley & Rosenblatt, 2017). And for the development of the current system, Eclipse IDE was used which is a well-known IDE, it is free, open-source, and community-supported.

The implementation or coding of the proposed system was performed using Java programming language which is based on the object-oriented paradigm. It organizes the system in modules or classes within their respective packages. And has become a popular approach not only in the field of programming but for system analysis and design.

The current system was implemented based on the software architecture standard, MVC, which describes its three layers. The information flow of this system, using the MVC standard highlights in the View layer, that is, the client section where information or resources are requested from the system. The Controller layer is responsible for receiving the requests and then processing and directing them to the Model layer in charge of satisfying the request by retrieving the information from the database. Then it passes the information obtained, to the Controller which delivers the response to the View and finally displays the information to the client, through the browser.

7 Conclusions

The present research was based on the computerization and the implementation of a sophisticated Web-Based Student Result Management System for the Catholic University of Mozambique. The main objective was to enhance and automate the management and declaration of students' results using a computerized system. A well-defined, efficient, controlled and managed information system or software based on web technology storing, processing and providing information through the internet.

And the objectives were achieved by following a process model such as system analysis, design and system implementation. The system analysis was composed of two activities, requirement determination and structuring. The first activity focused on the collection of data or requirements through structured interview, work environment observation and by collecting procedures and other written documents. And the latter, performed the modelling of the collected data and processes, transforming it into UML diagrams with the aid of a UML modelling tool, Astah into a graphically understandable manner. Just as structured analysis uses DFDs (Data Flow Diagrams) to model data and processes, systems analysts use UML to describe Object Oriented systems, on which the current system is based. UML is independent of any specific programming language and can be used to describe business processes and requirements generally. Finally, the implementation or coding of the proposed system was based on the software architecture standard, MVC using Java programming language, which is based on the object-oriented paradigm.

8 Future Work

In near future, the system interface could be improved, with more attractive, interactive and meaningful images; Enhance the system with an email and SMS (Short Message Service) or email notifications; Enhance the current system by computerizing almost all of the services provided by the institution (online exams, enrolment, library and others), turning it into a complete LMS; And evolve the system

by developing several versions through users' feedback, if a complete solution has not been worked out.

Acknowledgements

Immense gratitude to the colleagues from Catholic University of Mozambique (UCM) – Faculty of Engineering, who provided insight and expertise that greatly assisted the research.

References

Darian-Smith, E., & McCarthy, P. (2017). *The Global Turn*. Oakland, CA: University of California Press.

Dawson, C. (2015). *Projects in Computing and Information Systems* (3rd ed.). Harlow, England: Pearson.

Dennis, A., Wixom, B. H., & Tegarden, D. (2015). *Systems Analysis and Design* (5th ed.). Hoboken, NJ: Wiley Publishing.

Dias, S. B., Diniz, J. A., & Hadjileontiadis, L. J. (2014). *Towards an Intelligent Learning Management System Under Blended Learning*. Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-02078-5

Dooley, J. (2017). *Software Development, Design and Coding* (2nd ed.). Galesburg, IL: Apress.

Foreman, S. (2018). *The LMS Guidebook*. Alexandria, VA: ATD Press.

Freund, S. M., Last, M. Z., Pratt, P. J., Sebok, S. L., Vermaat, M., Campbell, J. T., & Frydenberg, M. (2017). *Discovering computers and Microsoft Office 365, Office 2016*. Boston: Cengage Learning.

Sommerville, I. (2016). *Software Engineering* (10th ed.). Boston: Pearson.

Tilley, S. R., & Rosenblatt, H. J. (2017). *Systems Analysis and Design* (11th ed.). Boston: Cengage Learning.

Valacich, J. S., & George, J. F. (2017). *Modern Systems Analysis & Design* (8th ed.). Boston: Pearson.

Wallace, P. (2015). *Introduction to Information Systems* (2nd ed.). Boston: Pearson.

Wundenberg, S.-M. (2015). *Requirement Engineering for Knowledge-Intensive Processes: Reference Architecture for the Selection of a Learning Management System*. Wiesbaden, Germany: Springer Gabler. https://doi.org/10.1007/978-3-658-08832-3

Mohammad Gulam Lorgat