

Design and Development of an Integrated Room Reservation System for Higher Education Institutions

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Abstract - The progression of today's technology has influenced the growth of many industries by providing innovations to improve systems and processes. The use of information systems in organizations has made a significant impact and helped in the elimination of delays and minimization of errors. This study was conducted to analyze and optimize the process of facility reservation of a higher education institute in the Philippines. Various entities responsible for governing the different types of facilities and rooms were located on different sections of the campus which required a tremendous amount of traveling activities. Also, there were several issues concerning the availability of the authorized personnel responsible for granting the use of the facilities. Through information system design, an online resource and management system was developed to ease room and facility management, handle real-time information exchange, minimize the required effort and time to make a reservation, and allow users to conveniently access and exchange information at hand.

Keywords - Technology, Information Systems (IS), Process waste analysis, Room reservation system

I. INTRODUCTION

Technological applications have been incorporated in many industries' operations such as automotive, electronics, food, and others [1]. This gave birth to the benefits of automation. Industries and businesses turn to automation to improve their efficiency and productivity [2]. One of the core applications of automation is the usage of Information System (IS). IS provides efficient and effective data management that can be used to improve the performances of many organizations. The use of IS has shown a positive impact even in the military environment, improving work productivity and decision-making skills [3]. IS has also become beneficial in the academic environment alleviating heavy managerial responsibilities and workload, resulting in enhanced work performance [4], and simplification of processes such as document preparation and handling [5].

Among the organizations that perform various document preparation and handling activities are educational institutions. This includes student admission, enrollment, assessment, preparation, and grade submission, facilities reservation, and others. Technology, specifically IS, have made these institutions make processes become faster and more convenient. It also offered improved market-efficient management of resources [6]. Higher education institutions (HEIs) are becoming reliant on the usage of computers and

information technologies in their facilities such as libraries, grading system, and enrollment since it improves the services they offer [7]. With this, services and operations become more accessible and convenient for the people in these institutions with good facility which results in better performance [8]. Facility management and reservation is one of the most important process in the conduct of classes which involves various users such as the facility manager, students, and faculty. More often, such reservation systems require document handling and processing which when improved, can result to ease of room management, thereby lessening the occurrences of overlapping of reservations [9].

The growing practices of automation to meet the rapidly expanding demand of industries made manual processes be transformed into modern automated systems. The introduction of technology is the proper response for bringing significant improvement in cost and operation. The approach of process integration, automation, and optimization eliminates the need for hierarchal representation of business processes and provides visibility, flexibility, and maintainability for further improvements [10]. Digital applications such as information systems have started to gain prominence in nature conservation and are progressively shaping conservation discourses and practices. [11].

This study utilized and validated the findings of [12] for a HEI in the Philippines and created the web-based application of the integrated room reservation system which facilitates ease of room and facility management, handles real-time information exchange, minimizes the required effort and time to make a reservation, and allows users to conveniently access and exchange information at hand.

II. METHODOLOGY

The researchers conducted semi-structured interviews with the students, faculty, staff, and directors of the various offices that manage the different reservable rooms in the HEI which include the Academic Office (AO), Institutional Laboratory Management Office (ILMO), Campus Development and Management Office (CDMO), and School of Civil, Environmental, and Geological Engineering (CEGE) department. A survey on the users' perception of the current room reservation system was also conducted to the various users. A sample of 141 respondents were selected to answer the survey using a five (5) point Likert scale to measure the agreement level of the respondents with the statements that reflect several issues of the current system. These scales are Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D),

and Strongly Disagree (SD). These issues were categorized into eight (8) statements representing the potential eight (8) lean process wastes of the current system.

Waste analysis was used to identify and classify the issues into process wastes based on the eight (8) primary lean wastes. The wastes were categorized into eight (8) types of lean waste namely defects, overproduction, waiting, unused talent, transportation, inventory, motion, and overprocessing. These wastes were further ranked through the weighted mean method. The weighted mean method was used to reflect the importance of each Likert scale into the final average for ranking the process wastes. Additionally, a waste correlation analysis was also done to investigate and evaluate the relationship between the process wastes identified in the current system. Use case diagram and sequence diagram were also created to show the use cases or specific actions that an entity operates within the system and view the proposed system sequentially while the web-based application of the room reservation system was created using open-source software called Booked Scheduler, PHP programming language, and Structured Query Language (SQL).

III. RESULTS AND DISCUSSION

A. Wastes of the Current Room Reservation Process

The survey conducted measured the agreement level of the users with regards to process wastes present in the current room reservation process of the HEI. Using the weighted mean method, the process wastes were ranked as shown in Table I.

TABLE I. RANKING OF PROCESS WASTES

Process Waste	Weighted Mean	Ranking
Transportation Waste	4.4539	1
Waiting Waste	4.3688	2
Motion Waste	4.1986	3
Overprocessing Waste	3.9433	4
Unused Talent Waste	3.9291	5
Inventory Waste	3.7234	6
Overproduction Waste	3.6667	7
Defects Waste	2.5957	8

Transportation waste was identified in the current reservation system as the unnecessary traveling activities of the requestors from one concerned office to another. In the survey, transportation ranked first in the conducted weighted mean method. This means that most of the respondents experienced unnecessary traveling activities with 61.7% of the respondents strongly agrees and 26.2% agrees.

Waiting waste was identified as the waiting for the approval of the reservation requests. In the survey, waiting waste ranked second in the conducted weighted mean method. This means that most of the respondents experienced severely delayed approval of reservation requests with 61.3% of the respondents strongly agrees and 19.1% agrees.

Motion waste signified the repetitive processes of filling out the same copies of reservation forms. In the survey, motion waste ranked third in the conducted weighted mean

method. This means that most of the respondents consider repetitive filling up of multiple reservation forms as a time-consuming activity with 39% of the respondents strongly agrees and 44.7% agree.

The overprocessing waste was observed in the unwarranted process of finding alternative schedules for a desired room to reserve. In the survey, overprocessing waste ranked fourth in the conducted weighted mean method. This means that most of the respondents experienced time wastage in activities such as finding alternative schedules with 32.6% of the respondents strongly agrees and 44.7% agree.

Unused talent waste represented the occurrences of unavailability of the concerned person when completing a reservation. In the survey, unused talent waste ranked fifth in the conducted weighted mean method. This means that most of the respondents experienced unavailability of the concerned personnel with 38.3% of the respondents strongly agrees and 36.2% agrees.

Inventory waste was reflected in the accumulation of physical papers such as forms and reservation records that take up physical space only for storage. In the survey, inventory waste ranked sixth in the conducted weighted mean method. This means that most of the respondents perceived the offices in-charge to be using too many physical papers with 24.8% of the respondents strongly agrees and 38.3% agree.

Overproduction waste occurred in the unnecessary and excessive production of reports and document copies in offices. In the survey, overproduction waste ranked seventh in the conducted weighted mean method. This means that most of the respondents consider the use of multiple same reservation forms as excessive with 42.6% of the respondents strongly agree and 17.7% agree.

Lastly, defects waste was identified as the data entry errors and bad or missing information in the reservations. In the survey, defects waste ranked eighth in the conducted weighted mean. Unlike the previous wastes, most of the respondents expressed their disagreement with the issue with 29.1% strongly disagree and 29.8% disagree. This means most of the respondents did not have any issues like information errors in their reservations.

B. Waste Analysis Correlation

Correlation analysis is a statistical method to investigate and evaluate the strength of the relationship between two variables [13]. Utilizing SPSS Statistics application, the Spearman correlation was performed to evaluate the relationships involving ordinal variables like Likert scale data. In the study, the survey results of 141 respondents were treated as ordinal data to be compared and analyzed.

For each Likert scale, the values assigned were five (5) for Strongly Agree, four (4) for Agree, three (3) for Neutral, two (2) for Disagree, and one (1) for Strongly Disagree. The results were interpreted based on Spearman's correlation coefficient denoted by r_s with a designed constraint [14]:

$$-1 < r_s < 1$$

The positive correlation coefficient suggests that there is a directly proportional relationship between two tested variables while a negative correlation coefficient denotes an inversely proportional relationship between two tested variables. In the study, four (4) different sets of variables were tested. These variables are transportation and waiting wastes, transportation and overprocessing wastes, overprocessing and waiting wastes, and overproduction and inventory wastes.

TABLE II. PROCESS WASTES CORRELATION TESTS

Variables	Correlation Coefficient (r_s)
Transportation and Waiting	0.249
Overproduction and Inventory	0.146
Overprocessing and Waiting	0.277
Transportation and Overprocessing	0.323

Table II shows the correlation tests done among the process wastes. Based on the results, all correlation tests were significant to each other. This means that each waste influences the occurrence of the other wastes. The results also show a positive correlation coefficient for each test. This suggests that the relationships of each waste are all directly proportional to each other and means that as one waste increases, the other waste also increases.

C. Proposed Improved Room Reservation Process

Figure 1 shows the proposed reservation process for rooms and other facilities in the HEI. From different reservation processes for each type of room, a single process was proposed to effectively handle all the room reservation requests. Since the current room reservation system has been decentralized into many interacting departments, this invited many issues such as difficulty in department coordination and communication. This improved system is called e-Reserba Cardinal.

The process starts outside the website application. The student initially asks the department representative for reservation permission via email. From then on, the department dean will decide whether to approve the request or not. Either way, the department dean will notify the student/requestor via email. If the request is permitted, the department dean forwards the permission attachment including the file to the student and the permission code to the facilitator for verification. Once the student receives the permission file, the students shall use the website and make a reservation request of the room desired. The permission file is then attached to the online request. The facilitator will then subject the request to approval by verifying the permission file and the permission code from the department dean. Once verified, the facilitator updates the reservation status in the notification function of the website.

The implementation of the proposed system will ensure elimination of the transportation and motion wastes since physical presence and movement of the student or user are

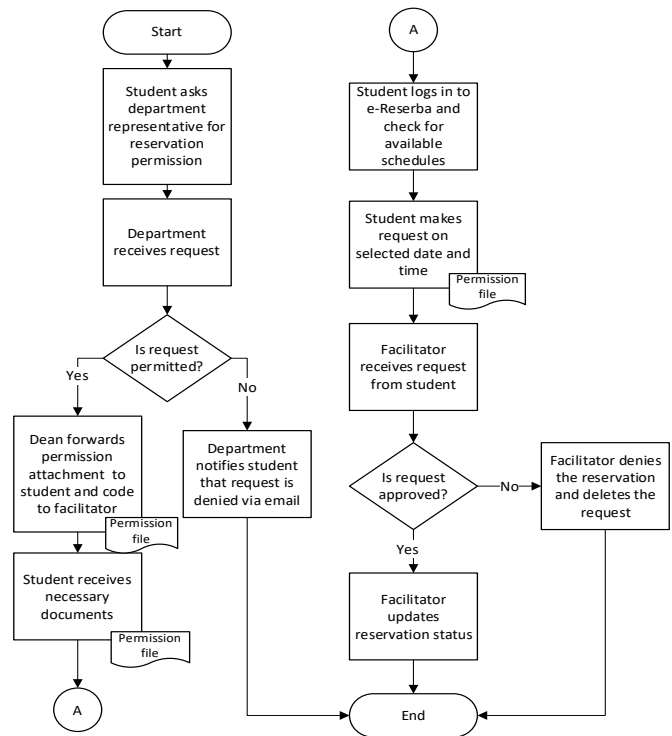


Figure 1. Proposed Room Reservation Process

no longer needed due to automation of the process. Inventory waste will also be reduced since data and reports may be stored in the database and are to be printed only when needed. The same applies for the other wastes such as waiting, overprocessing, and over production which will be minimized because of the system's capability to update and generate reports in real-time. The unused talent and defects wastes are still possible to occur in the proposed system and to minimize them, the institution should ensure that the administrator of the system will undergo proper training and will be provided with a user manual.

D. Users of the Proposed Reservation System

Users can be defined as goal-oriented people who a certain product or service supports. A user group is defined as the classification of user/person on the website. Each identified user group was assigned to various website roles. Roles are defined as a group of actions that can be done by a type of user. Table III shows the different roles in the proposed room reservation website.

As previously defined, user groups are categories or classification of users existing in a system. There will be three (3) user groups who are the primary entities within the website: Student (requestor), Facilitators (approving party), and Administrator. These user groups are assigned to the website roles. Table IV shows the type of user groups and the assigned website roles.

TABLE III. WEBSITE ROLES AND DESCRIPTION

Roles	Description
Group Administrator	Responsible for classifying a user to which type of user group
Application Administrator	Responsible for managing and editing the different functions and settings within the website
Resource Administrator	Responsible for classifying the types of resources. These resources are the reservable rooms.
Schedule Administrator	Responsible for managing and scheduling the resources; approval of reservation request

TABLE IV. TYPES OF USER GROUPS AND ASSIGNED ROLES

User Group	Assigned Role
Student	Requestor
Facilitators	Schedule Administrator and Resource Administrator
e-Reserba Cardinal Administrator	Group, Application, Resource, and Schedule Administrator

E. Use Case Diagram of the Proposed Reservation System

The use case diagram shows the different use cases, actors, and relationships existing within the system. this diagram helped in interpreting the user story and how each process is related to the actors in the system. From the diagram, three (3) vital elements were identified to represent the actors, use cases, and the system.

An actor is defined as the entity that interacts with the associated use cases within the boundaries of the system. This element is usually represented by a human figure icon. In Figure 2, the three (3) actors identified in the system are the students, facilitators, and administrators. The diagram also shows the relationship between an actor and a use case or process. Use cases represent the specific unit of actions or functions performed by an actor. These use cases are represented by an oval shape. The system also defined the boundary where use case only functions.

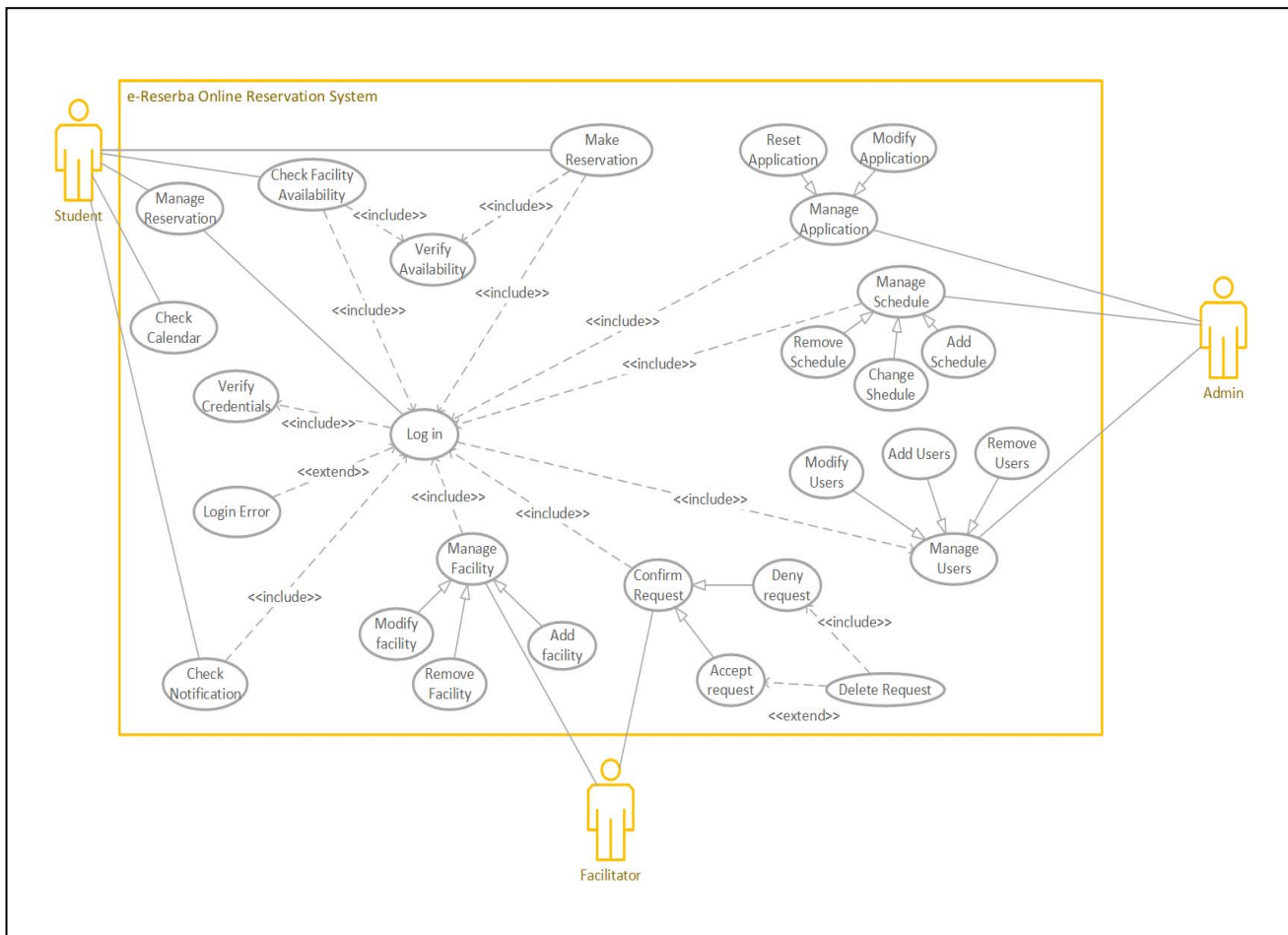


Figure 2. Use Case Diagram of the Proposed Reservation System

F. e-Reserba Cardinal Website Interfaces

For the design and development of the proposed room reservation system e-Reserba Cardinal website, the developers used an open-source application called Booked Scheduler as the primary scheduling solution for the website. This solution uses a PHP programming language, while Structured Query Language (SQL) was used for its data retrieval and storage function.

Figure 3 shows the Login page for all types of users. This is where the users (Administrator, Facilitator, Student) will enter the account username and password provided by the developers. Figure 4 shows the booking calendar interface of the website. This is where the students can find all the remaining available schedules for their reservations. The dropdown section at the top of the calendar allows the users to change their desired type of room reservation.

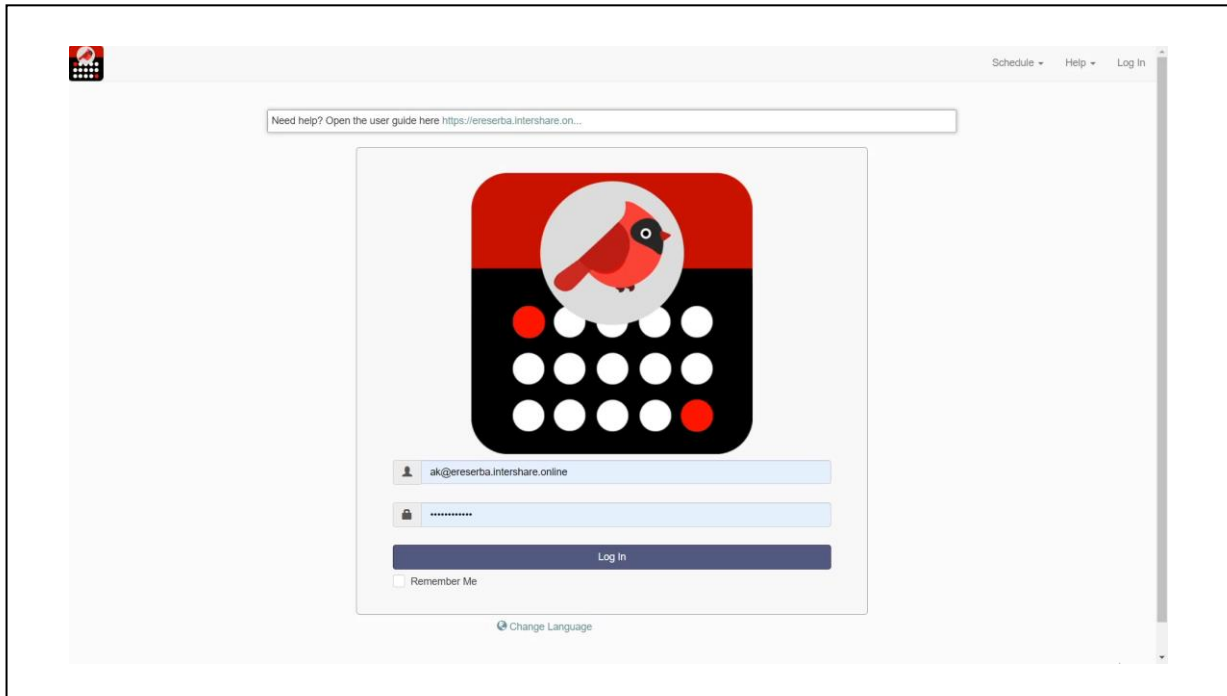


Figure 3. Login Page Interface

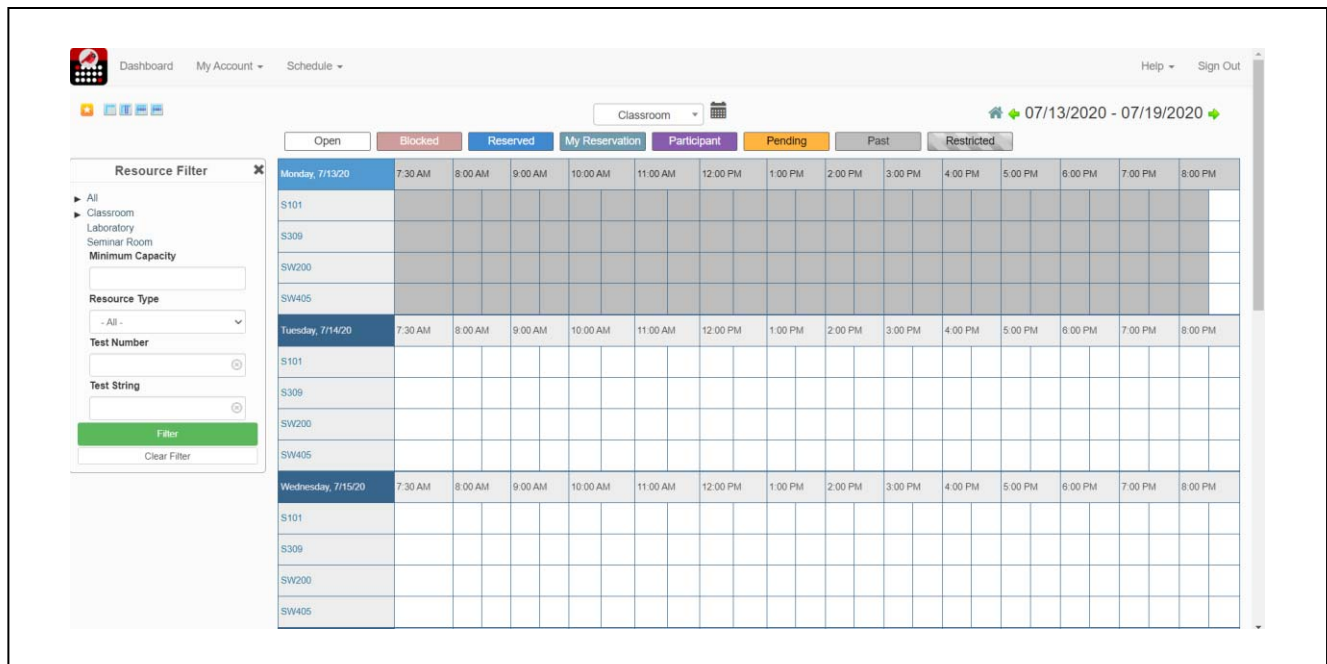


Figure 4. Booking Calendar Interface

Figure 5 shows the reservation form interface where the students enter the needed information and the permission file

from the department dean shall be uploaded for verification.

The screenshot shows a web-based reservation form titled "New Reservation". At the top, there are navigation links for "Dashboard", "My Account", and "Schedule". The user's email "f.p (fp@ereserba.intershare.online)" is displayed. The form contains several input fields and controls:

- Begin:** 07/15/2020, 9:00 AM
- End:** 07/15/2020, 9:30 AM
- Duration:** 0 days 0 hours 30 minutes
- Repeat:** Does Not Repeat
- Resources Change:** S309
- Accessories Add:** (empty)
- Title of reservation:** (empty text area)
- Description of reservation:** (empty text area)
- Student ID Number:** (empty text field)
- Send Reminder:** Two checkboxes, each with a "15 minutes" dropdown and "before the start/end time" label.
- Attach File (1 MB max):** A "Reservation Upload File" section with a "Choose File" button and "No file chosen" text.

 The form also includes "Cancel" and "Create" buttons at the top right.

Figure 5. Reservation Form Interface

IV. CONCLUSION

This study utilized and verified the previous findings of the current room reservation system of a HEI in the Philippines. Through waste analysis, various process wastes were identified in the system which include transportation waste as the unnecessary traveling activities of the requestors from one concerned office to another, waiting waste for the approval of the reservation requests, motion waste signified by the repetitive processes of filling out the same copies of reservation forms, overprocessing waste observed in the unwarranted process of finding alternative schedules for a desired room to reserve, unused talent waste as the occurrences of unavailability of the concerned person when completing a reservation, inventory waste reflected in the accumulation of physical papers such as forms and reservation records that take up physical space only for storage, overproduction waste as the unnecessary and excessive production of reports and document copies in offices, and defects waste as the data entry and errors and bad or missing information in the reservations. To eliminate the process wastes, an automated room reservation system using a web-based application was created for use by the administrators, students, and facilitators to handle room reservation requests for all types of rooms. The system helped reduce the unnecessary and non-value adding processes in room reservation and permitted paperless transaction which will help in the preservation of the environment.

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