U-Reserve: Development of a Facility Reservation System for UCSI University

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Abstract

In today's technology-driven era, there is an increasing emphasis on efficient and user-friendly methods to elevate user satisfaction. UCSI University, Kuala Lumpur, currently relies on a manual facility reservation process, necessitating either in-person or email submissions. This outdated approach frequently leads to double bookings and underutilization of resources. Thus, this project endeavours to create a web-based facility reservation system called U-Reserve, employing the prototype methodology. U-Reserve was crafted using HTML, CSS, JavaScript, and core Java (JSP and Servlet), while its database is administered through phpMyAdmin. Additionally, U-Reserve places emphasis on incorporating preferred colour tones and font types of the target users, aiming to enhance user experience and satisfaction. Through U-Reserve, the reservation request and cancellation processes are streamlined, and a data-driven dashboard facilitates informed decision-making regarding facility management.

Keywords: facility reservation system, web-based system, colour tone, design principle, data-driven decision-making, user permission management

1. Introduction

UCSI University's ongoing expansion has posed challenges in keeping facilities' information up-to-date, leading to students and staff being unaware of available resources. The Group Logistics Management Office (GLMO) depends on a manual reservation process, requiring students to email GLMO admin for facility availability confirmation, leading to a three-day response time. Subsequent booking procedures exacerbate inefficiencies, risking overlapping reservations and increasing the administrative workload.

Additionally, the manual confirmation process for Block B's discussion rooms at the library counter exacerbates these challenges, leading to time wastage and increased workload for library admins. This inefficiency significantly impacts the overall experience and satisfaction of students, staff, and lecturers at UCSI University, potentially impeding academic performance and participation in extracurricular activities [1], [2].

Therefore, this project introduces U-Reserve, a web-based facility reservation system aiming to address the issues associated with the current reservation process at UCSI University. The system has been developed using HTML, CSS, JavaScript, and core Java (JSP and Servlet) to establish its functionality. For database management, phpMyAdmin is used alongside the MySQL database management system. The primary objectives include streamlining the reservation process, enhancing security measures, and enabling data-driven resource optimization, which will benefit students, staff, lecturers, and administrators at UCSI University.

The remainder of this paper includes sections on system comparison, literature review, development methodology, conclusion, and future work, offering a comprehensive overview of the development process, system features, and potential areas for further improvement.

2. System Comparison

Comparison among four (4) existing facility reservation systems—Bookeo [3], MRBS [4], Reservator [5], and RoomBooker [6] highlights commonalities and distinctive features, detailed in Table 1. These systems share fundamental functionalities, enabling users to make reservations, check reservation history, and granting administrators slot management capabilities. These essential features eliminate manual processes, prevent double bookings, and ensure efficient slot control, forming the foundation for U-Reserve. Table 1 illustrates that Bookeo, MRBS, and Reservator offer reporting tools for analyzing reservation trends. U-Reserve utilizes graphs for visualizing data, aiding in decision-making. Bookeo, MRBS, and RoomBooker send email notifications to requesters—an absent feature in Reservator. U-Reserve ensures prompt updates for users upon request approval or rejection. Furthermore, MRBS and Reservator display booked slots, whereas Bookeo and RoomBooker exhibit available slots only. U-Reserve

combines both, providing a comprehensive Home Page table for clearer planning. Additionally, RoomBooker features admin reservation management and user-friendly slot searches—attributes adopted by U-Reserve for enhanced control and convenience.

Table 1. Features Comparison Between Different Facility Reservation Systems and The Proposed System.

Features	Bookeo	MRBS	Reservator	RoomBooker	U-Reserve
Make reservation.	√	√	√	√	√
Reservation history checking.	√	√	√	√	√
Slot management.	√	√	√	√	√
Report and analytics.	√	√	√	×	√
Email notifications.	√	√	×	√	√
Table showing booked slot.	×	√	√	×	√
Reservation management.	×	×	×	√	√
Search for available facilities or slots.	×	×	×	√	√
Batch reservation.	×	√	×	×	√
Track reservation details.	×	×	×	×	√
View announcements and contact information.	×	×	×	×	√

Moreover, MRBS introduces batch reservation options for weekly, monthly, and yearly bookings. U-Reserve customizes this feature for weekly reservations, offering users flexible date selection to minimize unnecessary bookings. Furthermore, U-Reserve empowers administrators to track reservation details, ensuring seamless user contact. Users can also access department announcements and contact information, streamlining communication.

In summary, U-Reserve integrates functionalities from Bookeo, MRBS, Reservator, and RoomBooker, while incorporating unique elements to provide a comprehensive solution.

3. Literature Review

3.1. *Security*

User Permissions: Managing user permissions is a critical and multifaceted aspect within web-based systems, serving as the cornerstone for security, privacy protection, web personalization, and access control. As emphasized in the referenced scholarly works, adopting Role-Based Access Control (RBAC) models and permission-based mechanisms equips web-based systems with essential tools for handling user permissions. The benefits are extensive, encompassing the mitigation of security risks, safeguarding user privacy, tailoring user experiences, and facilitating secure, controlled resource access. In the evolving landscape of web-based systems' influence on our digital lives, effective user permission management remains a pivotal component. It ensures system integrity, operational efficacy, and fosters trust among both users and administrators [7], [8], [9], [10].

3.1.1 Data-Driven Resource Optimization

Resource Management: Web-based systems have revolutionized resource management, particularly in domains like facility management. These systems provide a comprehensive platform for data analysis, decision support, accessibility, and collaboration. In the context of facility management, they enable quantitative and conceptual analysis, data sharing, remote accessibility, and secure data management. Ultimately, adopting web-based systems for resource management empowers businesses to optimize their operations, reduce costs, enhance safety, and improve overall efficiency. By leveraging the capabilities of these systems, organizations can ensure that their resource management processes are both effective and efficient, ultimately contributing to their success and competitiveness [11], [12].

Decision Making: Web-based systems have revolutionized the decision-making landscape for businesses by offering tools and frameworks that empower organizations to make informed, data-driven decisions. Decision support systems, business intelligence, analytics, interactive decision aids, and provenance-based strategies all contribute to more effective and efficient decision-making processes. In the era of big data and data science, web-based systems are essential for organizations aiming to stay competitive and improve business performance. The effective harnessing of data is a key driver of success, with web-based systems playing a pivotal role in achieving this goal [13], [14], [15].

3.1.2 Design Principle

System Design: It's the core foundation for web-based systems, addressing resource allocation, reliability, security, usability, and learning system design. Its critical role ensures reliable performance, secures sensitive data, enhances usability, and promotes effective web-based learning. Good system design is essential for seamless operation and user satisfaction in digital environments, be it large-scale enterprises or local host websites [16], [17].

Colour Theory: Color tone is a potent tool in web design, influencing users' perceptions, emotions, and behaviours when used intentionally. With a well-matched colour scheme that complements content, designers craft visually appealing designs and guide users effectively. This approach fosters trust, improves user experience,

and drives engagement and satisfaction in web-based systems [18], [19], [20].

Visual Appeal: Crucial in web system design, the layout establishes flow and hierarchy, guiding users effectively. Applying visual principles and aesthetics, designers craft engaging, user-friendly systems, contributing to satisfaction and success [21], [22].

3.2 Applications of Security, Data-Driven Resource Optimization, and Design Principle on U-Reserve

Table 2. Applications of Security, Data-Driven Resource Optimization, and Design Principle on U-Reserve.

Area	Applications
Security.	● A role-based security system prevents errors and safeguards system integrity.
Data-Driven Resource Optimization .	● Decision support design for administrators: comparing requests and enhancing efficiency. ● Dashboard presenting visualised data for data-driven facility management. ● Downloadable Excel report providing valuable insights into facility utilisation.
Design Principle.	● User preferences on colour tones and font types are gathered for UI design. ● Logical page structure, consistent navigation bar, and organised content ensure coherence. ● Font size variations create a clear visual hierarchy on pages.

4. Development Methodology

The project was completed using the prototype methodology, as illustrated in Fig. 1. This approach was selected due to its capacity to involve users in identifying missing functionalities at an early stage [23].

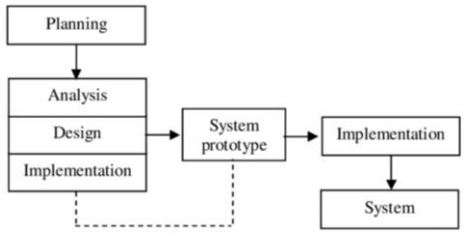

Fig. 1 Prototype Methodology [24]

4.3 Planning

Location of Study: All research activities were conducted at UCSI University, Kuala Lumpur, Malaysia, and remotely via Microsoft Teams using an Internet connection.

Target Population: Students, lecturers, staff, and admins of UCSI University, Kuala Lumpur.

Sampling Methods: Purposeful sampling entails preselecting participants based on specific criteria to ensure diverse insights into various system aspects. Snowball sampling recruits additional participants meeting specific criteria, allowing respondents to refer others.

Data Collection: Primary data collection involves identifying functional and non-functional requirements, as well as preferences for colour tone and font type for U-Reserve. Secondary data from sources such as journals guides the acquisition of user requirements, supporting project insights and results.

4.4 Analysis

Functional and Non-functional Requirements Analysis: A total of seventy-five (75) users actively participated in this survey via Google Forms, providing valuable insights and feedback.

Functional requirements include checking availability, making reservation requests, checking request status, request history, and tracking reservation details. All highlighted functional requirements identified by respondents are integrated to enhance user satisfaction. Priority will be given to enabling users to check availability, make reservation requests, and check request status, as these received the highest percentages: 93.33%, 86.67%, and 74.67%, respectively.

Moving to non-functional requirements, feedback on the ease of use of a facility reservation system shows that 73.33% prefer high user-friendliness. U-Reserve prioritizes easy navigation and efficient user interactions in line with this preference. The next query assesses reliability and security, with 53.33% rating them as very important, guiding U-Reserve's robust security design. The importance of 24/7 availability is evident, with 65.33% considering it crucial for user convenience and efficiency. Lastly, 70.67% emphasize scalability's importance for a reservation system's effectiveness. Despite its local host development, U-Reserve needs to meet availability and scalability as vital non-functional requirements when adopted by UCSI University.

User Interface (UI) Preferences Analysis: The feedback received from these one hundred (100) users via Google Forms provided insights on their preferred colour tones and font types for U-Reserve.

Four (4) commonly used colour tones - blue, red-violet, green, and red - were selected for the user interface (UI) of U-Reserve. Respondents could choose their preferred colour tone for each questionnaire question. Blue, linked to familiarity and professionalism, emerges as the top choice across multiple criteria: visual appeal (32%), suitability (39%), calming effect (42%), professionalism (34%), modernity (30%), and accessibility (47%). This preference for blue aligns with research highlighting its universal appeal, trustworthiness, and readability in digital environments. Notably, cool colours like blue and green consistently dominate preferences (60.83%), reflecting users' preference for calming and trustworthy associations. Emphasizing the importance of contrast in U-Reserve's UI, achieved through thoughtful design considerations, is crucial for readability and enhancing the overall user experience [25].

Additionally, respondents were asked to select a font type—Josefin Sans + Dosis, Sans-Serif, Verdana, Arial, or Georgia—based on suitability, readability, and aesthetic appeal for the UI design. Verdana emerges as the top choice, favoured by 38% for suitability, 48% for readability, and 49% for aesthetic appeal. Sans-Serif and the combination of Josefin Sans + Dosis also receive varied support. The consistent preference for Verdana aligns with research emphasizing its screen-centric design, readability advantages, and aesthetic appeal, making it the optimal font type for a user-friendly experience in a facility reservation system [26].

4.5 Design

System Design:

The following figures show the main pages of U-Reserve.

Fig. 2 displays a login page with ID number and password fields. Regardless of their role, users must provide the correct ID number and password for authentication.

Fig. 2 Login Page of U-Reserve

After a successful login, the home page, as depicted in Fig. 3, is displayed, showcasing a navigation bar, announcement slides, contact information, and an availability table for facility reservations.

Fig. 3 Home Page of U-Reserve

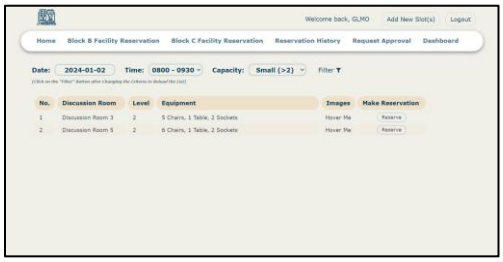

Fig. 4 Block B Facility Checking and Reservation Page of U-Reserve

Users can check availability by viewing the cell's colour and make reservations by clicking on the cells. Additionally, users can navigate to specific facility reservation pages for Block B, as illustrated in Fig. 4, or Block C, as illustrated in Fig. 5.

Fig. 5 Block C Facility Checking and Reservation Page of U-Reserve

After selecting a facility, users are redirected to the reservation page, as depicted in Fig. 6 which is used to fill in the details. Additionally, users can review their reservation request list and check the status from the reservation history page, as shown in Fig. 7. Finally,

admins can approve or reject reservation requests on the reservation approval and checking page, as illustrated in Fig. 8.

Fig. 6 Reservation Page of U-Reserve

Fig. 7 Reservation History Page of U-Reserve

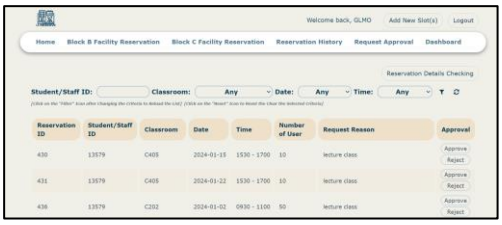

Fig. 8 Reservation Approval and Checking Page of U-Reserve

Use Case Diagram:

The U-Reserve use case diagram delineates three user roles: students and staff, lecturers, and administrators (Group Logistics Management Office (GLMO) and library admin), illustrated in Fig. 9.

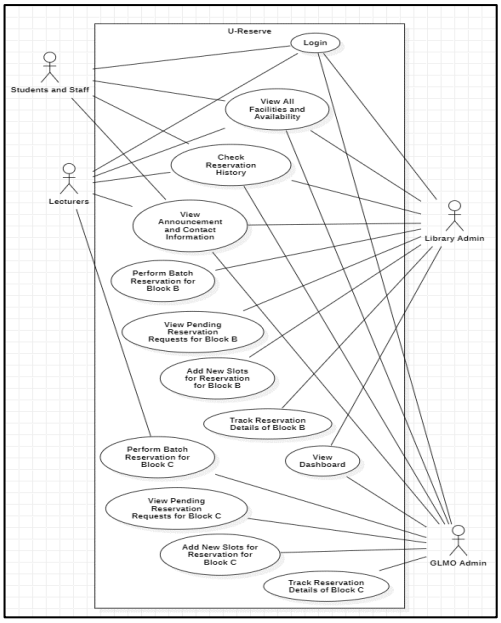

Fig. 9 Use Case Diagram for U-Reserve

Students and staff possess various capabilities, including logging in, password management, accessing announcements and contact details, checking facility availability, making reservations, reviewing reservation history, and canceling reservations. Additionally, lecturers enjoy extended privileges, allowing batch reservations specifically for Block C classrooms. GLMO and library admins have the highest permissions, sharing fundamental functionalities with students and staff while also conducting batch reservations, adding new slots, and overseeing reservation requests. GLMO admins can access a dashboard and download usage reports for Block C classrooms, whereas library admins focus on managing discussion rooms in Block B, significantly contributing to efficient oversight and management.

Entity Relationship (ER) Diagram:

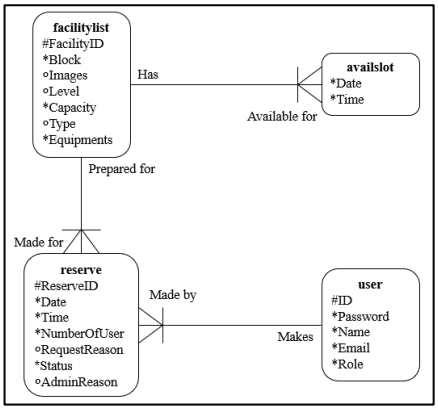

Fig. 10 ER Diagram for U-Reserve

In the ER Diagram displayed in Fig. 10, four entities are represented: “facilitylist”, “availslot”, “reserve”, and “user”. The “facilitylist” entity stores data about all facilities, utilizing “FacilityID” as its unique identifier, and includes mandatory attributes like “Block”, “Capacity”, “Equipments,” as well as optional attributes such as “Images”, “Level”, and “Type”. The “availslot” entity comprises mandatory attributes “Date” and “Time.” Identified by “ReserveID,” the “reserve” entity contains mandatory attributes like “Date,” “Time,” “NumberOfUser,” and “status,” along with optional attributes like “RequestReason” and “AdminReason”. The “user” entity, marked by “ID,” encompasses mandatory attributes like “Password”, “Name”, “Email”, and “Role”. Relationships are established using UID bars: a facility can have multiple available slots, each uniquely linked to a facility through the “FacilityID” attribute. Similarly, a facility can be prepared for multiple reservations, each associated with a facility through the same “FacilityID”. Finally, a user can make multiple reservations, with each reservation linked to a user through the “ReserveID” attribute.

Activity Diagram:

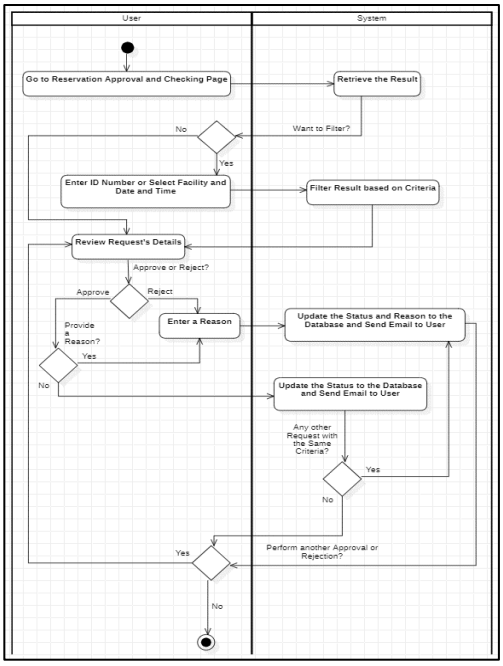

Fig. 11 Activity Diagram for U-Reserve – Approve or Reject Reservation Requests

In Fig. 11, users handle reservation requests by accessing the reservation approval and checking page through the “Request Approval” link. Here, they can browse and filter pending reservation requests by ID number, facility, date, and time. Users review request details and decide to approve or reject. Giving a reason for rejection is necessary. The system updates the status and notifies requesters via email. Approved requests prompt the system to check for similar ones, automatically rejecting them, updating the status, and sending notifications.

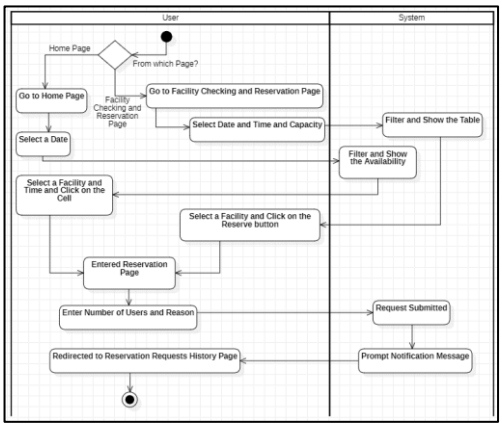

Fig. 12 Activity Diagram for U-Reserve – Make Reservation

As per Fig. 12, users reserve through two methods: via the home page’s availability table or Block B/Block C facility checking and reservation page. To reserve from the home page, users scroll, pick a date from the date picker, check facility availability, select time and facility, and click a cell. This redirects to the reservation page where they input user count and reason, get confirmation, and are sent to the reservation history. Alternatively, from the facility checking and reservation page, users choose Block B/C, set date, time, capacity, select a facility, and click “Reserve”. This proceeds to the reservation page following the same steps.

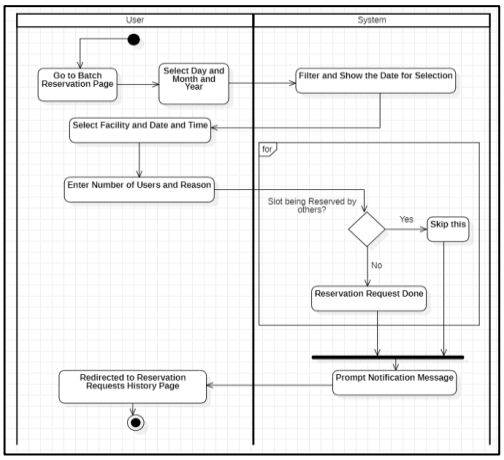

Fig. 13 Activity Diagram for U-Reserve – Batch Reservation

In Fig. 13, users perform batch reservations on the batch reservation page. Here, users select the day of the week, month, and year. The system retrieves corresponding dates from the database and presents them. Users then pick the facility, date, and time, enter user count and reasons, and submit the request. The system checks for existing reservations for the selected slots. If available,

the system adds the new reservation request to the database; otherwise, it skips it. This cycle repeats for each selected date until completion. Users are notified of the submitted requests and redirected to the reservation requests history page.

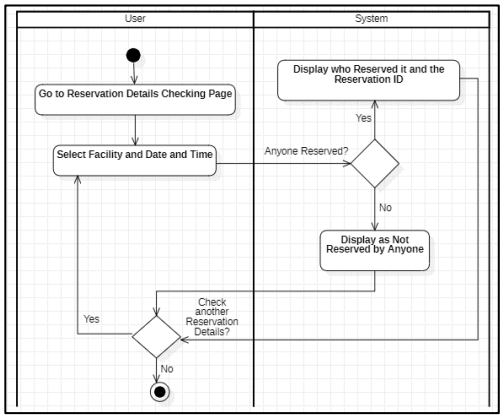

Fig. 14 Activity Diagram for U-Reserve – Track Reservation Details

In Fig. 14, users can monitor reservations for a particular facility, date, and time via the reservation details checking page. They choose the desired parameters, and the system scans the database for reservations that match the criteria. If found, the system displays the Reservation ID and requester's ID number; otherwise, it indicates no reservations.

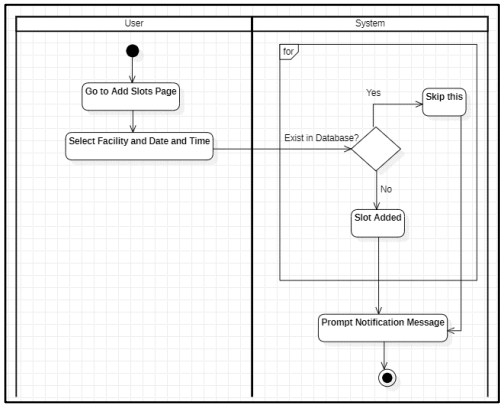

Fig. 15 Acytivit Diagram for U-Reserve – Add New Slots

In Fig. 15, admins can include reservation slots by clicking the "Add New Slot(s)" button to access the Add Slots page. On this page, they select the facility, date, and time, and submit the details to the system. For each slot, the system verifies its existence in the database; if already present, the system skips that slot. Upon completion of the loop, the system informs admins about the number of submitted slots.

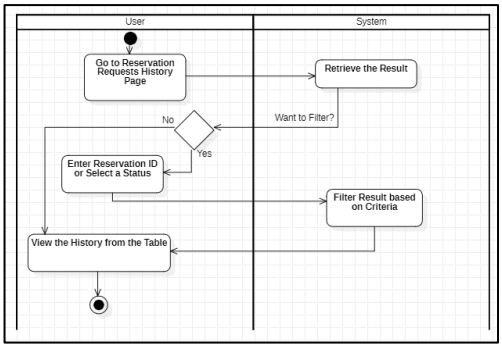

Fig. 16 Activity Diagram for U-Reserve – Check Reservation History

Users can access their reservation request history by clicking the "Reservation History" link on the navigation bar, as depicted in Fig. 16. Upon reaching the reservation requests history page, users can observe all their reservation requests. They have the option to input the Reservation ID, select a status, or both to refine the history. Subsequently, the system connects to the database, filters the results based on the provided criteria, and displays them to the users.

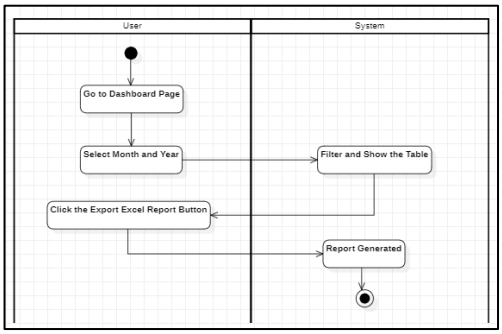

Fig. 17 Activity Diagram for U-Reserve – Export Excel Report

In Fig. 17, users can generate an Excel format utilization report from the dashboard page by clicking the "Dashboard" link on the navigation bar. They choose the preferred month and year, and the system filters and displays the corresponding data. Clicking the "Export Excel Report" button prompts the system to generate and download the report.

4.6 Development and Implementation

Table 3 displays the tabulated data from the user acceptance test (UAT) forms, utilising a Likert scale ranging from 1 for strongly disagree to 6 for strongly agree, as suggested by research [27], as shown in Fig. 18. The analysis used the arithmetic mean technique, following the methodology of [28]. A comprehensive evaluation of different sections can be accomplished by calculating the mean rating for all items within each section. A mean rating exceeding five (5) indicates user agreement. In this three-scale representation of

agreement, encompassing 4 - Agree, 5 - Somewhat Agree, and 6 - Strongly Agree, five (5) serves as the midpoint.

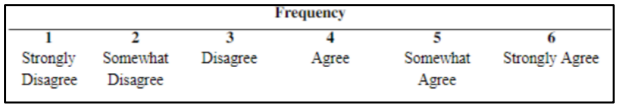

Fig. 18 Likert Scale [27]

Table 3 User Acceptance Test (UAT) Result.

Item	1	2	3	4	5	6	Mean Rating
User Interface Design *[27]*							
Appropriate colour tone.	0	1	1	5	10	13	5.1000
Appropriate font type.	0	0	0	3	9	18	5.5000
Appropriate font size.	0	0	0	3	7	20	5.5667
Navigation is easy.	0	0	0	3	7	20	5.5667
Navigation is clear and concise.	0	0	0	1	8	21	5.6667
Perceived Usefulness *[29]*							
Using the system in my job/study increases my productivity.	0	0	0	4	9	17	5.4333
Using the system enhances my effectiveness in my job/study.	0	0	0	1	10	19	5.6000
I find the system to be useful in my job/study.	0	0	0	2	11	17	5.5000
Perceived Ease of Use *[29]*							
My interaction with the system is clear and understandable.	0	0	0	1	13	16	5.5000
Interacting with the system does not require a lot of my mental effort.	0	0	0	1	10	19	5.6000
I find the system to be easy to use.	0	0	0	1	8	21	5.6667
I find it easy to get the system to do what I want to do.	0	0	0	1	10	19	5.6000
Output Quality *[29]*							
I have no problem with the quality of the system's output.	0	0	0	3	11	16	5.4333
I rate the results from the system to be excellent.	0	0	0	2	9	19	5.5667
Result Demonstrability *[29]*							
The results of using the system are apparent to me.	0	0	0	1	11	18	5.5667
I would have no difficulty explaining why using the system may be beneficial.	0	0	0	4	11	15	5.3667
Behaviour Intention *[29]*							
Assuming I had access to the system, I intend to use it.	0	0	0	0	10	20	5.6667

In addition, Table 3 presents survey results indicating a favourable user perception of U-Reserve across various aspects, such as UI design, effectiveness, ease of use, output quality, result demonstrability, and behavioural intention. The system meets user expectations and preferences satisfactorily. However, potential areas for improvement have been identified, and several suggestions are currently under consideration. In essence, U-Reserve stands as a well-developed system proficient in efficiently managing facility reservations for UCSI University while assisting university staff in handling lecturers' timetables.

5. Conclusion and Future Work

In conclusion, the development of U-Reserve, UCSI University's web-based facility reservation system, followed a prototype methodology involving planning, analysis, design, and implementation. This approach successfully engaged users early in the process, incorporating feedback from user acceptance tests to modify and enhance the system. Notable contributions include streamlining the reservation process for students, staff, lecturers, and administrators, reducing workloads, and improving facility management through data-driven analyses.

U-Reserve meets user preferences for colour tone and font type, fulfilling functional and non-functional requirements. It stands out from existing systems by integrating their features while introducing unique elements like tracking reservation details and offering announcement and contact information. Moreover, the comprehensive project report lays the groundwork for implementing the facility reservation system at UCSI University, signifying a substantial achievement for the institution and its users.

Future improvement suggestions for the facility reservation system at UCSI University include redesigning for formality and consistency, migrating to a cloud-based or hosted server, implementing approval periods for reservation requests, integrating with central databases and the IIS, expanding reservation options, and enhancing the password reset mechanism. These enhancements aim to boost the system's functionality, security, and user experience, aligning it with the evolving needs of the university community.

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