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Optimizing Procurement System Using Nielsen's Heuristics

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ABSTRACT

A fitness center grapples with significant challenges related to administrative errors, prolonged purchase cycles, and supplier management issues, resulting in escalated costs and operational inefficiencies. To address these hurdles, this project aims to develop a procurement system for this fitness center, targeting the optimization of procurement activities, improvement of inventory management, and facilitation of smoother interactions with suppliers for managers, staff, and suppliers alike. The objective of this study was to identify the requirements for the procurement system, design and develop the system with integrating Nielsen's heuristics. Furthermore, a system evaluation has been conducted to test its functionality and usability to the target users. Utilizing an adapted waterfall model as the framework, the system's scope encompasses user registration, login procedures, purchase order submission, invoice generation, and equipment maintenance and management. The evaluation results demonstrated that the system meets all requirements outlined in the test plan. Additionally, feedback from both users and experts has been integrated to further refine the system. Implementation of this system will make the procurement process smoother and more organized. By prioritizing usability, efficiency, and user satisfaction, the system has the potential to optimize procurement activities, reduce errors, and ultimately improve the overall functioning of the fitness center.

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1. Introduction

In recent years, there has been a notable surge in the utilization of gyms and fitness centers, reflecting a growing emphasis on health and wellness in society[1]. This trend can be attributed to various factors, including increased awareness of the importance of physical fitness, a desire for healthier lifestyles, and the influence of social media promoting fitness culture. As per a survey conducted by Rakuten Insight (https://insight.rakuten.com/) on gym memberships, approximately 49 percent of individuals surveyed in Malaysia said they go to the gym several times a week. As people prioritize their well-being and seek avenues for physical activity, the popularity of gyms and fitness centers continues to escalate, underscoring a broader societal shift towards prioritizing health and self-care.

As the demand for fitness centers and gyms increases, the importance of having a centralized procurement center to manage equipment becomes paramount. A dedicated procurement center streamlines the process of acquiring, maintaining, and updating fitness equipment, ensuring that facilities have access to state-of-the-art machines and tools necessary for providing quality workouts. This project conducted a study for a gym and fitness center located in

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Kuala Terengganu, Malaysia. The challenge faced by the company is to ensure the longevity and quality of the equipment purchased. Based on the interviews conducted with the manager and the staff, this gym often invests substantial sums in acquiring exercise machines, weights, and other fitness equipment, expecting them to withstand heavy usage over time. However, issues such as premature wear and tear, equipment malfunction, or inadequate durability can arise, leading to frequent repairs, replacements, and unexpected expenses. This problem can be worsened by purchasing equipment from unreliable suppliers or failing to conduct thorough research into the durability and performance of the products. Additionally, with the rapid advancements in fitness technology, gyms may face difficulties in keeping their equipment up-to-date and competitive, leading to potential obsolescence. Effective procurement strategies that prioritize quality assurance are essential for mitigating these challenges and ensuring the long-term sustainability of gym operations. Despite these challenges, there are limited studies discussing procurement technology with the fitness industry and associated with the importance of having user interface (UI) design following the designated UI principles in system implementation. Only one study from [2] focuses on user experience (UX) in procurement system to accurately gauge user satisfaction and enhance service provision.

Therefore, this study aims to develop a procurement and equipment maintenance system for the gym and fitness center by integrating Nielsen's heuristics in designing the UI of the system. The objective of this project starts with identifying the user and system requirements for the procurement system and is followed by designing and developing the procurement system using Nielsen's usability heuristics. The last objective of this project is to evaluate the system in terms of its functionality and usability. With a well-managed procurement system, fitness centers can consistently provide high-quality equipment and amenities to their members, thereby enhancing their overall experience. This can result in increased member satisfaction and loyalty.

2. Literature Review

2.1 Procurement System in the Fitness Industry

Procurement is an essential aspect of a business and involves purchasing goods and services for a company, whether public or private. Procurement, a key component of supply chain management (SCM), involves identifying, sourcing, and managing the resources necessary for a company's operations. In procurement, the focus is on ordering products or services from vendors, managing inventory, and processing vendor invoices [3]. The overarching goal of the procurement process is to ensure the right materials or services are delivered in the right quantity, place, time, and at the right price[4]. One of the ongoing issues in the fitness industry related to the procurement process is the challenge of sourcing and acquiring quality equipment and supplies amidst global supply chain disruptions. The COVID-19 pandemic has severely impacted the manufacturing, shipping, and distribution of fitness equipment and related supplies. This has led to delays, shortages, and increased costs for fitness centers when procuring necessary items to maintain operations and meet customer demand [5]. Furthermore, with the rapid advancements in fitness technology, there may be difficulties in evaluating and selecting the most suitable equipment and software solutions for fitness centers. Procurement teams need to stay updated on emerging technologies, assess their compatibility with existing systems, and make informed decisions to ensure that investments in new equipment and technologies deliver value to the business and enhance the member experience. According to [6], service quality has become crucial in the competitive fitness industry, and meeting customer expectations is a challenge for health and fitness clubs. Jang and Choi [7] classified the most important reasons for re-joining the fitness center as equipment, atmosphere, membership fee, and accessibility. Study from [8] identified users express dissatisfaction with systems that are inefficient, expensive, and not user-friendly. It is imperative to explore the aspects of e-procurement that could improve the overall user experience. The study conducted by [3] has demonstrated the beneficial influence of digital adoption on the procurement process. When there is technology adoption inside the procurement function, it makes the company more transparent, employees with authorization can access the database, which can help the company to justify cost saving and cost effectiveness from data availability inside and across company functions[9]. Thus, navigating these challenges requires fitness centers to adapt their procurement strategies by adopting the digital solutions, collaborate closely with suppliers, and prioritize efficiency, quality, and sustainability in their procurement processes.

2.2 Nielsen's Heuristics Theory

Heuristic evaluation (HE) is commonly employed for assessing a range of software, interfaces, systems, or application domains. It is the extensively used inspection method in finding usability problems and popular option due to its cost-effectiveness[10]. Evaluators analyze the interface against established usability standards independently. Diverse evaluators enhance effectiveness due to varied user experiences [11]. A previous study from [12] emphasized the importance of the principles of UI design which are learnability and robustness to be implemented in the electronic ordering system which shows the significant results towards user satisfaction. Supported by the study from [13] when implementing Nielsen's heuristics to the preschool event management system, they found that the high usability satisfaction among the users with SUS score of 82.5. With that motivation, this study emphasizes Nielsen's heuristics to be implemented in the development of the procurement system. Developed in 1990, Nielsen proposed ten heuristic laws to identify usability issues to facilitate interface improvement [14]. Nielsen's usability heuristics provide a set of principles for designing user-friendly interfaces and systems [14]. The theory elaborated on ten heuristics as described in Table 1.

Table 1. Nielsen's Heuristics Theory

No.	Nielsen's Heuristics	Description
1	Visibility of system status	Users should consistently receive up-to-date and relevant feedback from the system to stay informed about ongoing events.
2	Match between the system and the real world.	The system can communicate with understandable human language such as providing recognizable icons, text, or buttons that are easy for users to understand.
3	Users control freedom	The user possesses the capability and permission to navigate to other pages and exit the system as required.
4	Consistency and standard	The system's interface should exhibit uniformity and consistency in design elements, including aspects like font size.
5	Error prevention checklist	Users of the system can promptly rectify any errors they make, even in cases of failure, and perform tasks within the system with minimal mistakes.
6	Recognition rather than recall	Users can effortlessly recall and identify the features within the system without the need for memorization or reliance on instructions.
7	Flexibility and efficiency of use	The system adeptly adjusts to the user's pace, readily accommodating interactions for both novice and proficient users.
8	Aesthetic and minimalist design	Eliminating superfluous elements or attributes is essential to ensure effective communication of vital information to the user.
9	Help users recognize	Error messages must be composed in plain language, accurately pinpoint the problem, and offer a useful solution
10	Help and documentation	While the ideal scenario is for the system to be usable without external aid or documentation, there might be instances where assistance and documentation are necessary. Such resources should be easily accessible, focused on the user's objectives, provide actionable guidance, and avoid unnecessary length.

When applied to the interface design of a procurement system, these heuristics can have significant implications. For instance, the heuristic of "visibility of system status" suggests that users should be continuously informed about what's happening within the system. The study by [15] confirms that the Sport Analysis Application achieves its main goals with a user-friendly interface. With a "visibility of system status" score of 151, the app provides clear feedback and keeps users well-informed about its status. In the context of procurement, this means providing clear feedback on the status of orders, deliveries, and inventory levels, allowing users to track the progress of their procurement activities effectively. Similarly, the heuristic of "recognition rather than recall" emphasizes the importance of making information and actions easily accessible, minimizing the need for users to remember complex procedures.

In a procurement system, this could involve providing intuitive navigation, searchable databases, and customizable dashboards to simplify the process of finding and managing procurement-related information. Further explanation is discussed in the next section.

3. Methodology

This project consists of four phases following the adapted waterfall model as a system development methodology. The project starts with the requirement gathering and analysis phase followed by the design, implementation, and testing phase. During the initial stage, the interviews were conducted with the manager and the staff of the gym and fitness center to help the researcher identify the current procurement process. Later, the requirements for developing the system were captured and analyzed to assist the development process. From the user requirements, the developer transformed them into functional and non-functional requirements. These requirements are crucial for guiding the development of a system aligned with user needs. This procurement system involves three distinct user groups which are staff member, manager, and supplier, each with unique functions and processes, all addressed within the specified requirements.

During the design phase, various diagrams have been produced to get overview details from the systems requirements such as the context diagram (CD), data flow diagram (DFD), entity relationship diagram (ERD), functional hierarchy diagram, site map, and UI design. The primary objective of this stage is to visualize and transform the system's processes and specifications into a complete and integrated system. In the testing phase, the system was published as a standalone application and later evaluated based on its functionality and usability in the evaluation phase. The objective of the evaluation phase was to uncover flaws and suboptimal performance that might not have been easily labeled as bugs. By employing the devised test strategy, the testing was conducted by expert users. Table 2 shows the summary of this project method.

Table 2. Project Development Methodology

Phase	Activities
Phase 1: Requirement Gathering and Analysis	• Conduct interviews, research and find relevant literature • Identify project scope • Gather users' requirements • Analyze system requirements
Phase 2: Design	• Create Context Diagram • Develop a Data Flow Diagram • Construct Entity Relationship Diagram • Design a functional hierarchy diagram and site map • Design user interface and theory implementation
Phase 3: Implementation	• System development
Phase 4: Testing	• System testing to measure the applied theory • Evaluation to execute procurement process

3.1 Implementation of Nielsen's Heuristics in Procurement System

When designing the interface of the system, the developer integrates Nielsen's heuristics into its interface design. This theory significantly streamlines the development process by providing precise directives for developers to follow during the system's construction.

As shown in Figure 1, the interface provides clear feedback on the status of orders which are represented as *Approved* or *Pending*, allowing users to track the progress of their procurement activities effectively. Staff can view the report of purchase order where this report shows the date, purchase order number, number of items, subtotal and purchase order status.

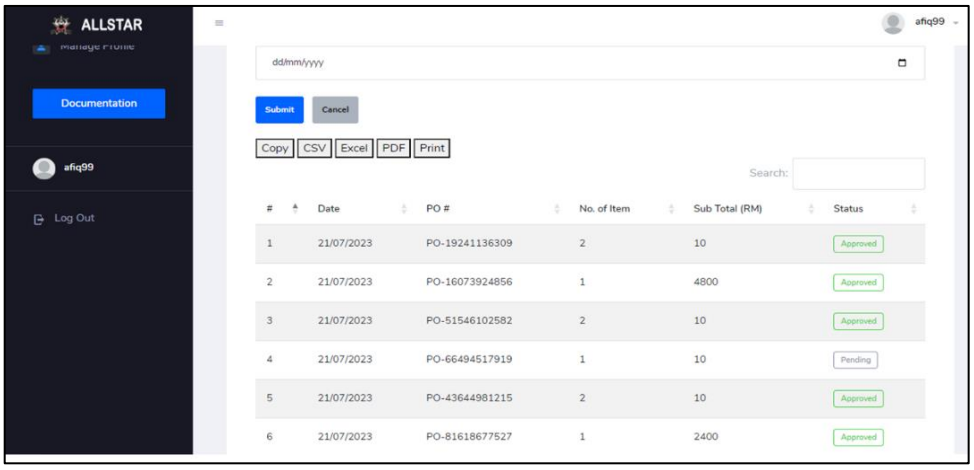

Figure 1. Nielsen's Heuristics 1 - Visibility of system status

By choosing the date range, it will execute the database on the date as shown in Figure 1. The report can be viewed, copied and downloaded in Excel, CSV and PDF. This interface also provides a search bar that allows users to filter based on the purchase order number.

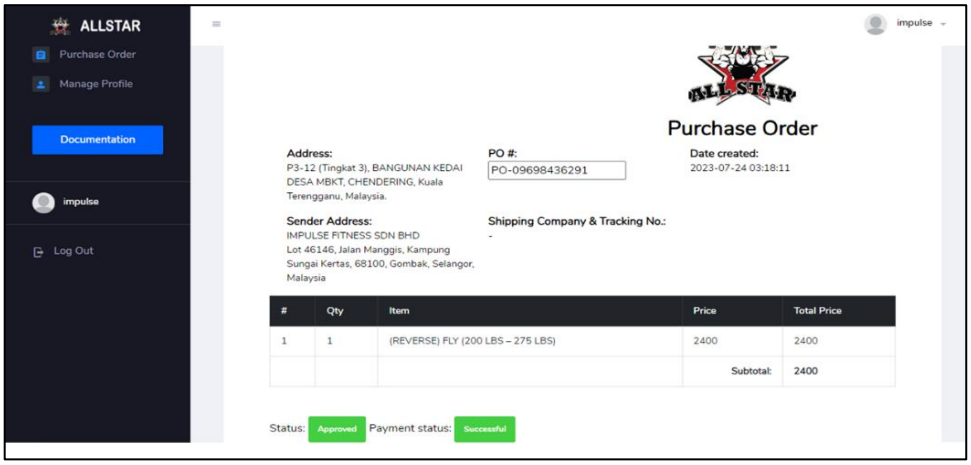

Figure 2. Nielsen's Heuristics 2 - Match between the system and the real world

Terms such as *"purchase orders", "invoices*", and "*items*" were used in this system as shown in Figure 2, to imitate the real-world language used in the procurement process within the company. By aligning users' mental models and real-world expectations, the system becomes more flexible and intuitive to use.

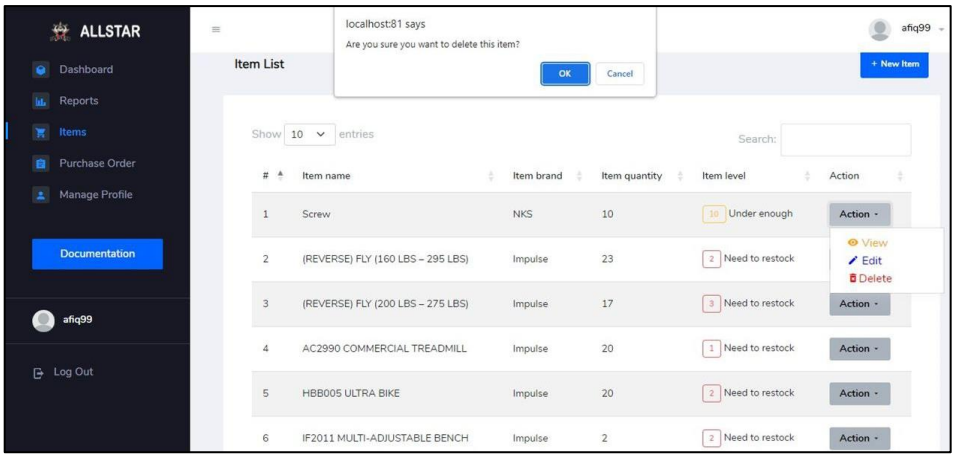

Figure 3. Nielsen's Heuristics 3 & 5 - User control and freedom and

As seen in Figure 3, the user can see the alert for low inventory levels or order approvals. For example, staff can see the status *"Need to restock"* for an item required to restock, meanwhile status *"Under restock"* will be displayed for items that reach a minimum level of quantity. Other than that, a confirmation dialog is displayed when submitting purchase orders or making changes to sensitive information. For example, staff who requested to delete the item according to the supplier's request will be notified with a confirmation box message to prevent errors in the future.

This system also provides the same login page for all types of users, as shown in Figure 4 below. The same terminology for describing items, vendors, and procurement documents is used throughout the system to ensure that users can easily identify and comprehend relevant information. By maintaining its consistency and standard, this heuristic can help users predict how the interface will behave and reduce user confusion.

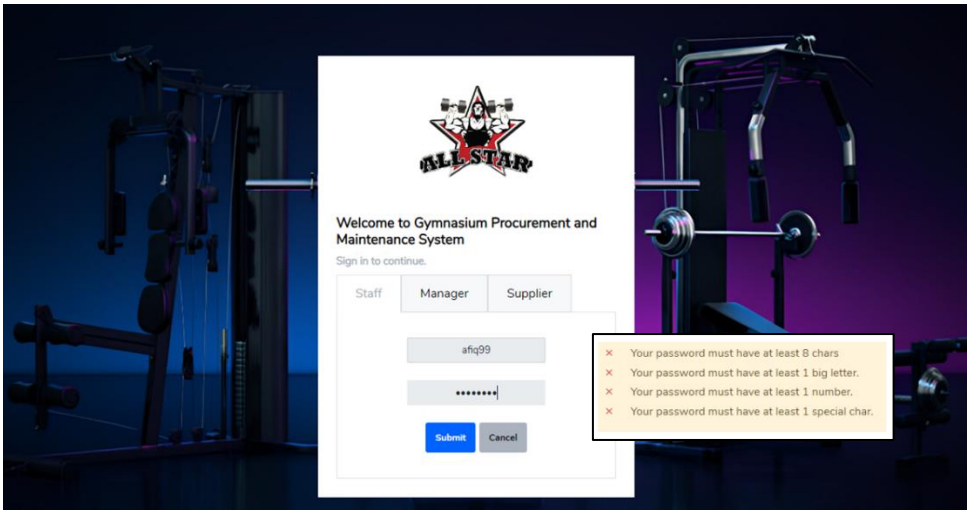

Figure 4. Nielsen's Heuristics 4 & 9 - Consistency and standard and Helping users to recognize, diagnose and recover from errors

Furthermore, to comply with Nielsen's heuristic of helping users to recognize, diagnose and recover from errors, error messages should be clear and informative. For example, when the user fails to log in to the system, an error message will display all relevant checklists of password conditions for the user to follow. This error message helps the user to understand what went wrong and how to correct it, as seen in Figure 4.

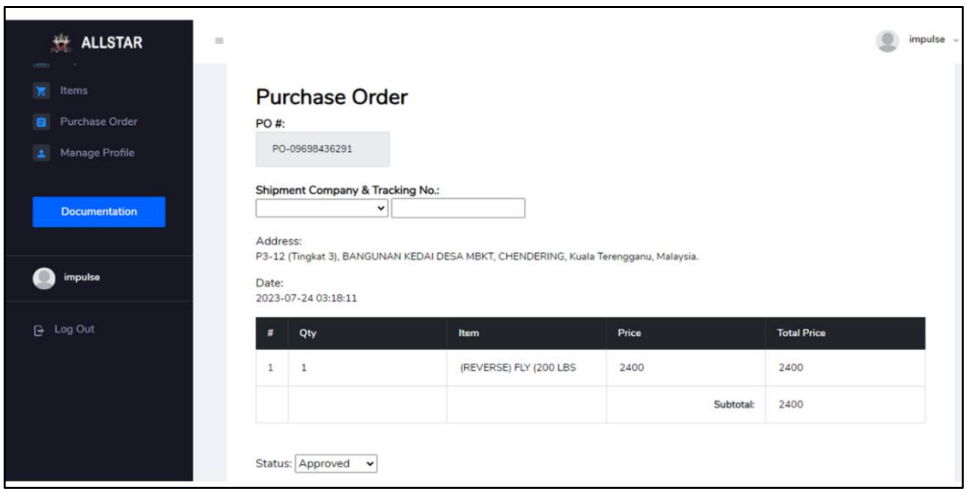

Figure 5. Nielsen's Heuristics 6 & 7 - Recognition rather than recall and Flexibility and efficiency of use

To comply with heuristics "recognition rather than recall", a dropdown list of suppliers is provided to allow users to search and find information about the supplier, without the need to manually enter the information, see Figure 5. This intuitive navigation and searchable database help to simplify the process of finding and managing procurement-related information. On the left side of the menu bar, the interface shows clear menus and provides shortcuts for tasks such as creating purchase orders, managing item information, viewing user manual documentation, and managing profiles. These allow users to interact with the system as efficiently and flexibly as possible.

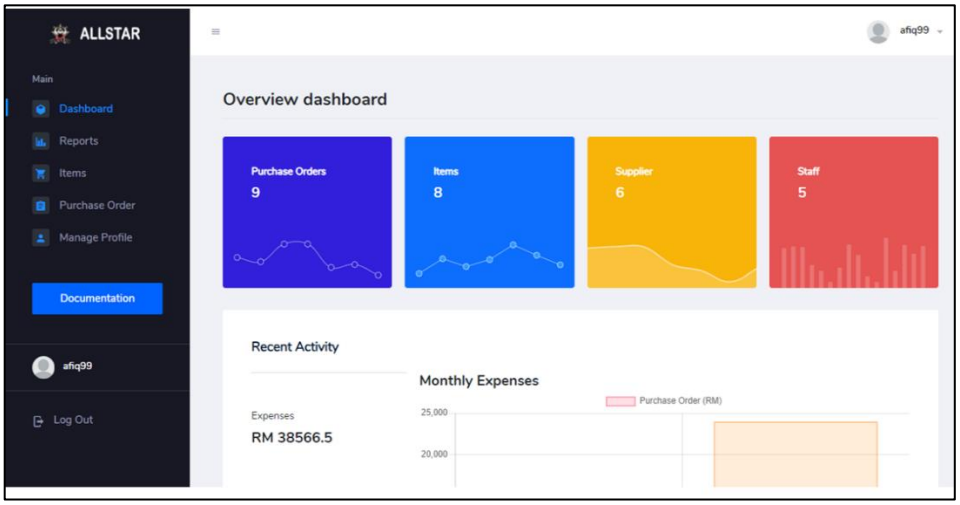

Figure 6. Nielsen's Heuristics 8 - Aesthetic and minimalistic design

Figure 6 shows how this system used a simple and minimalistic design for its dashboard to minimize cognitive overload and help users focus on the task at hand. For example, once the manager logs onto the system, the manager will redirect to the dashboard page that shows the overview information on the total number of purchase orders, total items in inventory, total registered suppliers, and total number of staff. This view helps managers to get a snapshot of the current state of affairs at a glance, enabling the manager to make informed decisions more efficiently. Besides that, the dashboard also displayed the total expenses and monthly expenses of the company, which represent the company purchase orders that have been approved and the total payments that have been made. Knowing the total expenses and monthly expenses helps management track spending trends and make adjustments as necessary to meet financial goals.

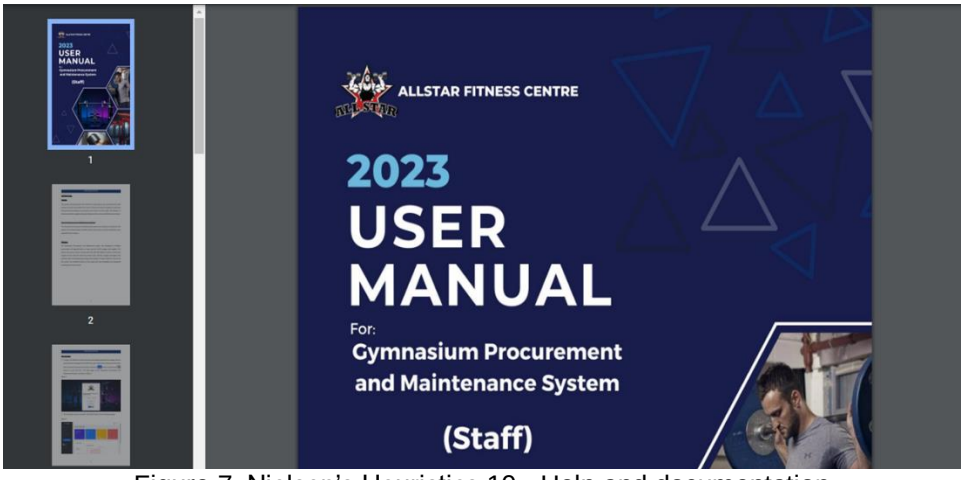

Figure 7. Nielsen's Heuristics 10 - Help and documentation

This system has a documentation button to show the user manual, so that the user will understand how to use it. Every new or old staff can read the user manual by clicking the *"documentation"* button and the user manual will execute to help the staff understand how to use the system and how the

cycle of the system from start until the end as shown in Figure 7. Adhering to this heuristic can enhance the flexibility of users seeking assistance.

3.2 System Evaluation

The testing phase encompasses assessing both the functionality and usability of the system. The objective of this evaluation is to ensure that the system aligns with user requirements and offers a comprehensive overview of its capabilities. It caters to three distinct user roles: staff, manager, and supplier, each with tailored functionalities. Special attention is given to aligning the system with user needs and gauging its effectiveness in facilitating procurement and maintenance tasks. This evaluation process enabled the developer to pinpoint necessary enhancements for user acceptance. Statistical methods such as mean, mode, median, and standard deviation were utilized to analyze the gathered data. The evaluation was divided into six constructs: A - system interface, B - functionality, C - navigation, D - reliability, E - satisfaction, and F - Nielsen Heuristics.

The evaluation took into account the user's perspective, involving thirty-two (32) participants, primarily comprising students from UiTM Kuala Terengganu (93.8%), along with one (1) lecturer (3.1%) and one (1) system analyst (3.1%). Additionally, three (3) expert users from relevant fields were involved in this process. The testing results provide valuable insights into the system's performance, strengths, and areas for improvement, underscoring its significance in enhancing efficiency and usability.

In section A, experts were queried regarding their satisfaction with the UI of the system, using a Likert scale, which indicated 5 as *strongly agree* and 1 as *strongly disagree*. On average, the experts concurred that the interface was satisfactory and easy to comprehend. Section B focused on assessing the functionality of the system, with experts opining on whether it meets user needs and if all functions and buttons operate effectively. The majority of experts agreed that the system functions well based on the Likert scale. Section C evaluated the navigation of the system, probing whether it functions smoothly and if buttons lead to their intended destinations. One expert suggested providing a user manual to aid in understanding the system's operation. Section D involved experts evaluating the system's reliability and user-friendliness. In Section E, experts voted on the system's satisfaction and usability as a procurement tool, with most expressing satisfaction with its use. Finally, an evaluation was conducted on the implementation of Nielsen's heuristics theory in the system, with experts expressing satisfaction with its incorporation. Table 3 shows the results from the expert evaluation of Nielsen's Heuristics.

Table 3. Expert Evaluation for Nielsen's Heuristics Theory

SECTION F: EXPERT EVALUATION FOR NIELSEN HEURISTICS THEORY		
Item	**Questionnaire**	**Likert scale (1-5)**
F1	The system always keeps informed of current events by providing timely, pertinent feedback.	*E1:* (5), *E2:* (4), *E3:* (4)
F2	The system uses recognizable icons and text that ease me to understand the features and elements provided in the system.	*E1:* (4), *E2:* (5), *E3:* (5)
F3	I have the access and ability to go to the other pages as well as to exit from the system when needed.	*E1:* (5), *E2:* (5), *E3:* (4)
F4	I can immediately recover the errors made and able to do all the tasks in the system with minimum errors.	*E1:* (4), *E2:* (4), *E3:* (5)
F5	The system reduces unnecessary elements to ease the users.	*E1:* (5), *E2:* (4), *E3:* (3)
F6	The system shows the error messages in clear language, properly identifies the issue and provide helpful solutions.	*E1:* (5), *E2:* (4), *E3:* (5)
F7	The system provides guideline information for users to understand all important features of system.	*E1:* (5), *E2:* (4), *E3:* (5)
F8	Overall, do you think all the usability heuristics by Jakob Nielsen's being applied to the system?	*E1:* (5), *E2:* (4), *E3:* (4)
Comment	Expert 1, 2, 3: None	
Suggestion	Expert 1, 2, 3: None	

4. Results and Discussion

Based on the evaluation, the researcher calculates the mean value for each item and the result shows that items F2, F3, F6 and F7 get the highest mean of 4.67, see Figure 8. This indicates that the heuristics principle fulfills the user's intended expectation and the lowest mean is for item F5 which indicates that users generally find the system successful in minimizing unnecessary elements to improve ease of use, but there may still be opportunities for optimization to further enhance the user experience.

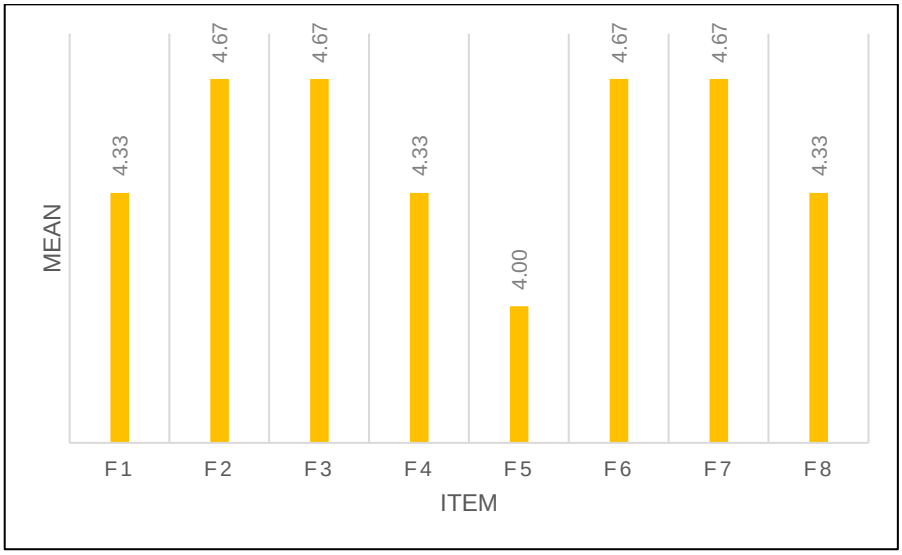

Figure 8. The mean value from experts' evaluation related to Nielsen's Heuristics Theory

For overall constructs, the mean value for User Interface (A) is 4.59, indicating that, on average, users perceive the interface positively, albeit slightly lower than other aspects evaluated. Functionality (B) has a mean value of 4.61, suggesting that users find the system's features and capabilities highly satisfactory. Navigation (C) received a mean value of 4.58, indicating that users generally find it easy to move around and locate desired features within the system. Reliability (D) scored 4.62 on average, implying that users perceive the system as dependable and consistent in its performance. Satisfaction (E) attained a mean value of 4.60, suggesting that users overall are satisfied with their experience using the system. Nielsen's Heuristics (F) received a mean value of 4.61, indicating that the system adheres well to Nielsen's usability heuristics, which are guidelines for designing user-friendly interfaces.

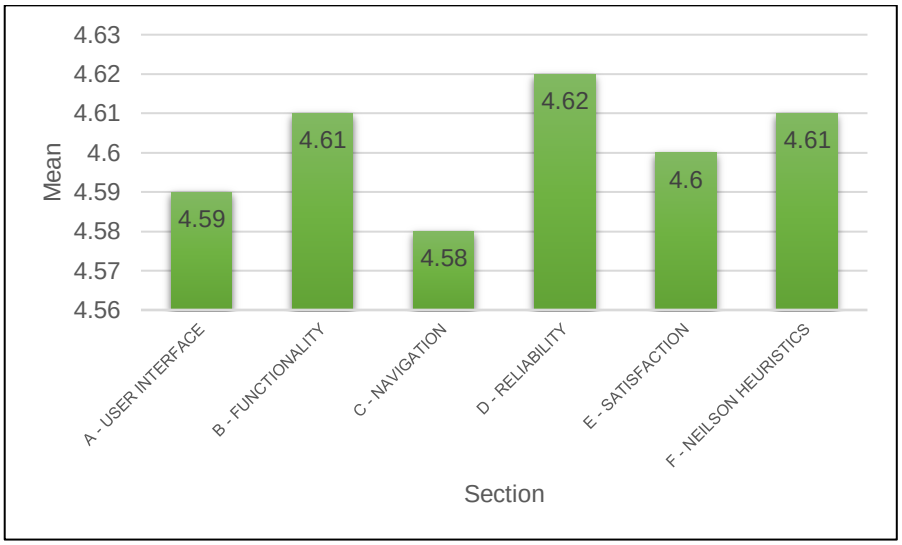

Figure 9. The mean value for all constructs

Figure 9 shows the graph representation of the mean value for all constructs. In summary, these results suggest that the system generally performs well across various aspects evaluated, with users expressing high levels of satisfaction, particularly in terms of functionality, reliability, and adherence to usability heuristics. The high mean values show the system effectively meets user expectations. Users are very satisfied with the system's functionality and its ability to efficiently perform tasks has pleased users. Additionally, reliability is crucial for user experience, and positive feedback indicates the system is dependable, enhancing user satisfaction and trust. Users have also praised the system's adherence to usability heuristics, which ensure the system is easy to use and intuitive. Positive feedback here suggests the system effectively meets these criteria, resulting in a positive user experience. However, the slight areas for improvement in UI design represent an opportunity to enhance the overall user experience and ensure that the system continues to meet user needs effectively. Further refinement in UI design will help in maintaining the system's positive trajectory and ensuring continued user satisfaction.

5. Conclusion

The procurement system was developed to streamline the procurement process for the gym and fitness center for this case study, aiming to reduce cycle time and enhance management efficiency through systematic recording of procurement activities. The adapted waterfall model guided the project to ensure timely completion and achievement of objectives. These objectives included identifying procurement issues, developing a system with the implementation of Nielsen's heuristics, and evaluating the system in terms of its functionality and usability. The findings indicate that the system aligns effectively with Nielsen's heuristics, which serve as guidelines for crafting user-friendly interfaces. By prioritizing usability, efficiency, and user satisfaction, the system holds the promise of optimizing procurement activities, reducing errors, and ultimately bolstering the overall operation of the fitness center.

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Conflict of Interest

The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript.

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