Examination Scheduling System for Mapua University

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Abstract

Examination timetabling/scheduling is a complex task in many academic institutions that requires intensive analysis and human scheduling expertise and experience to generate an optimal examination schedule. Without the assistance of modern computers, the accomplishment and process of this task can be tedious, time-consuming, and error-prone. The School of Information Technology (SOIT) department at Mapua University faced a technological problem with their examination scheduling process due to the dependence on manual methods and automated scheduling software with a fixed output for only the 2015 student batch. This study proposes a web-based examination scheduling system as an alternative to the school department's existing examination scheduling method and technology. It will incorporate both the concept of interactive and automated computer-based scheduling methods and is designed to have the capability to adapt and generate optimal schedules based on the dynamic scheduling variables and specified scheduling constraints. Moreover, the proposed system has been successfully demonstrated to and tested, and evaluated by the major stakeholder of the examination scheduling process of the mentioned school department, the Technical Assistant to the Dean and Proctors. Consequently, accepting and recognizing it as an alternative to their existing examination scheduling methods.

Keywords
Examination Timetabling Problem, Examination Scheduling System, Interactive Scheduling Method, Automated Scheduling Method, Scheduling.

1. Introduction
In academic institutions, examination timetabling/scheduling is an essential administrative task that occurs periodically. As described by Aldeeb et al. (2019) and Kristiansen and Stidsen (2013), it is a recurring task and a form of educational timetabling that involves decision-making to solve the problem of scheduling a set of examinations to a set of resources (rooms and proctors) and time slots based on a finite set of constraints. Aldeeb et al. (2019) also observed that the problem definition of the examination timetabling could be more complex in most universities or large academic institutions because of the wide variety of scheduling constraints and the vast amount of variables that need to be analyzed and considered.

Another factor contributing to the examination timetabling problem's difficulty is the stakeholders of the scheduling process. Gashgari et al. (2018) defined these stakeholders as the students, administrators, professors/faculty, and departments, and each has goals, wants, and relevance to the scheduling process. Despite the complexity of the examination timetabling problems and processes, many academic institutions still use manual systems (paper-based or software that does not aid the human scheduler) as their scheduling method. According to Gashgari et al. (2018), manual systems for the examination scheduling process can be applicable and efficient for small institutions. However, they identified that, as the size of the problem increases, manual systems may deteriorate to become unusable and may adversely affect the scheduling process to become time-consuming and tedious. At the same time, the results are prone to constraints violation and sub-optimality. The availability of modern computer-based scheduling methods positively impacts the timetabling practices and serves as a prospect to replace manual systems. According to Qu et al. (2009) and Oude Vrielink et al. (2019), the most common type of computer-based scheduling is currently the interactive scheduling method, the automated scheduling method, or the combination of both. They also identified that the technology's applicability and specification mainly depend on the academic institution. As a result, different

institution-specific information needs to be collected and implemented to apply the modern computer-based method to the scheduling process effectively.

In the Philippines, the School of Information Technology (SOIT) at Mapua University uses a manual system and an automated examination scheduler that only produces output for one curriculum (student batch 2015) as a method for their examination scheduling process. In addition, there is also a lack of in-depth analysis of the student conflicts due to the manual system. Having the comprehension about the nature of the examination timetabling problem at the university level, the limitations of the use of the manual system and the inapplicable tools to solve the problem, and the importance of the well-known computer-based scheduling method, there is a clear need for a technological solution to the examination scheduling process of the mentioned school department. Thus, the researchers initiated this study to propose a computer-based examination scheduling system that will serve as an improvement to their current exam scheduling method, which is beneficial to their exam scheduling process.

The proposed system incorporates both the concept of modern interactive and automated computer-based scheduling methods. On the other hand, because examination scheduling problems and the implementation of the modern computer-based scheduling methods are often defined as institution-specific, the aim of this study is also to customize the proposed system to optimally solve the examination scheduling problem of the mentioned school department and take into account their business preferences in terms of their examination scheduling task. Also, the researchers reviewed relevant literature and studies as a foundation for this study.
Furthermore, the general objective of this study is to propose an interactive and automated web-based examination scheduling system as an alternative to the current examination scheduling methods of the School of Information Technology department at Mapua University. In order to satisfy the stated general objective, two specific objectives need to be achieved. These specific objectives are as follows:

- To develop and design an interactive and automated web-based examination scheduling system for the school department mentioned.
- To apply the examination scheduling parameters of the mentioned school department to the proposed system.

2. Literature Review

From an academic perspective, when defining the allocation of resources on a time slot, there has been confusion between the terminology of "scheduling" and "timetabling." Based on Aldeeb et al. (2019), scheduling and timetabling are somewhat synonymous and can be used interchangeably from an academic perspective. It is also observed in the survey of Qu et al. (2009), Gashgari et al. (2018), and Oude Vrielink et al. (2019) that many kinds of studies also define academic scheduling problems from the perspective of a timetabling problem. Despite that, Petrovic and Burke (2004) still determine "subtle differences" between the two terminologies.

Moreover, according to Kristiansen and Stidsen (2013) and Gashgari et al. (2018), educational/academic timetabling is the most widely studied among all the kinds of scheduling problems and one of the most time-consuming, critical, and complex administrative tasks that occur periodically across all academic institutions. Kristiansen and Stidsen (2013) also identified that education timetabling has many variants: examination timetabling, course timetabling, high school timetabling, and student sectioning. Despite the various interesting areas of educational timetabling, this literature review will focus only on the examination timetabling problem.

Aldeeb et al. (2019) defined examination timetabling/scheduling in their literature as an NP-complete problem and a process of decision making and problem-solving in terms of scheduling of resources (examinations) to tasks (rooms and proctors) at a particular time slot with respect to the scheduling constraints and academic institution needs and requirements. There are two kinds of scheduling constraints: Hard and Soft. Based on the study of Qu et al. (2009) and Gashgari et al. (2018), hard constraints are constraints that cannot be violated under any circumstances (mostly due to physical restrictions) because it affects the feasibility aspect of the timetable. In contrast, the soft constraints can be violated, but the cost is the quality of the timetable. They also consolidated that soft constraints are usually practically impossible to satisfy but at least minimize violating them fully. In addition, Qu et al. (2009) identified that the number of scheduling constraints contributes to the complexity of the examination timetabling problem. There are also conventional examination scheduling constraints that Qu et al. (2009) and Aldeeb et al. (2019) surveyed in their literature.

Despite the high contribution of the scheduling constraints to the degree of difficulty of the examination timetabling problem, other aspects complicate the given problem. Gashgari et al. (2018) and Aldeeb et al. (2019) analyzed that

the number of students and examinations increases with restricted dynamic resources, such as limited rooms, limited proctors, and limited time slots difficulty and complexity of the problem also rise. Another aspect that adds complexity to the problem is the involvement of various people in the process. As observed by, Gashgari et al. (2018), these people are called stakeholders; each has its own goals and wants that influence the timetable.

Because of the degree of complexity and difficulty of the examination scheduling/timetabling task, Aldeeb et al. (2019) and Gashgari et al. (2018) proposed that the usage of manual scheduling systems, especially in universities or colleges, can be time-consuming and tedious while the output can also be sub-optimal and conflict-prone. There are well-known solutions to replace the manual system and to ease the task of educational timetabling/scheduling in many academic institutions. In accordance with Oude Vrielink et al. (2019) and Qu et al. (2009), these solutions are computer-based scheduling methods which are called interactive (semi-automated) and automated scheduling systems (fully automated). On the other hand, some researchers prefer to integrate both of the mentioned computer-based scheduling methods because, as Müller et al. (2009) stated, an interactive interface for the automatically generated academic schedules is an important approach since it allows the users to apply corrections, alterations, and improvements. It also lessens the needed actions or steps to achieve user-preferred schedules.

The study of Arikpo and Okokon (2019) developed a web-based automated timetabling system for scheduling both examinations and lectures. Both the researchers stated that their application only fully-automate the scheduling process but has not completely solved the conflicts in terms of time for irregular students in a university. Therefore, addressing these conflicts will further enhance the efficiency of the application and any other applications developed by other researchers. On the other hand, Güler and GeÇici (2020) prioritized implementing an interactive computer-based scheduling method called Decision Support System, which provides more flexibility and control to the output. They also stated that developing a web-based DSS is a good idea to be used on other computers without requiring installation processes.

Furthermore, Saat et al. (2019) proposed an expert system called Examination Management System (eMas) that ameliorates the existing scheduling method of the University of Technology Mara (UiTM), which is a manual scheduling system. Their proposed system covers and combines both automated and interactive scheduling methods, generating precise final examination schedules within 1 minute and enabling the user to edit them as required. The users have evaluated the system as fast, time-saving, and producing accurate results based on the business requirements. They also suggest, for future work, that an invigilation system interface should be implemented and a mobile application as an extension of access.

Despite the prosperous advancement and availability of computer-based timetabling, Oude Vrielink et al. (2019) observed that most timetabling/scheduling software applications adopted and developed for academic institutions or higher education institutions highly depend on their characteristics. These characteristics are their timetabling problem, operational timetabling process, needs, requirements, and organizational structure. The reason behind it is the individual preferences of each institution in terms of their timetabling practices. This fact is also observed by Qu et al. (2009) in their survey, and the focus is for examination timetabling/scheduling.

In summary, the examination scheduling process is a vital administrative activity to accomplish in every academic institution. It composes different parameters to analyze and optimally solve to derive less-to-none conflict-ridden examination schedules. The degree of difficulty arises depending on the size and needs of the academic institution. As the difficulty escalates, manual systems hinder the feasibility of accomplishing and conducting it. Thus, the interactive and automated computer-based scheduling methods are an excellent baseline to propose a solution to the given technological problem. It is also identified from the related studies that web-based scheduling application adds beneficial factors to the modern computer-based scheduling method because it allows being accessed on any computer with a web browser without any required installations.

3. Methodology

As depicted in figure 1, the process model of the methodology will be based on one of the Software Development Life Cycle (SDLC) models called the Iterative Waterfall. The Iterative Waterfall model used was modified to satisfy the scope of this study. It will only consist of four different stages instead of five. Also, it has a feedback path that allows the researchers to return to the current or previous stage/s for error correction or if specific changes are requested to be made. Each stage is briefly discussed below:

1. **Requirement Gathering/Analysis** - In this stage, the researchers will analyze and capture the requirements and needs of the SOIT department and use the knowledge obtained from the reviewed literature and studies. It will help to consolidate and accurately compose the next phase.

2. **System Design** - The requirements and information specified in the previous phase are studied to compose the suited software design. The overall system architecture is also discovered and learned in this phase.

3. **Implementation/Development** - In this phase, the system design is translated into computer code using the selected programming language by the software developers. Unit tests are also conducted to test the codes for errors, bugs, or performance issues.

4. **Testing** - Once the development of the proposed system is achieved, this phase will send it to the test and staging environment. The proposed system will be tested if there are any bugs or defects and if it is working according to the specified requirements of the business client. It will include integration testing, system testing, and user acceptance testing.

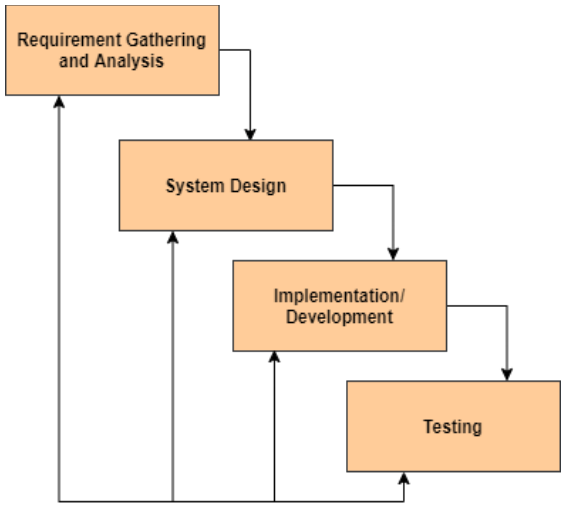

Figure 1. SDLC - Iterative Waterfall Model

3.1 Requirement Gathering/Analysis

In this phase, the researchers collected vital information to consolidate and narrow down the existing problems to be solved and the required capabilities and parameters for the proposed system. The source of information for this workflow is the SOIT department and the reviewed related literature and studies discussed in the previous chapter. Also, this phase contributes to gaining a baseline in developing and forming the system architecture and design of the proposed system.

The research instrument used for gathering information from the SOIT department is an interview. This information is the business needs and requirements and current state and technology related to their examination scheduling process. Two research respondents were targeted from the mentioned school department because they are the only ones that have practical experience and education and administrative role in scheduling an examination; one of them also has proctoring experience. These two research respondents are Sally I. Zara (Technical Assistant to the Dean) and Joel C. De Goma (Professor/Student Activities Coordinator)

3.2 Implementation/Development

In developing the proposed system, XAMPP will be used as a database and application server emulator in the developer's local machine to execute PHP files and gain access to the RDBMS, which is MYSQL. On the other hand, the Graphical User Interface will be coded using HTML for the structure, CSS for the overall presentation and layout,

and JavaScript for the interactive capabilities. The AJAX technology will also be implemented for asynchronous communication to the servers, which can help provide fast and dynamic web pages. In addition, Server-sent event technology is applied for real-time updates from the server; this real-time update includes notifications and process progress reporting.

Moreover, writing unit tests cases and reports was also part of this workflow so that the written codes would be tested and reviewed. If a specific unit test fails, the corresponding code will be debugged, and, once done, the test cases will be re-tested. In summary, this workflow's main activities are writing the proposed system's computer codes based on the programming and scripting language mentioned, application of the database design using the RDBMS, unit testing, and debugging.

4. Results and Discussion

4.1 Initial Data Collected

Initially, the researchers interviewed Prof. Joel C. De Goma and Ma'am Sally I. Zara to know the details of the SOIT department's current examination scheduling method and process stakeholders. The chosen research respondents were one of the administrative stakeholders of the examination scheduling process and had practical experience using the current examination scheduling method. The following were the information gathered about their current examination scheduling method:

- The current examination scheduling tools are Excel and automated scheduling software built for the student batch 2015 curriculum.
- The method is manual scheduling using the Excel software and generating fixed output using the existing automated scheduling software.

Moreover, they also mentioned two types of stakeholders involved in the scheduling process: the faculty and the Technical Assistant to the Dean. The function of the faculty is to provide their preferred time, date, and course for the upcoming examination week. In contrast, the Technical Assistant to the Dean is the one who solves the examination timetabling problem and produces the finalized and published examination schedules. After stating the current examination methods and process stakeholders of the SOIT department, the research respondents also conveyed brief information about their expectations about the proposed system. They mentioned that it should have attributes that can provide scheduling automation based on dynamic scheduling parameters, decision support, and alternatively to their current scheduling software.

On the other hand, the imperative parameters for examination scheduling are also gathered. These parameters are the courses, rooms, proctors, and constraints. As per the reviewed literature and studies, these parameters are primarily institution-specific; thus, this will make sure that the outputs of the proposed systems are tailored to the expectation of the mentioned school department. For that reason, the researchers collaborated with Prof. Joel C. De Goma and Ma'am Sally I. Zara on consolidating the specification of these parameters. In addition, the researchers also consider the critical conventional examination scheduling parameters surveyed from the reviewed literature. Thus, these actions provided completeness that can pave the way to derive up-to-date and optimal examination scheduling parameters. The constraints were categorized into hard and soft for the examination scheduling constraints. The following were the defined scheduling constraints:

Hard Constraints:

1. No proctor should supervise two or more exams in the same time slot in different rooms.
2. The room has the capacity to cater to the number of students in an exam.

Soft Constraints

1. No student should take more than two exams in the same time slot.
2. Spread courses that have student conflicts.
3. Exams that have common students should be prioritized to be scheduled.
4. Exams should be prioritized to be scheduled based on the number of student conflicts and the same course code.
5. Consider 1 hour or 30 minutes time allowance for each students' exams.
6. Depending on the room capacity, two or more exams that have no student conflict can be assigned to a room (maximize room utilization).
7. Schedule preferences of the Proctor.
8. All exams should be scheduled at a time slot, supervised by a proctor, and assigned to a room.

9. All available proctors should be allocated to supervise an exam.
10. All available rooms should have an assigned exam.

After gathering the detail about all the mentioned sets of information and data, the researchers scrutinized and deeply analyzed them to derive the proposed system's complete needed functional and non-functional requirements. The reviewed literature and studies also influenced the definition of functional and non-functional requirements; this helps gain a baseline and ensure that the researchers have up-to-date knowledge about the available technologies. Both parties consolidated all the proposed functional and non-functional requirements that dictated the system architecture, network architecture, and system design.

All the collected data and information are documented and contribute to accomplishing the following stages of the development life cycle. Also, the feedback paths indicated in the declared process model were utilized to go back to this project phase since the researchers encountered many change requests and additional refinement from the User Acceptance Testing (UAT) sessions conducted with the targeted business clients.

4.2 System Discussion

4.2.1 System Architecture

Figure 2 shows the diagram of the system architecture of the proposed system. The system architecture is modeled based on the 3-tier architecture pattern. It has three layers: the presentation, application, and data layer, which modularize the different components of the proposed system. There are two types of end-users: Technical Assistant to the Dean (System Administrator) and the Proctor. A desktop computer was selected as a model of an interface of the end-user to the presentation layer.

The presentation layer displays the content and valuable information for the end-users to interact with or view the system's expected outputs. It is programmed using HTML, CSS, and JavaScript. The HTML and CSS will design the proposed system's user interface, while JavaScript will provide the user interface's interactive elements, logic, and dynamics. Asynchronous JavaScript and XML (AJAX) technology was also implemented in the JavaScript code to enhance users' experience and communication with the server.
The application layer houses the web application's business logic in software processes involving user-input data processing and data manipulation and querying in the database server. It is implemented based on the Hypertext Preprocessor (PHP) programming language. Figure 2 shows that the application layer comprises three components: Access Control, Administrative Tools, and Proctor Tools. Access Control facilitates the authorization and authentication of the user. It determines the type of functions or accesses the client-side would have. Both Administrative Tools and Proctor Tools encapsulate different kinds of system functionalities, and they can be accessed based on the credentials of the authenticated user. The following will discuss each component of each tool:

- Administrative Tools
  - **Manage Examination Events -** A component that facilitates creating, deleting, and searching an examination event, accessing the scheduling workspace for the scheduling process of the specific examination event, and displaying the corresponding generated schedules for an examination event.
  - **Manage Rooms -** This component encompasses creating, deleting, searching, and displaying rooms data.
  - **Manage Courses -** This component encompasses creating, deleting, searching, and displaying courses data.
  - **Manage System Users -** A component that encompasses creating, deleting, searching, and displaying system users' data.
  - **Notification System -** A component with a function to send, receive, store, and display notifications.
  - **Manage My Account -** A component that has the function of enabling the user to change password email, name, and user type.
  - **Generate Examination Event Report -** This component includes exporting and displaying an examination event schedule and data report. In addition, this also contains the task of data querying and processing for both.
  - **Messaging System -** A component with a function to send, receive, view, and save messages.
  - **Examination Scheduler Data Loader –** A component that queries the database for the necessary data set needed by the Examination Scheduler component. The data set will then be sent immediately once received.
  - **Examination Scheduler -** This component houses the scheduling algorithms for the manual and automatic scheduling modes. Also, this component displays the different kinds of messages and output that the scheduling algorithm will produce.

- Proctor Tools
  - **Manage Proctoring Events -** A component that allows users to set scheduling preferences display proctoring events and their corresponding proctoring schedules.
  - **Manage My Account -** A component with a function to enable the user to change password, email, and name.
  - **Export Proctoring Schedules -** A component that structures and produces the proctoring schedule file.
  - **Messaging System -** A component with a function to send, receive, display, and save messages.
  - **Notification System -** A component with a function to send, receive, store, and display notifications.

Furthermore, the data layer is where all the data used for software processes are stored and retrieved by the application layer. MySQL was selected to be the Relational Database Management System (RDBMS) for the relational database of the web application.

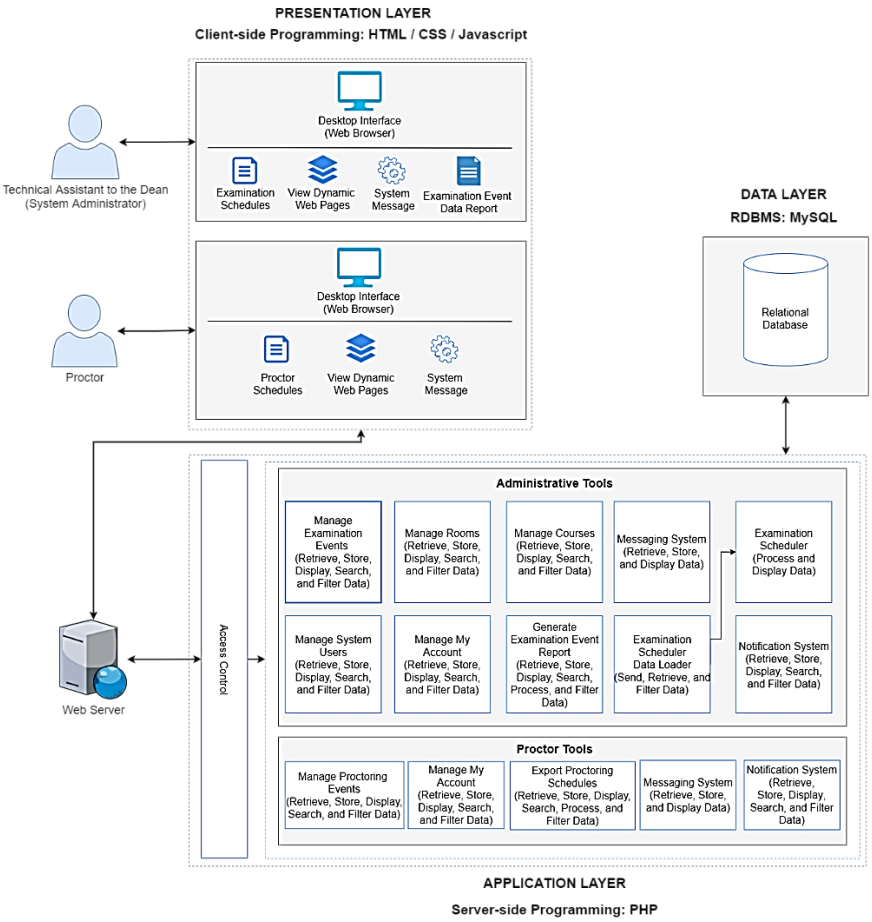

Figure 2. System Architecture of the Proposed System.

4.2.2 Network Architecture

In Figure 3, the diagram of the network architecture of the proposed system is shown. The network architecture consists of the Local Area Network (LAN) of Mapua University's Makati Branch and the different types of servers to be accessed through the Wide-Area Network (WAN). There are three types of servers: web, application, and database. The web server is in charge of accessing and returning the web pages to the organization's system interface. If there are requests for dynamic content regarding data access, manipulation, and processing in the web application, the web server will not immediately respond to the end-user; instead, it will send a request to the application layer that encapsulates the software process command. The database server, where all the data of the proposed system is stored and retrieved, will comply with the request of the application server. Once the database server returns the request, the application server will acknowledge this and respond to the webserver about the result. The web server will deliver the requested result integrated into the requested web pages to the system interface.

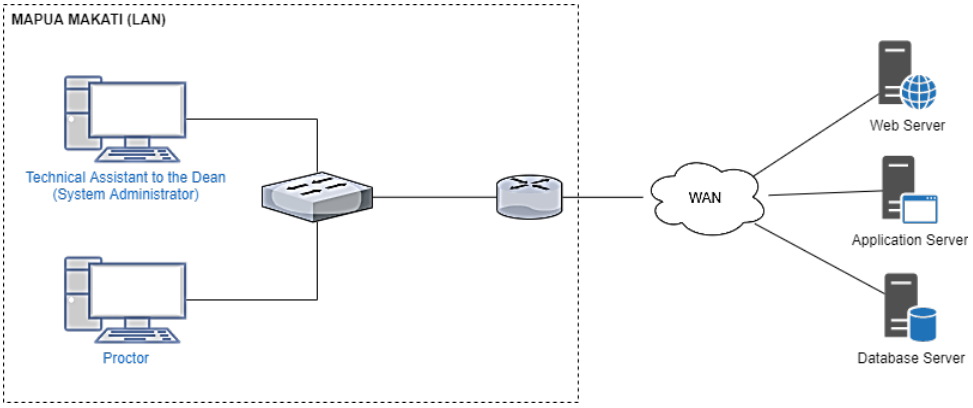

Figure 3. Network Architecture of the Proposed System.

4.3 User Acceptance Testing

The User Acceptance Testing (UAT) results were presented and interpreted in this section. User Acceptance Testing (UAT) was conducted to showcase and justify the main result of this study. 4 UAT sessions were executed, and 8 UAT stakeholders were involved in each. These UAT stakeholders are the Researchers, the Technical Assistant to the Dean, and the Professors. All operate in the business process of the School of Information Technology (SOIT) of Mapua University. The total number of respondents for the UAT is 5; 1 for the Technical Assistant to the Dean and 4 Professors.

All the UAT respondents are well educated and experienced in terms of the examination scheduling process of the school department mentioned. Also, their scope in this testing activity mirrors their current roles and responsibilities on the mentioned process of the organization. In addition, a real-world dataset was also provided for the scheduling automation, which further enhances the accuracy of the respondents' evaluation and acceptance of the proposed system. The real-world dataset has the following specifications:

- 2004 students
- 52 courses
- 10 - 20 rooms with 35 capacity each.
- Two days and 3-5 time periods. Each time period has a 2-hour interval.

4.3.1 System Administrators and Proctors Evaluation

System evaluation is one of the crucial parts of User Acceptance Testing (UAT) because it enables the researchers to gather the assessment and judgment of the UAT respondents in terms of the proposed system. The evaluation questionnaires were segmented into three parts: System Usefulness, Information Quality, and Interface Quality. Information Quality pertains to the quality of the correct and informative output. While the System Usefulness describes the user's overall experience, the system's ability to reduce work, and its significance. Lastly, the Interface Quality describes the appearance of the proposed system.

Furthermore, the researchers referenced the 5-point Likert scale of the evaluation forms described and approached by Pimentel (2019), refer to table 1. Based on Pimentel (2019), a statistical analysis method called Mean should be used to interpret and analyze the evaluation result with basis on the defined Likert scale interval and its corresponding verbal interpretation; the researchers patronized this evaluation method.

Table 1. Scoring and Data Interpretation of Likert Scale

Scale Value	Interval	Verbal Interpretation
1-Poor/Not Acceptable	1.00 - 1.79	Not Acceptable

2-Fair/Fairly Acceptable	1.80 - 2.59	Fairly Acceptable
3-Good/Acceptable	2.60 - 3.39	Acceptable
4-Very Good/Very Acceptable	3.40 - 4.19	Very Acceptable
5-Excellent/ Highly Acceptable	4.20 – 5.00	Highly Acceptable

4.3.1.1 Proctors Evaluation Results

The proctor evaluation form had been filled in by 5 UAT respondents resulting in an overall weighted mean of 4.72 for all categories, which is interpreted as Highly Acceptable. On the other hand, Figure 4 displays the summary of each Proctor's results on each evaluation category. It provides specifics on each weighted Mean of each category based on the assessment of each Proctor. It is evident that the Proctors graded the proposed system with a verbal interpretation circulating in "Very Acceptable" or "Highly Acceptable."

In addition, the specific data presented in Figure 4 was further used to calculate the overall weighted Mean of each and whole category to know the general aspect of the evaluation result. The following will discuss each category's overall weighted mean and its key observed facts conveyed by each Proctor.

- **System Usefulness (Overall Weighted Mean: 4.65 / Highly Acceptable)**
  - Based on the evaluation result for this category, it is evident that the proctors have positive insights regarding the usefulness of the Proctor System Interface. All system functions and features were working as expected, and they were able to choose a preferred schedule feasibly and with convenience.

- **Information Quality (Overall Weighted Mean: 4.6 / Highly Acceptable)**
  - The proctors did not have a hard time using the Proctor System Interface because the information content of the prompt messages, mainly in the data validation aspect, and the help center is clear and concise. On the other hand, the research respondents also acknowledged the exported file for the proctoring schedule as well-structured and aligned to their expectations.

- **Interface Quality (Overall Weighted Mean: 4.92 / Highly Acceptable)**
  - The overall user-interface design of the Proctor System Interface was well praised by the proctors receiving the highest weighted Mean compared to the other characteristics. The proctors were able to navigate through it quickly. Also, the structure of the UI is pleasing to their eyes, and the displayed information is very readable as well (Figure 4).

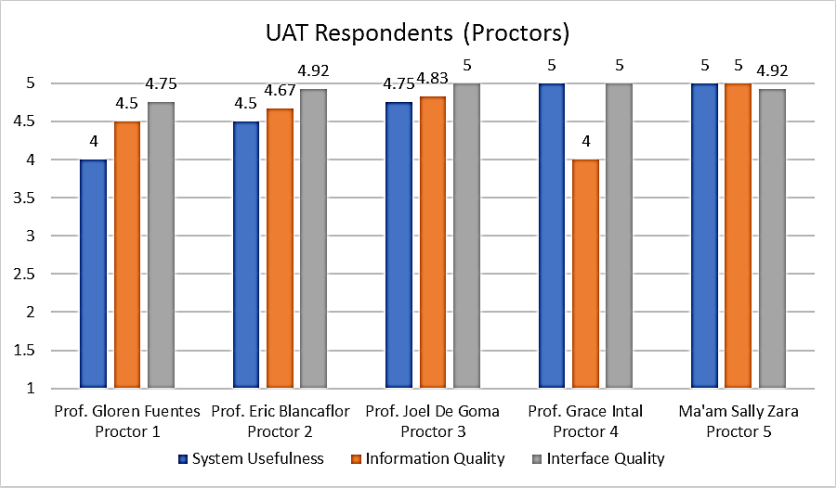

Figure 4. Proctor Respondents Result

4.3.1.2 System Administrators Evaluation Results

There are two respondents for this evaluation, and the overall weighted Mean for all categories is 4.86, which is interpreted as Highly Acceptable. The justification of the number of respondents for this evaluation is that only two personnel have administrative authority regarding the scheduling of the examinations and publication of it. On the other hand, Figure 5 displays the summary of each system administrators' results on each evaluation category. It provides specifics on each weighted Mean of each category, and it is evident that the proposed system is graded with a verbal interpretation circulating in "Very Acceptable" or "Highly Acceptable."

In addition, the specific data presented in Figure 5 was further used to calculate the overall weighted Mean of each and whole category to know the general aspect of the evaluation result. The following will discuss each category's overall weighted mean and its key observed facts conveyed by each corresponding UAT respondent.

- **System Usefulness (Overall Weighted Mean: 4.78 / Highly Acceptable)**
  - The research respondents with a scope of the system administrator were well satisfied with the automatic scheduler since it facilitates the efficiency and ease of doing the scheduling task while generating an optimal examination schedule. Considering the schedule preferences of each Proctor was also convenient for them since the proposed system facilitates coordination and communication. Overall, the proposed system is an excellent proposed improvement compared to their previous scheduling system.

- **Information Quality (Overall Weighted Mean: 4.85 / Highly Acceptable)**
  - The proposed system provided prompts, especially the indication of Scheduling Logs in the Scheduling Workspace, that guide the system administrator on accomplishing his/her scheduling task. The display of progress status for user actions when uploading, updating, creating, and deleting a course, room, and system users were also acknowledged as informative communication to the system administrator. On the other hand, they also considered the produced data reports and examination schedules in PDF format as well-structured.

- **Interface Quality (Overall Weighted Mean: 4.96)**
  - The research respondents with a scope of the system administrator were highly satisfied with the appearance of the user interface for the data management pages and the Scheduling Workspace. The navigation between the pages is smooth and precise. The overall satisfaction rate of the system administrators for this category is excellent (Figure 5).

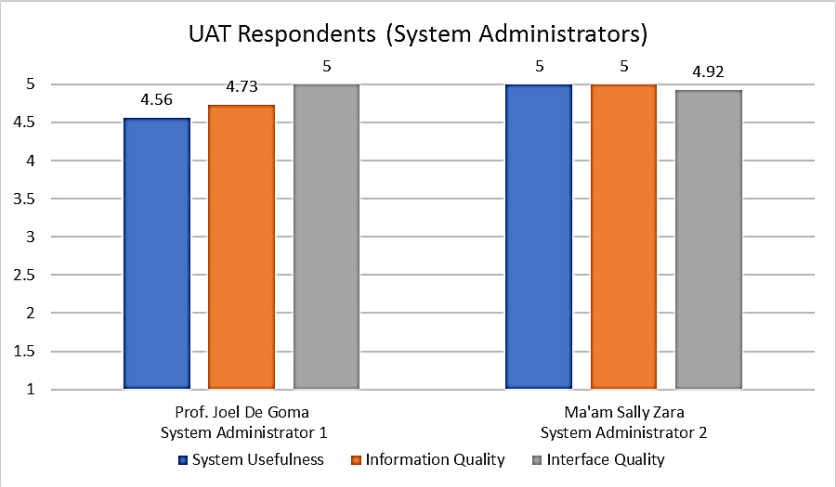

Figure 5. System Administrator Respondents Result

5. Conclusion

While the role of computer-based scheduling methods that provide automation and adaptability to produce optimal examination schedules from dynamic scheduling parameters is vital in the examination scheduling process due to the complexity of the nature of an examination timetabling problem, the School of Information Technology (SOIT) department fails to implement it, and persistently to use manual methods and software that have fixed output for only

the 2015 student batch. Thus, this negatively impacts their process of scheduling and producing examination schedules.

A web-based system that incorporates the concept of interactive and automated computer-based scheduling methods is proposed by the researchers as an alternative to their existing scheduling system. Combining both mentioned computer-based scheduling methods adds automation and total flexibility and control on the generation of examination schedules and complementation on human expert judgment and computing power. In addition, the outcome of applying both promotes ease of change on the examination schedules. On the other hand, the gathering and analysis of the examination timetabling problem, operational scheduling process, and the business needs and requirements of the mentioned school department also supplement to enhance the proposed system's effectiveness and competency since these characteristics vary from different academic institutions and there are no software applications available to accommodate and satisfy these fully.

The proposed system is accepted by the qualified stakeholders of the examination scheduling process of the school department mentioned as an excellent alternative to their existing examination scheduling method and technology. The use of real-world scheduling parameters was also inputted into the system, which is a factor that verifies and validates its capabilities. It is evident that automation is required to be applied in an examination scheduling process, especially in universities, due to large-scale scheduling parameters. However, the researchers of this study stand to consider not using a fully automated examination scheduling system instead of implementing an interface that can preserve and contribute the human expertise since the output is always aligned to the preferences of the academic institutions. Thus, the application of the combination of interactive and automated computer-based scheduling methods to the proposed system.

6. Recommendations/Future Works

The gathering and analysis of the examination timetabling problem, operational scheduling process, and the business needs and requirements of the School of Information Technology (SOIT) department at Mapua University are recommended to conduct even though they are already recorded in this document. These imperative data vary over time, and not considering them to be collected and scrutinized will lead to inaccuracy for future work of this study. Also, knowing the positive results of this study, it could be excellent to verify and validate the proposed system's existing capabilities by applying it to other school departments of the university. Thus, this can be a stepping stone to finding the general model of the university's examination timetabling problem, contributing to the body of knowledge since it is not yet well-defined globally.

Furthermore, the researchers suggest a Student System Interface be added to the functionality scope of the proposed system because students are one of the key stakeholders in the examination scheduling process. Applying it creates a portal that eases and centralizes access to the published examination schedules for the students. On the other hand, a mobile application could also be developed and integrated with the proposed system to enhance its portability.
The mobile application should initially cover the following for each system interface:

- System Administrator: Viewing and exporting data reports, examination schedules, and chat system for preference discussion.
- Proctor: Viewing proctoring schedules, setting schedule preferences for a particular examination event, and chat system for preference discussion.
- Student: Viewing of examination schedules and course conflicts.

All system interfaces of the mobile application should also have a built-in reminder/notification system and, for account security, a login system. In addition, applying miscellaneous logic for the automatic proctor scheduler to consider allocating the proctors to their teaching class could also be beneficial since this is one of the optional suggestions of the business clients. Significantly, the researchers assert that these enhancements will provide high satisfaction and positive innovation to the mentioned school department.

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