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The design and development of student information and violation management system (SIVMS) for a higher educational institution

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Abstract: *This study aimed to design and develop a Student Information and Violation Management System (SIVMS) for a Higher Educational Institution in Central Luzon, Philippines. It utilized the descriptive-developmental design of research in which the researcher described and explained the processes performed to design and develop the prototype system. The Incremental Model of Software Development Life Cycle (SDLC) framework was employed to guide the researcher in designing and developing the project. Specifically, the following stages were undertaken: Planning and Requirements Analysis, Design and Development, and Testing Stage. The researcher was able to design and developed a prototype system of the Student Information and Violation Management System (SIVMS) using the Incremental Model. Based on the design and development of the prototype, the study provides essential recommendations for future projects related to the design and development of a Student Information and Violation Management System (SIVMS).*

Key Words: *Descriptive-Developmental Research, Software Development Life Cycle, Student Information System (SIS), SIVMS, Violation Management System (VMS)*

1. INTRODUCTION:

The advent of new technologies has brought significant changes in different sectors of society. Cascio and Montealegre [1] explain in a review of how technology has changed work and organizations. Accordingly, new technologies were not only helping people perform different tasks better and faster, but also enabled profound changes in how work was done [1]. Several types of research have mentioned how new technologies have impacted the ways processes and activities were performed. Business sectors [2], the medical field [3], engineering sector [4], sciences [5], and social sciences [6] and education [7] have observed how innovations greatly affected their ways of handling and performing different processes and tasks. Information and Communications Technology (ICT) solutions have brought remarkable impacts, which caused a radical shift in the means of how these sectors handled their respective operations and procedures. In education, several Information Technology (IT) solutions and applications have been deployed and implemented to address different concerns and essential processes to provide the utmost quality of service to different types of stakeholders. According to [8], IT has made both teaching and learning more accessible, helped the teachers and administration to keep track of all students in the classroom, encouraged for a more digital-oriented classroom environment, made education more fun and entertaining, contributed in making education more accessible for all the students, access to research and information became much easier, and group studies and students' collaboration has been intensified and made possible.

Over the years, several IT solutions were developed and implemented to optimized systems and procedures in different educational institutions. Enrolment Systems [9] [10], Student Admission Systems [11], Grade Monitoring and Evaluation Systems [12] [13], Attendance Monitoring Systems [14] [15] [16], and Student Information Systems [17] [18] are some of the IT solutions which can be implemented in different educational institutions to optimize and improve the quality of performing operations and procedures. It has been observed that these solutions have significantly provided positive results to different educational institutions in this era of Industrial Revolution 4.0. The Industrial Revolution was the dramatic period of economic and technical change in the late 18^{th} and early 19^{th} century [19]. Industry 4.0 is the term used to describe the emergence of new technological advancements and innovations emanated from the discoveries and products developed during the third industrial revolution or the era of diffusion of digital fabrication devices and democratization of production [20]. Automation has been one of the buzzwords commonly attached to Industry 4.0 because of its direct impact and benefits concerning IT solutions and innovations. Automation involves creating innovations and technologies to control and monitor human-related activities with the aid of electronic devices. It was already observed and evident during the third industrial revolution but immensely intensified and improved in Industry 4.0 to cater to the ever-changing and fast-growing communities' needs.

The development of different IT solutions to improve different systems and procedures continuously thrives in Industry 4.0, thus the need to further understand the process of designing and developing different solutions remain relevant and essential at this time. A Student Information Management System (SIMS) is an example of an IT solution related to automation. Several kinds of research have been published discussing about designing and developing a student information management system [17] [18]. Undoubtedly, significant positive impacts have been observed, and a more efficient and effective means of delivering services to students have been provided with the use of an automated system. Suvin [21] cites the different benefits which can be acquired using Student Information Management Systems. Accordingly, SIMS provides a hassle-free enrolment process, more accessible means of managing student information, provides student portal, improved way of academic advising, foster efficiency, reduced redundant human errors, provide parental portals, avoidance of data breaches, effortless communication, and collaboration among alumni. Apart from the mentioned benefits, the following are the advantages of implementing a student information management system: Enhanced productivity, improved student success, parental involvement, enhanced data security, improved inter-relations between departments, and student safety [22]. As far as students' safety is concerned, educational institutions provide dedicated offices and personnel to handle different activities related to them.

The guidance office is one of those dedicated offices concerned about student safety, as well as recording and managing student information. In a different Higher Educational Institution (HEI), the guidance office typically handles the recording, organizing, maintaining, securing, and managing the student information essential for the office to monitor the students. An automated student information management system suits a guidance office to perform its different tasks. However, the need to include the management of students' violation is essential to make meaningful insights from the records being kept in the guidance office. This study attempts to design and develop a Student Information and Violation Management System (SIVMS) to provide a possible solution to an HEI's guidance office to organize and properly manage student information and violations. The need to conduct such a study to contribute to the existing body of knowledge, focusing on designing and developing IT solutions, is one of the researcher's goals. Also, there is a need to contribute to the pool of existing knowledge to support previous studies related to designing and developing a Student Information Management System to strengthen previous claims and add new insights from a different context.

1.2 Statement of the Objectives

In general, this study seeks to describe the process of designing and developing a prototype of a Student Information and Violation Management System for a Higher Educational Institution in Central Luzon, Philippines. Specifically, it sought to describe the different activities undertaken following the stages of Incremental Model, which include: Planning and Requirements Analysis, Design and Development, and Testing.

1.3 Scope and Limitation

This study was undertaken to develop a system prototype of a Student Information and Violation Management System in one of the Higher Educational Institutions in Central Luzon, Philippines. It only covers the following stages of the Incremental Model: Planning and Analysis, Design and Development, and Testing. This study did not cover the implementation and maintenance stage it only focused on the design and development of SIVMS.

2. METHOD:

2.1 Research Design

Descriptive-Developmental Research Design was utilized in this study to describe the process of developing the prototype system. Olipas [23] explains that developmental research design covers a systematic approach of developing the prototype, from designing, developing, to evaluating the output. On the other hand, descriptive research answers the what, when, where, and how questions related to the process of developing the system prototype [24]. When methods are combined, meaningful insights can be drawn. The study of [25] [26] utilized descriptive-developmental research design in developing IT solutions to explain the processes undertaken following a software development model properly.

2.2 Software Development Framework

The Software Development Life Cycle (SDLC) was the framework used in this study, for it involved the essential stages required for the successful development of the prototype system. According to [27], SDLC is all about minimizing the possible risks and failures that the software may encounter and the maximization of the quality of the software product. SDLC provides an opportunity for developers to properly analyze and identify possible problems concerning software being developed to increase the quality of the output provided to customers. SDLC covers the complete life cycle of software – from inception to deployment of the product. It has defined stages which include: Requirements Gathering and Analysis, Design, Implementation and Coding, Testing, Deployment, and Maintenance [28]. Figure 1 presents the SDLC framework.

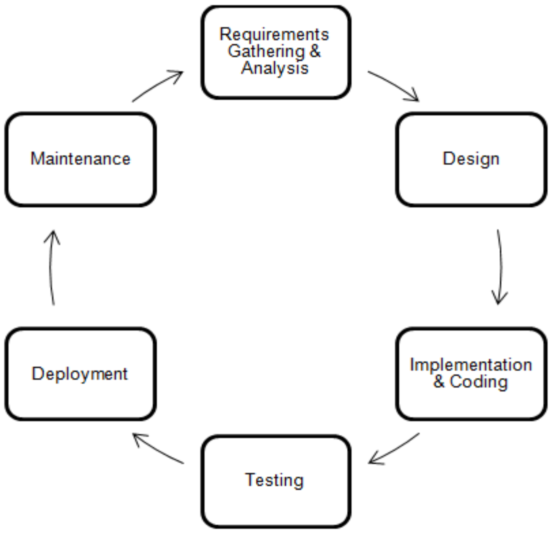

Fig.1 The Software Development Life Cycle

Using the SDLC framework, different types of software development models have been devised, which may be used in developing IT solutions. This includes the Linear Sequential Model, Iterative and Incremental Model, Prototype Model, Spiral Model, and the V-Shaped Model.

2.3 Software Development Model

The researcher of this study utilized the Incremental Model in developing the SIVMS. Incremental Model involves the process where requirements are divided into multiple standalone modules. Each module goes through the stages of the Incremental Model. After the successful completion of a module, the existing module is added to the previous module released, making it "incremental" in the sense that the amount of work done increases as the project progresses [28]. The following are the stages of the Incremental Model, as presented in Figure 2.

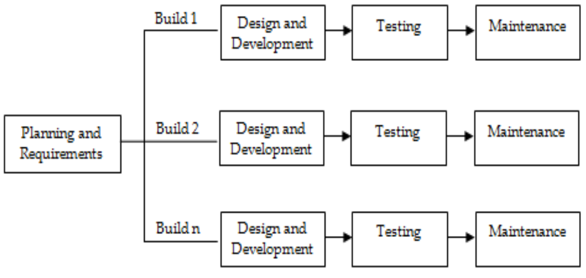

Fig. 2 The Incremental Model

Planning and Requirements Analysis

In developing IT solutions like SIVMS, requirements play a significant role in the overall success of designing and developing the project. It is in the planning stage where the requirements are gathered and analyzed. IEEE Standard 729, as cited in [28], defines requirement as a condition needed by a user to solve a problem or a capability required to achieve an objective. Requirements are documented representation of conditions essential for delivering the expected output to satisfy the customers. Requirements can be classified into three types. This includes functional requirements, non-functional requirements, and domain requirements [29]. The requirements gathering and analysis focus on collecting relevant information needed from the customers. Typically, members of a development team meet with the customers to collect the necessary information to understand the necessary components expected from the project. Once requirements are gathered, a thorough analysis of the feasibility of the project is done. Any ambiguities should be resolved before proceeding to the next stage [30].

Design and Development

The incremental model's design and development stage cover the actualization of the requirements gathered during the Planning and Requirements Analysis Stage. The requirements identified and analyzed are translated into different diagrams and models to understand them clearly. It is in this stage where the "actual work" happens. Meaning, the systems' design, and development take place in this stage of the Incremental Model [31]. It is essential that in this stage, members of a development team have identified the different diagramming, designing, and development tools to be utilized, for it significantly contributes to the overall success of a project.

Testing

After the successful design and development, the prototype system can be immediately subjected to this stage of the Incremental Model to check whether the customers' requirements have been translated into actual components and features of a system. This stage always follows the design and development stage to ensure that the system's developed module conforms to the standards and possesses an acceptable degree of quality. Testing is a critical element of software quality assurance since it is in this stage where a series of test cases are applied in the developed module of the system to "demolish" it. Different testing techniques can be performed to ensure software quality [32]. Testing also provides an opportunity to uncover possible risks and problems that may occur. This enables a development team to conduct pre-emptive measures and activities to mitigate and avoid possible risks and problems that may occur.

3. DISCUSSION:

3.1 Planning and Requirements Analysis

In the design and development of the SIVMS, the researcher conducted several data gathering activities to have initial information about designing and developing the prototype system. Interview with the guidance office staff, teachers, and students about the process of filing and settling violations was performed. The manual process of filing, recording, and organizing student information in the guidance office was also observed and understood to have a clearer insight on how to design and develop the prototype. Several necessary documents were studied, such as the college student manual, which consists of the rules and regulations of the HEI, the list of student violations and corresponding punishments, sample student information form, and guidance referral and violation forms. Apart from the researcher's mentioned activities, an extensive review of related literature and studies was also conducted to gather new information and clarify existing knowledge related to the study. After gathering the requirements, planning was performed wherein the researcher drafted paper prototypes and the Gantt chart. With the help of the guidance office staff, clearer plans were devised.

3.2 Design and Development

The requirements gathered and analyzed in the previous stage of the Incremental Model were transformed into different models and diagrams to understand the development of the prototype system easily. Use-Case diagram, Data Flow Diagram, Entity-Relationship Diagram, and User Interface were developed based on the requirements identified from the guidance office.

Use-Case Diagram

A Use-Case Diagram is a representation or depiction of a user's interaction among the elements of the system. The researcher developed it during the early stage of the design and development to specify the context of the prototype system, capture the system's requirements, validate the systems architecture, and drive implementation and generate test cases [33]. Figure 3 presents the Use-Case Diagram of the SIVMS.

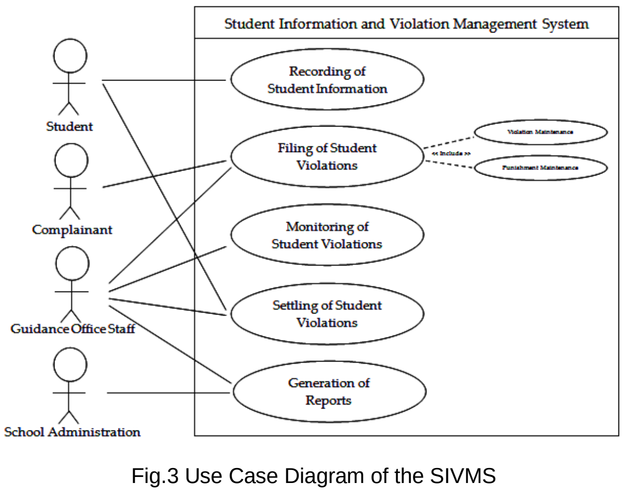

Fig.3 Use Case Diagram of the SIVMS

In Figure 3, the Use-Case Diagram for SIVMS is composed of four Actors: Student, Complainant, Guidance Office Staff, and School Administrators. These actors are directly connected using a line to different major scenarios covered by SIVMS. These extreme scenarios include recording student information, filling student violations including violation and punishment maintenance, monitoring student violations, settling student violations, and generating reports. Based on the diagram in Figure 3, the student interacts in the recording of student information process because they provide the necessary information in the scenario and settle the violations filed against them. Meanwhile, the complainant interacts in the scenario of filing the student violations. Included in the scenario of filing of student violations are violation and punishment maintenance.

On the other hand, the guidance office staff interacts in the following scenarios: Filing of student violations, monitoring of student violations, settling of student violations, and generation of reports. The guidance office staff was involved in the different scenarios because SIVMS was designed and developed intended to aid them, and they were the primary beneficiaries of the system. Lastly, the School Administrator was only connected in the process of generation of reports.

Data Flow Diagram

The Data Flow Diagram (DFD) was used to illustrate data flow from the different processes in the prototype system. A DFD is composed of process or function, data flow, data store, and terminators. The researcher developed the DFD of SIVMS to understand the flow of data and the processes involved. The DFD was based on the requirements identified and analyzed, and in agreement to the use-case diagram developed for SIVMS. Figure 4 presents the context diagram or level 0 of SIVMS, which covers the prototype system's general processes.

Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9 also present the Level 1 illustration of the different processes in the prototype system.

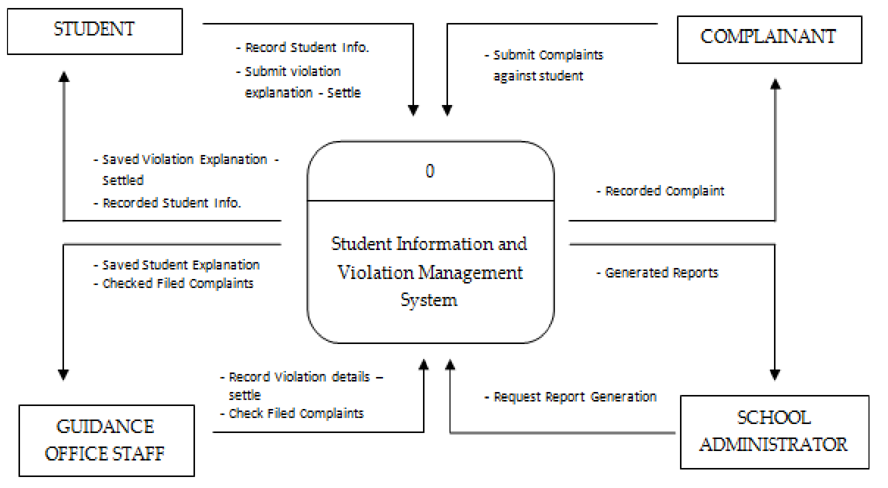

Fig.4 Context Diagram of the SIVMS

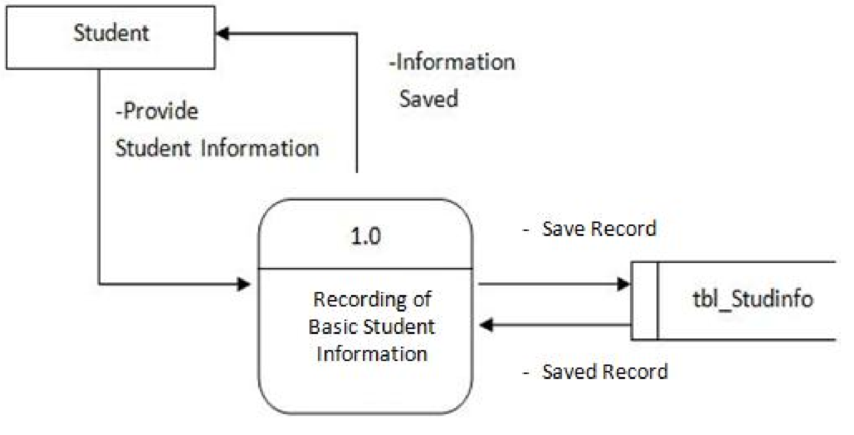

Fig.5 Level 1 DFD for Recording Student Information

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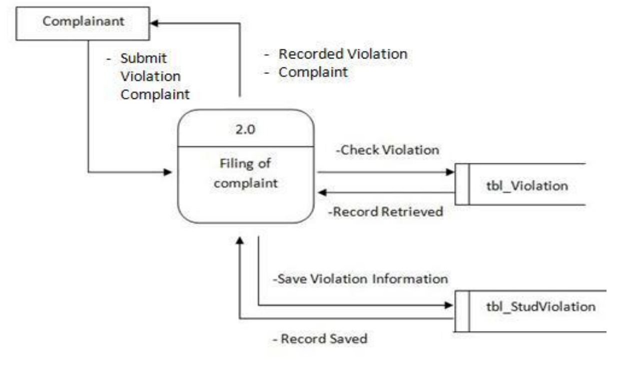

Fig.6 Level 1 DFD for Filing Student Violation

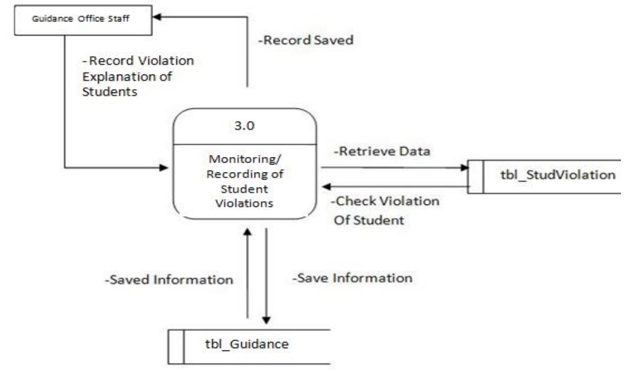

Fig.7 Level 1 DFD for Monitoring/Recording Student Violations

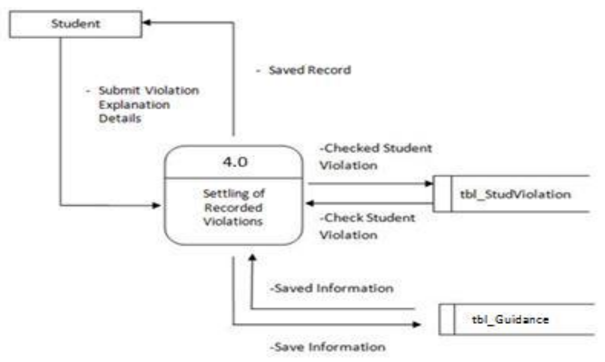

Fig.8 Level 1 DFD for Settling of Student Violations

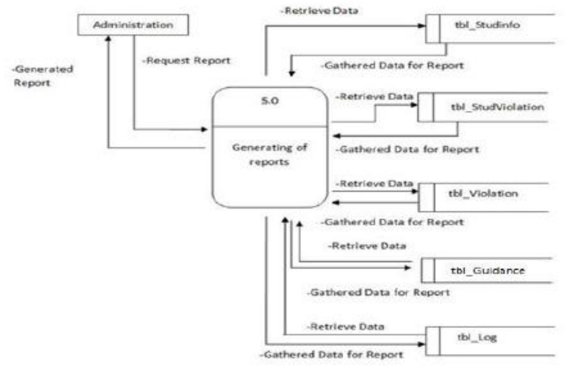

Fig.9 Level 1 DFD for Generating Reports

Entity-Relationship Diagram

The Entity-Relationship Diagram (ERD) plays an integral part in understanding the database design for the development of the prototype system. The SIVMS' ERD illustrates the database design, which includes the entities and their relationships. In Figure 10, the ERD shows the tables and their relationships (mapping cardinalities) to other tables. It is vital that when designing the ERD, tables are already in its normalized state. That is, the principle of database normalization must be applied appropriately and practice to make the database design more effective and efficient.

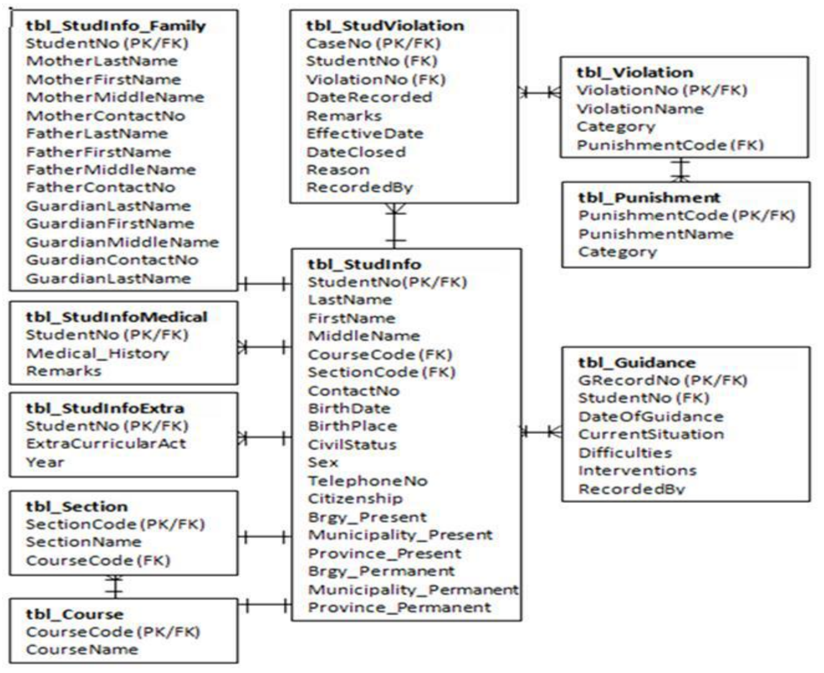

Fig.10 Entity-Relationship Diagram of SIVMS

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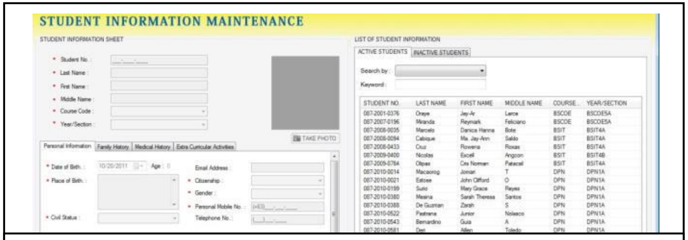
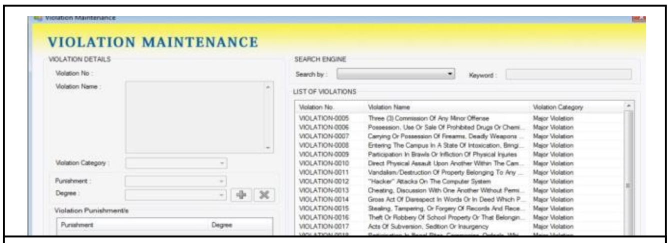
User Interface Design

The User Interface (UI) Design of the prototype system has a critical role for users to understand and use the system quickly. The research made a simple UI so that the users can easily manipulate and understand them. Figure 11, Figure 12, Figure 13, Figure 14, and Figure 15 present the UI included in the prototype SIVMS.





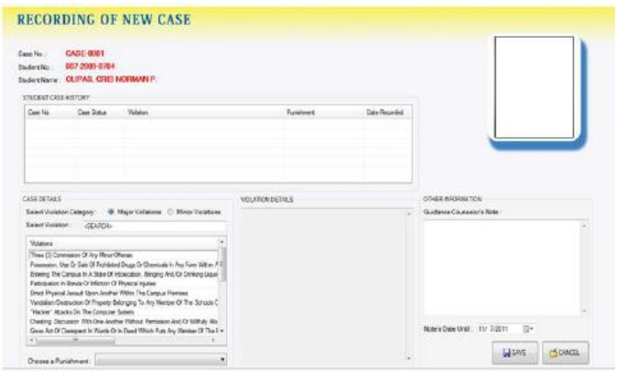


Fig.13 UI for Recording New Violation

Fig.14 UI for Settling Student Violations

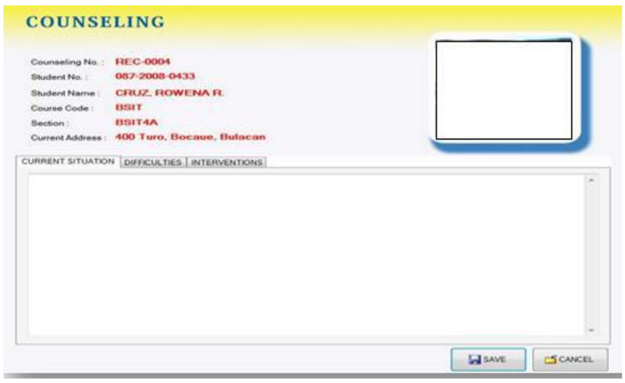


Fig.15 UI for performing Guidance

Testing

In this stage of the Incremental Model, the researcher utilized different testing techniques to "demolish" the prototype system and to reveal possible problems and risks to provide preemptive measures to avoid them. Functional and Non-Functional testing techniques were applied to SIVMS, and different test cases were used to test the prototype system. It was found out that using different test cases, the prototype system can be further enhanced and developed. Also, though errors were identified, the risk and possible problems may still occur since testing activities must be continuously performed even after deployment and implementation were done.

4. CONCLUSION:

This study aimed at designing and developing a prototype system for a guidance office of a higher educational institution in Central Luzon, Philippines. The researcher designed and developed a prototype system called Student Information and Violation Management System (SIVMS). It utilized a Descriptive-Developmental design of research and followed the Systems Development Life Cycle (SDLC) framework Incremental Model with the following covered stages: Planning and Requirements Analysis, Design and Development, and Testing. This study did not cover the implementation stage. The researcher, after following the stages of the Incremental model, was able to design the essential models and diagrams needed for the development of the prototype system. After the development of the prototype system, it was found out that the requirements gathered and provided by the guidance office were translated into a value system that can be used by the office to reduce and solve the problems they encounter concerning organization and management of student information and student violations.

5. RECOMMENDATIONS:

After the design and development of the prototype SIVMS, the following recommendations were drawn: (1) the guidance office may consider implementing a SIVMS to aid them in the management of student information and violations; (2) the prototype system can still be further enhanced, and additional features may be added to optimize its process; (3) the prototype system after successful completion may be subjected to the assessment of different possible users; (4) other researchers who are interested in designing and developing similar prototype systems may use the findings of this study.

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