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Applying User Centered Design and System Usability Scale to Design Knowledge Management System for Exam Proctors in Higher Education

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Abstract.
Purpose: This research aims to develop a system interface design solution to address the university's knowledge management problem with exam proctors. Developing a knowledge management system is expected to maintain the integrity of examinees and reduce the risk of plagiarism. This research identifies user needs in business processes and maps them to relevant features based on previous research.
Methods: This research adopted a user-centered design methodology in developing interface design solutions, which consisted of four stages: understanding the context of use, specifying user requirements, designing solutions, and evaluating against requirements. Semi-structured interviews were used for data collection, and a system usability scale (SUS) questionnaire was employed for design solution evaluation.
Result: This research identified the needs of business processes in higher education in the context of exam proctors and mapped them to a suitable feature solution. Recommendations for information architecture and knowledge management system design implementation in higher education were also provided. This research achieved a SUS score of 74.8, indicating that the developed system met users' needs.
Novelty: This research provides a practical implementation of developing a knowledge management system in higher education with user-centered design.

Keywords: Knowledge management system, higher education, problems, solutions, user-centered design, system usability scale
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INTRODUCTION

Higher education institutions rely on various organizations with members responsible for specific tasks, which often require effective knowledge-sharing to ensure continuity and enable performance evaluation [1]–[3]. However, knowledge-sharing requires a suitable medium to facilitate the process [4]. Knowledge management (KM), often implemented through knowledge management systems (KMS), provides a centralized platform to manage knowledge resources by enabling creation, storage, and dissemination [5], [6]. KMS is essential for improving efficiency and preserving best practices in organizational contexts.

At the Faculty of Computer Science, University of Indonesia (Fasilkom UI), exam proctors are critical in ensuring the integrity and smooth execution of midterm and final exams. Their responsibilities include overseeing exam sessions, enforcing compliance with rules, and addressing issues such as plagiarism. However, the rotational assignment of proctors results in inconsistencies in preparation and knowledge-sharing due to the absence of a system for documenting and sharing best practices. This inconsistency compromises the enforcement of exam rules, increases the likelihood of operational errors, and diminishes the overall quality of exam supervision. For example, proctors may fail to enforce plagiarism policies uniformly, leading to discrepancies in handling academic misconduct or mismanaging exam schedules, causing delays and confusion. Such failures disrupt the exam process and undermine the institution's academic credibility.

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Currently, proctor management at Fasilkom UI relies on manual tools such as Google Drive, Google Sheets, and WhatsApp. This inefficient approach requires the assistant board manager to contact proctors individually to confirm availability and attendance, resulting in significant administrative burdens. Furthermore, the lack of a centralized platform prevents the systematic documentation of experiences and solutions, limiting future proctors' ability to benefit from prior knowledge and practices. Addressing these challenges requires an innovative and scalable solution that enhances knowledge-sharing, reduces administrative workload, and ensures consistent exam supervision.

Previous studies have demonstrated the role of KMS in enhancing organizational processes within higher education. For instance, KMS has been used to improve efficiency and facilitate process evaluation in university counseling organizations in the Philippines by systematically documenting problems and solutions [7]. Similarly, Sensuse et al. [8] developed a KMS for teaching assistant management at Fasilkom UI, introducing features that encourage active participation, streamline document management, and clarify stakeholder roles. Other research highlights the potential of KMS for problem-solving and knowledge-sharing, emphasizing the importance of structured documentation to evaluate processes and address recurring challenges [9]. Innovative features like gamification have also been used to incentivize knowledge-sharing [1], while centralized storage makes expertise more accessible to faculty and staff [10]. These findings demonstrate the versatility of KMS in addressing diverse challenges within higher education environments.

Despite these advancements, few studies have addressed specific business processes in higher education, such as exam proctor management. This study seeks to fill this gap by designing a KMS tailored to the unique context of Fasilkom UI. The proposed KMS aims to centralize proctor-related information with automated scheduling, availability tracking, and streamlined communication to reduce manual workload and minimize errors. Additionally, it will serve as a repository for knowledge-sharing, enabling previous proctors to document their experiences and solutions and creating a knowledge base that is accessible to future proctors. By facilitating consistent knowledge-sharing and improving operational efficiency, the KMS is expected to enhance the overall quality of exam supervision while upholding academic integrity.

To ensure the system meets the specific needs of stakeholders, this study adopts a User-Centered Design (UCD) approach. UCD emphasizes understanding users' needs, experiences, and constraints through iterative feedback and collaboration. Key stakeholders, including exam proctors, teaching assistant coordinators, and student volunteers, are actively involved in the design process to ensure the system is adaptive and relevant [11]. UCD enables the system to evolve based on user input, ensuring its usability and continued relevance [12]. By integrating UCD principles with the capabilities of KMS, the proposed system addresses immediate operational challenges and supports the institution's broader goal of maintaining high academic standards.

This research builds upon previous studies on KMS development, particularly those addressing challenges similar to managing exam proctors at Fasilkom UI. By focusing on the specific context of exam proctors at the faculty, this study addresses the research gap identified in the work of Sensuse et al. [8]. It also draws on insights from Lee et al. [7] and Ahn & Choi [9] to develop the proposed KMS features. Accordingly, this study seeks to answer the following research questions:
Q1: What are the problems of exam proctors in sharing knowledge through experience?
Q2: What are the features of the knowledge management system that can be a solution to identified obstacles?
Q3: How is the proposed knowledge management system's information architecture and design implementation?

METHODS

This research uses a user-centered design (UCD) methodology to develop interface design solutions with one iteration. UCD was chosen because it enables a structured exploration of user needs and behaviors, ensuring the developed system aligns directly with those needs. Compared to other methodologies, UCD emphasizes iterative feedback and user involvement, making it highly suitable for addressing the operational challenges of KMS in educational settings, such as those faced by exam proctors [13]. Using a user-centered method, the authors can explore and dig deeper into the problems users face before providing system solutions [14], [15]. This methodology is also used to identify features needed by users to be implemented in the KMS [16], [17]. Although this research only used one iteration, the system solution

was developed based on the stakeholders' proposed features. The UCD methodology provides a comprehensive framework that ensures the solutions are grounded in real user problems and validated through feedback loops.

The UCD methodology consists of four stages, as illustrated in Figure 1, understanding the context of use, specifying user requirements, designing solutions, and evaluating against requirements. Each stage is detailed below to ensure clarity and replicability.

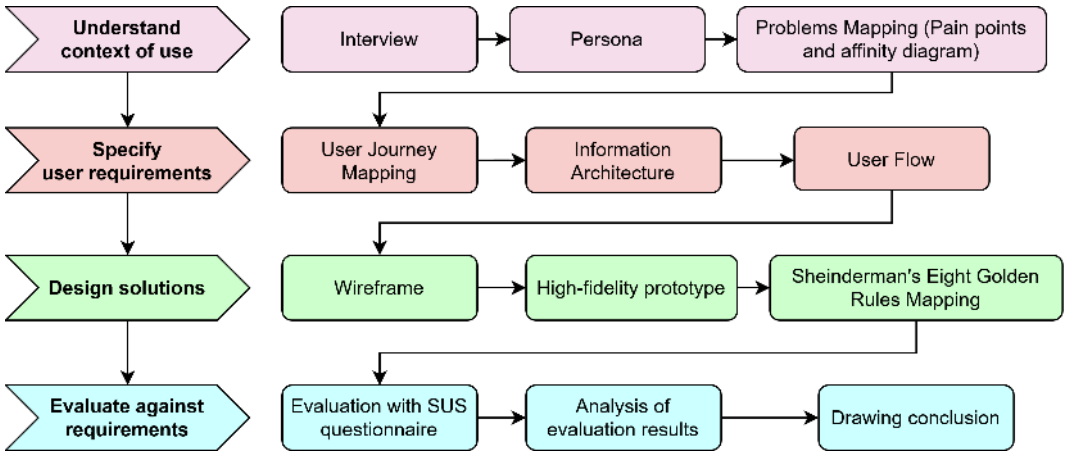

Figure 1. User-centered design steps

The first stage is understanding the context of use. A qualitative approach was employed at this stage, primarily through semi-structured interviews, to gather in-depth insights into user needs, challenges, and preferences. Participants were selected using purposive sampling to ensure they had relevant experience with the exam proctoring process [15]. The participant pool consisted of exam proctors, assistant institutions, and course teaching assistant coordinators. Each participant provided a unique perspective on their roles and challenges. The interview guide included questions covering roles, specific challenges, case scenarios, recommendations, feature needs, and willingness to adapt to new solutions. The results of these interviews were used to create personas that represented the main characteristics of each user group [16]. Afterward, the authors performed problem mapping by defining the pain points identified from the interviews and aligning them with proposed solutions and relevant features. The authors also created affinity diagrams to categorize and connect the identified problems in a broader context to address user needs effectively [17].

After understanding the user context, the second stage is to specify user requirements. This involves creating a user journey that describes the steps or interactions users take to achieve a goal [18]. Then, an information architecture is designed to help organize and manage information efficiently so that users can easily understand the proposed design of KMS [19]. Finally, this stage also creates a user flow to visualize the expected flow of users using the product or system [20].

The third stage is designing solutions. This step involves the process of developing interface design solutions based on the findings from the previous phase. The authors utilize the Figma application to create wireframes and high-fidelity prototypes. In this study, the principles of Shneiderman's Eight Golden Rules were applied and adapted to address the exam proctoring process's specific requirements, forming the interface design's foundation. Shneiderman's Eight Golden Rules are basic guidelines proposed by Ben Shneiderman for creating effective and user-friendly interface designs [21]. These principles include striving for consistency, enabling frequent users to use shortcuts, offering informative feedback, designing dialogs to yield closure, offering simple error handling, permitting easy reversal of actions, supporting internal locus of control, and reducing short-term memory load [21].

Key adaptations were made to tailor Shneiderman's principles to the context of KMS for exam proctors. For instance, "permit easy reversal of actions" was implemented in the Repository feature to allow users to return to the document list during uploads. The Assign Proctors feature applied "offer simple error handling" by using drop-down menus that prevent double assignments. Additionally, "support internal

locus of control" was enhanced in the Exam Proctors feature, enabling users to manage their schedules independently. These modifications ensure the principles address the unique needs of exam proctoring efficiently.

The last stage is to evaluate against requirements. This stage involves assessing the designed solution to meet the user's needs. The evaluation uses the System Usability Scale (SUS), a standard method for measuring system usability. Participants for the SUS evaluation were recruited through purposive sampling, focusing on students of the Faculty of Computer Science, University of Indonesia, who had proctored exams at least once. This ensured the participants had adequate context to provide meaningful feedback. The SUS questionnaire contained 10 items scored on a Likert scale ranging from strongly disagree (1) to strongly agree (5) [22]. Data was processed using Microsoft Excel, where each participant's responses were converted into an overall SUS score using a standard formula. From the results of this analysis, further improvements or enhancements can be made to improve the quality and user engagement of the designed product or system [23].

RESULTS AND DISCUSSIONS

At this stage, the authors will explain the application development results. The explanation of the results will be divided based on the steps of user-centered design. In this section, the authors will also attach visualizations of the stages, such as information architecture, personas, user journey, user flow, and application design.

Understand the context of use

The first step in UCD is to understand the user context first. The authors used the interview method to identify user problems with the exam proctor knowledge management business process. Interviews were conducted with five participants: one assistant institute administrator, one course assistant coordinator, and three exam proctors who had experienced problems while proctoring exams. The five participants represent each stakeholder whose business processes will be facilitated by the system to be developed. After conducting interviews and creating interview transcript data, the authors mapped user roles by creating personas. The participant mapping was carried out by making three different personas. Figure 2 shows the persona of the lecturer assistant coordinator.

Figure 2. Persona of lecture assistant coordinator

After defining three different personas, the authors identified the primary triggers of each user's needs and problems, providing valuable insights into the challenges of managing exam proctors. The interviews highlighted several critical issues. First, the current manual process of assigning proctors using Google

Sheets and WhatsApp was described as time-consuming and prone to errors, with proctors often missing important updates due to fragmented communication channels. This finding informed the development of the Assign Proctors and Notification features, which aim to streamline scheduling and ensure timely updates. Second, proctors, particularly new ones, faced difficulty accessing clear and consistent guidelines for their responsibilities. For instance, exam proctors often experienced delays in preparation because they needed to consult multiple individuals for clarification, underscoring the lack of centralized and easily accessible guidelines. To address this, the Repository feature was proposed to centralize access to documents such as Standard Operating Procedures (SOPs) and anti-plagiarism protocols, ensuring clarity and efficiency. Third, the absence of a system to document and share experiences, such as handling plagiarism cases, emerged as a significant concern. Proctors expressed frustration at the lack of resources to help them manage unique situations, emphasizing the need for knowledge continuity. The Lesson Learned feature was therefore designed to enable proctors to record and share exceptional cases and their resolutions, improving preparedness for similar issues in the future. Additionally, frequent repetitive questions about proctoring responsibilities created inefficiencies for both administrators and proctors. To mitigate this, the FAQ feature was developed to centralize and streamline answers to common questions. Lastly, managing accurate proctor data, including availability and contact information, was identified as a significant challenge by coordinators. The Exam Proctor Details feature was designed to centralize proctor information for easier access and management. These findings directly informed the development of the proposed KMS features, as summarized in Table 1. The mapping of user needs to specific features addresses RQ1 by identifying critical user problems and RQ2 by proposing tailored solutions, demonstrating how the user context was central to the system's design.

Table 1. Problems and user needs with proposed solutions

Trigger Question	Problems/Needs	Proposed Solution	Features	Classification
How do you centrally provide information to exam proctors?	The current management of exam proctors is not practical because it is done manually with Google Spreadsheets.	Provide exam proctor assignment feature.	Assign Exam Proctors	Knowledge Sharing System
	Assistant Institution administrators have to manually contact exam proctors to confirm attendance one by one via WhatsApp.	Provide a confirmation feature for assigned test proctors.	Confirm Exam Proctors	Knowledge Sharing System
	Proctors find it challenging to see their schedules due to the large number of exam schedules on the same sheet.	Create features filtering on the list of exam proctors that enable users to filter data based on courses and exam schedules.	List & Filter Exam Proctors	Knowledge Sharing System
	Data collection of proctors from each course is done by contacting each teaching assistant coordinator, so it takes much time.	Provide a notification feature to request the course coordinator to fill in the exam proctor requirement.	Notification	Knowledge Sharing System
	Exam proctor registration is currently still separate on Google Forms.	Provides an exam proctor registration feature that stores exam proctors' data.	Exam Proctors Registration	Knowledge Discovery System
How can exam proctors know what to do?	Guidance is needed for exam proctors, especially for new proctors.	Provide a repository feature to store SOPs and other guidance documents for exam proctors.	Repository	Knowledge Sharing System
	There is no place to store lessons learned related to causal cases during the exam or actions that must be taken in some instances.	Provide a lesson learned feature for each test proctor who experienced a particular case and a template for documenting their experience.	Lesson Learned	Knowledge Capture System
	Many questions are redundant in the large group of Exam Proctors, so some questions need to be answered and answered.	Provide an FAQ feature to display a list of questions and answers.	FAQ	Knowledge Application System

		Provide detailed assignment features of each exam proctor according to specific courses.	Task Details	Knowledge Discovery System
How do you get the proctor's contact information and contact him?	It is challenging to find exam proctor data because there is no centralized database.	Provide a contact list of registered exam proctors	Exam Proctor Details	Knowledge Discovery System
	There is a lack of media links between exam proctors and lecturers, so exam proctors have difficulty with the technicalities of exam proctors.	Provide a liaison between the course assistant lecturer coordinator and the exam proctor.	Task Details	Knowledge Discovery System

As an additional explanation of the mapping, the authors classify each proposed feature with KM Process [24]. This classification is distinguished based on each feature's purpose in solving the problems found. Two examples are the Lesson Learned and Repository feature. Lesson Learned feature could classified as the knowledge discovery, knowledge capture, or knowledge sharing process [1]. However, the authors chose knowledge capture because the Lesson Learned feature in the developed KMS serves as a database of the exam supervisor's experience, making it easily accessible in the future [24], [25]. Then, the Repository feature can be classified into knowledge discovery and sharing systems. The purpose of developing the Repository feature is to share knowledge about the exam supervisor guide to increase user understanding and knowledge [26], [27]. This goal aligns with the knowledge-sharing system, which focuses on disseminating and exchanging pre-existing knowledge [26]. Meanwhile, knowledge discovery systems use analytical methods to identify patterns to build new, more complex knowledge [27]. Therefore, the authors classify the Repository feature as a knowledge-sharing system.

Specify user requirements

The next stage in UCD is to specify user requirements, which begins with creating user journeys for each persona. These journeys were developed based on insights from interviews, highlighting the distinct challenges and needs each user role involved in the exam proctoring process faced. The first user journey focuses on the exam proctor persona, emphasizing their need to understand their duties before and during exams. Interviews revealed that proctors, particularly new ones, often struggled with unclear responsibilities and lacked access to centralized guidance, resulting in delays and confusion. Proctors frequently mentioned relying on multiple individuals for clarification, which hindered their preparation. This journey informed the development of features like the Repository, Lesson Learned, and FAQ, designed to provide access to guidance documents, share knowledge from past cases, and address common questions efficiently. The complete user journey can be accessed at https://bit.ly/KMS_UserJourney, showing exam proctors' steps to access essential information and effectively prepare for their duties.

The second user journey addresses the assistant board manager persona, whose primary responsibility is assigning exam proctors to schedules. Interviews highlighted significant inefficiencies in this process, which was managed manually using tools like Google Sheets and WhatsApp. These methods often led to scheduling conflicts, communication delays, and increased administrative workload. This journey maps the steps in collecting proctor availability, assigning proctors to specific exams, and confirming their attendance. The challenges identified in this process guided the design of the Assign Proctors, Notification, and Exam Proctor Details features, which automate scheduling, streamline communication, and centralize proctor information to enhance efficiency and reduce errors.

The third user journey focuses on the assistant lecturer coordinator persona, who provides exam proctors with critical information about course-specific rules and exam procedures. Interviews revealed that the lack of a centralized system often led to miscommunication or missing information, as coordinators relied on fragmented methods like WhatsApp groups to share details. This journey involves uploading exam guidelines, sharing special requirements, and responding to proctor inquiries. These insights informed the development of the Task and Notification features, which ensure that proctors receive timely and organized information, enabling them to perform their duties effectively.

By mapping these user journeys, the authors identified key inefficiencies and gaps in the current processes while aligning system requirements with the unique needs of each persona [28]. These journeys provided a comprehensive understanding of user behavior, translating their challenges into actionable features that

form the foundation of the proposed knowledge management system. This approach ensures that the KMS addresses individual user needs and enhances the overall proctoring process by improving efficiency, communication, and knowledge sharing.

To further address RQ3, the authors developed an information architecture consolidating the proposed features into a coherent system. This architecture organizes seven key features derived from the problem and solution mapping results. For example, the FAQ, Task, and Repository features aim to integrate explicit knowledge from exam proctors, making it easily accessible for current and future use. Meanwhile, the Lesson Learned feature facilitates the sharing of tacit knowledge based on individual experiences, such as resolving plagiarism cases, ensuring that critical insights are preserved and shared effectively [1], [8], [26]. Figure 3 visualizes the information architecture, with role-based access control to maintain data security and confidentiality. This step highlights how insights from user journeys directly informed the system's design, ensuring the architecture aligns with identified user needs and effectively addresses RQ3.

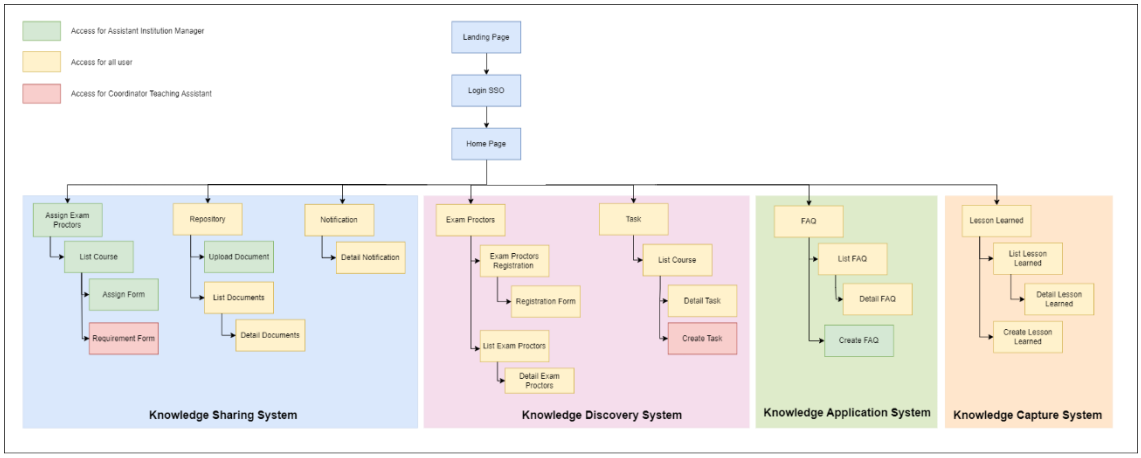

Figure 3. Information architecture

Building on this, the authors created user flows to detail how users interact with the system to achieve their goals efficiently [29]. Seven user flows were designed based on the main features identified in the information architecture. However, this study emphasizes the most critical functionalities. As an example, Figure 4 illustrates the user flow of the Exam Proctor feature, which includes essential processes like listing exam proctors, viewing details, completing the registration form, and confirming schedules. The complete set of user flows can be accessed at https://bit.ly/KMS_UserFlow. These prioritized features ensure clarity and focus, laying a robust foundation for the next stage of interface design development.

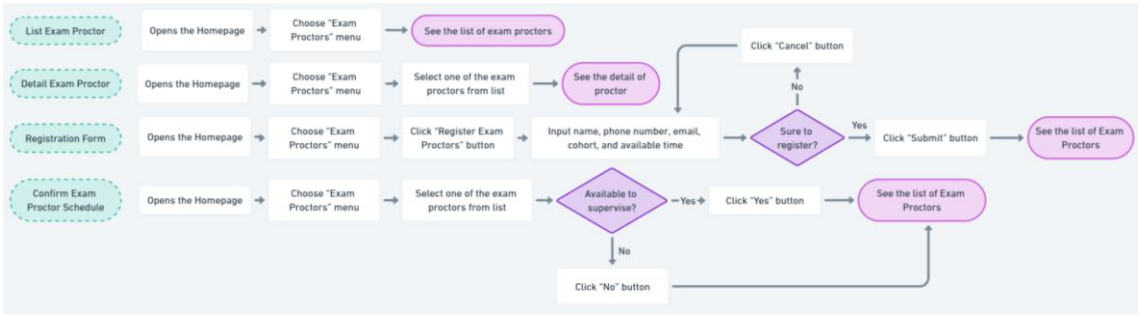

Figure 4. The user flow of exam proctors feature

Design solutions

The next stage of UCD involves creating interface design solutions and translating user research findings into actionable system features. The design process began with developing wireframes, which served as initial drafts for the system's interface. These wireframes were refined into a high-fidelity prototype to provide a detailed visual representation of the system's functionality. Wireframes are made with black, gray, and white color components as essential illustrations of design development. Next, the authors gave the wireframe actual colors, icons, and shapes to become a high-fidelity prototype. Implementing the high-

fidelity prototype design aims to answer RQ3 as a recommendation for the proposed system solution to solve user problems. Shneiderman's eight golden rules were applied to ensure usability and consistency across the interface [30]. For instance, the principle of "strive for consistency" was implemented through uniform text colors, button styles, and navigation elements, creating a seamless user experience [21]. The final design results can be accessed at https://bit.ly/KMS_CompletedDesign.

The high-fidelity prototype integrates seven key features from the challenges identified during user interviews. These interviews highlighted inefficiencies and pain points in the exam proctoring process, informing the design of solutions tailored to user needs. For example, the Repository feature was developed in response to feedback from proctors who lacked access to centralized guidelines, resulting in delays and confusion. This feature centralizes essential documents, such as Standard Operating Procedures (SOPs) and exam regulations, providing consistent and timely access to necessary resources [8]. Additionally, the feature incorporates a form interface that adheres to the principle of "permit easy reversal of actions," allowing users to navigate back to the repository list page by clicking the Cancel button if they choose not to upload a document [18]. By addressing the need for clear and accessible guidance, the Repository feature enhances efficiency during exam preparation. The complete Repository feature design can be accessed at https://bit.ly/KMS_Repository, highlighting its intuitive structure and functionality.

Complementing the Repository, the system's main page is designed to enhance user accessibility and efficiency. The system's main page features a welcoming landing page and a home page that displays the user's name and role, granting specific access based on their responsibilities. This design applies the principle of "enable frequent users to use shortcuts" from Shneiderman's rules by including an exam proctor registration button on the home page. This feature allows users to fill in the registration form efficiently, eliminating the need to navigate multiple pages to access this functionality [18]. The complete design of the system's main page can be accessed at https://bit.ly/KMS_HomePage. These features demonstrate how the system's design aligns with user needs, ensuring usability and functionality.

The Assign Exam Proctors feature directly addresses critical requirements identified during analyzing user needs and challenges. Assistant board managers highlighted the inefficiency of existing manual assignment processes, which often resulted in scheduling conflicts, increased administrative workloads, and delays in communication [7], [9]. These challenges emphasized the need for a centralized and automated system to streamline the assignment of exam proctors.

In line with user requirements, the feature includes several functionalities designed to resolve these pain points. The course list view consolidates all courses and exam schedules, providing an organized repository of assignment information. This directly meets the need for easier access to assignment data, as identified in earlier interviews. Additionally, the requirement form enables teaching assistant coordinators to submit their specific proctoring needs, improving communication and reducing errors in information transfer.

The assign form further simplifies the process by using a drop-down menu that displays only the names of available students. This feature prevents double assignments, adhering to Shneiderman's principle of "offer simple error handling" [18]. Such automation minimizes errors and ensures an efficient allocation of resources, directly addressing the requirement for reducing administrative burdens. Moreover, this feature integrates seamlessly with the overall system requirements derived from interviews. By centralizing assignment management, the Assign Exam Proctors feature supports broader goals of improving scheduling efficiency and enhancing stakeholder collaboration. Figure 5 displays the Assign Exam Proctors feature, showcasing how it translates user requirements into an intuitive and practical design.

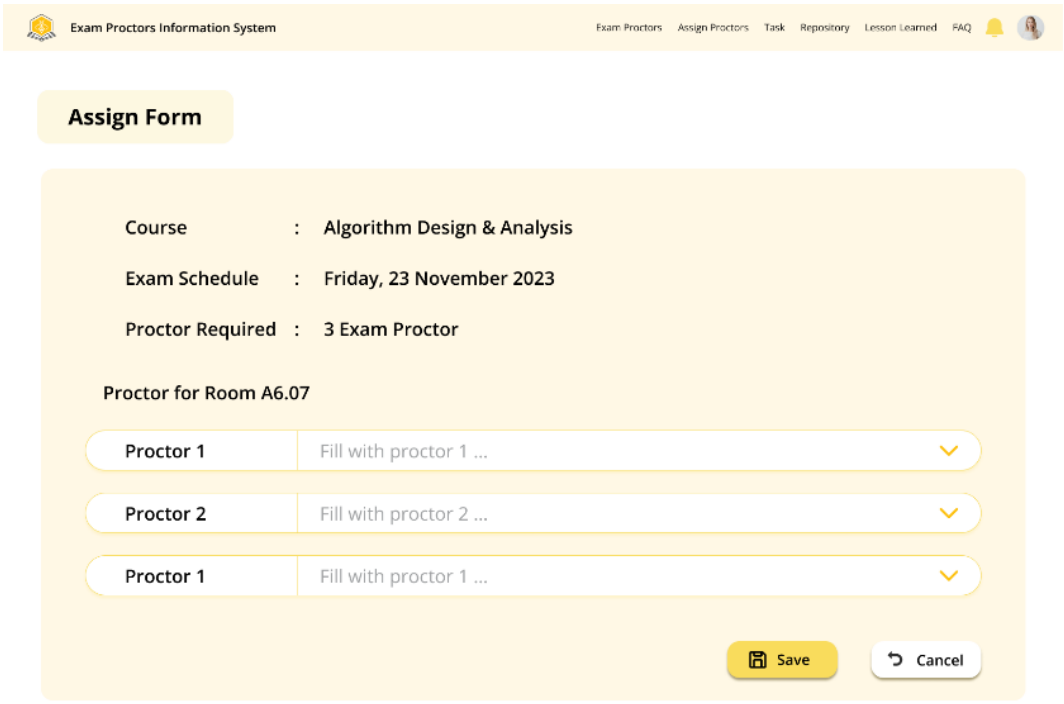

Figure 5. Display of assigned exam proctors feature

Based on the results of identifying user needs, registering and collecting data on exam proctor applicants is still carried out manually by the assistant institution of Fasilkom UI. Then, the confirmation of the registrant's willingness is also still done manually. These needs are relevant to the features proposed in previous research, namely features that provide a specific assignment for individuals [7]. In this study, the authors propose a feature that includes registration activities, status checking for attendance confirmation, and a list of exam proctors. The authors named Exam Proctors the proposed feature.

Figure 6 shows the exam proctor feature that all system users can view. The feature also has an exam proctor list page, exam details for each course and an exam proctor registration form. On the course exam details page, each proctor must confirm that they can proctor the exam, and the confirmation status will be visible on the exam proctor list page. The confirmation status applies the "design dialogue to yield closure" principle on Shneinderman's rule by displaying feedback on the user's confirmation action [18]. On the exam proctor list page, filtering allows sorting by specific exam dates. Then, on the registration form, students who want to become exam proctors can fill in only the schedule they are available for. The schedule selection applies the principle of "support internal locus of control" which gives the exam proctor full authorsity to determine their schedule on the checkbox in the registration form [18].

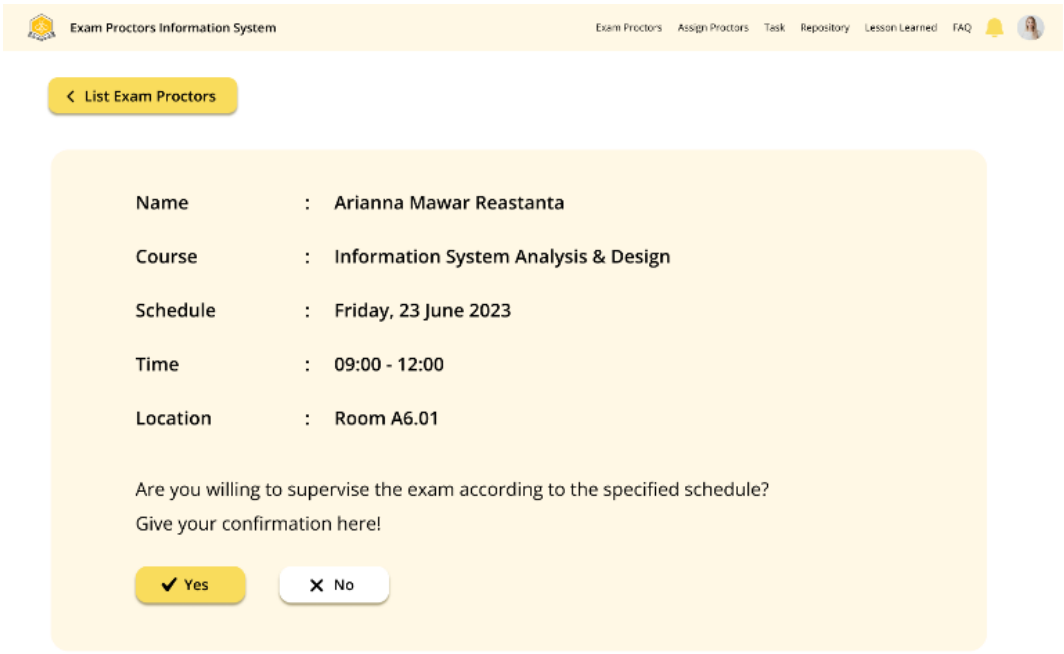

Figure 6. Exam proctors feature view

Based on the results of identifying user needs, registering and collecting data on exam proctor applicants is still carried out manually by the assistant institution of Fasilkom UI. Confirmation of the registrant's willingness is also managed manually, leading to inefficiencies and communication gaps. These challenges align with the features proposed in previous research, which advocate for tools that provide specific assignments for individuals [7]. The authors propose the Exam Proctors feature, encompassing registration activities, attendance confirmation, and a centralized list of exam proctors to address this. This feature streamlines the management process by allowing students to register their availability and confirm their assignments through an intuitive interface. The confirmation status is displayed on the exam proctor list page, adhering to Shneiderman's "design dialogue to yield closure" principle by providing feedback on user actions [18]. Additionally, the filtering functionality on the list page enables users to sort data by specific exam dates, while the registration form empowers proctors to select their schedules, reflecting the principle of "support internal locus of control" [18].

Complementing this, the Lesson Learned feature was introduced to address the frustrations of proctors who struggled to handle unique cases, such as plagiarism incidents, due to the lack of prior knowledge or guidance. This feature captures and shares tacit knowledge by documenting exceptional cases and their resolutions, ensuring continuity of expertise. By equipping proctors with insights from past experiences, this feature enhances their preparedness and supports the integrity and smooth execution of the exam process. The complete design of the Lesson Learned feature can be accessed at https://bit.ly/KMS_LessonLearned, ensures knowledge sharing and retention, further strengthening the system's ability to address user needs effectively.

Based on the results of identifying user needs, many exam proctors are first-time proctors who often struggle to understand their tasks. This uncertainty leads to frequent, repetitive questions, creating inefficiencies in communication and delays in preparation. These needs align with features proposed in previous research, such as discussion forums, customer help desks, issue management systems, and lessons learned [8], [9]. To address this, the authors designed the Frequently Asked Question (FAQ) feature, consolidating answers to common queries, providing immediate solutions for proctors, and reducing the communication burden on administrators.

The FAQ feature includes three views: the FAQ list, FAQ details, and FAQ form. The FAQ list page allows proctors to search for answers efficiently, while the FAQ detail page displays comprehensive explanations for each query. Additionally, the assistant institution can create and update FAQs by summarizing

experiences documented in the Lesson Learned feature. This approach ensures that recurring issues are systematically addressed and accessible to all users. The design of the FAQ feature applies the principle of "reducing short-term memory load" by centralizing and summarizing common questions, thereby improving usability and accessibility [18].

Furthermore, the FAQ feature complements the Task feature, developed to address miscommunication regarding course-specific exam requirements. The Task feature provides detailed instructions for each course, ensuring proctors are fully informed about their responsibilities. This integration of features fosters better communication, prevents errors, and enhances the overall proctoring experience. The complete design of the FAQ feature can be accessed at https://bit.ly/KMS_FAQDesign, highlighting its role in simplifying information access and promoting efficiency.

The Notification feature was designed to address recurring issues of miscommunication and missed updates between assistant board managers and exam proctors, particularly regarding attendance confirmations. Often, proctors unintentionally overlook private messages from assistant institutions, resulting in significant information gaps. To mitigate these challenges, the Notification feature provides timely reminders for tasks such as confirming attendance and submitting proctor requirements. This feature applies the "offer informative feedback" principle in Shneiderman's rules, distinguishing read notifications with yellow color and unread ones with white, enhancing user awareness and ensuring important updates are not missed [18]. The complete design of the Notification feature can be accessed at https://bit.ly/KMS_Notification, showcasing its ability to keep users informed and minimize disruptions in proctor management. By ensuring consistent and timely communication, this feature resolves inefficiencies in the proctoring process and aligns system functionalities with identified user needs.

Each feature has a significant impact on improving the exam proctoring process. Automating manual tasks and centralizing information reduces administrative burdens and enhances operational efficiency. Features like Repository, Lesson Learned, and FAQ promote seamless knowledge sharing, ensuring both new and experienced proctors are adequately prepared. Additionally, the documentation of unique cases and the provision of clear guidelines contribute to maintaining exam integrity and minimizing errors.

The proposed KMS demonstrates how a user-centered design approach can effectively address operational challenges in higher education by linking user needs to specific features and emphasizing their impact. The high-fidelity prototype not only meets the objectives outlined in RQ1 and RQ2 but also offers valuable insights into the potential of knowledge management systems to enhance efficiency, communication, and knowledge sharing within academic institutions.

Evaluation of prototype application

The prototype that has been made will be tested on potential users of the system using the system usability scale (SUS) questionnaire. Participants who filled out this questionnaire were selected by purposive sampling, namely students of the Faculty of Computer Science, University of Indonesia, who had proctored the exam at least once. Purposive sampling was chosen so that participants could use the context of the system being developed to increase the validity of the research data [31]. Participants filled out a questionnaire sent online after trying to explore the high-fidelity prototype system.

Thirty-five participants filled out the questionnaire and met the participant needs for the SUS evaluation, which is a minimum of 30 participants [22], [32]. Next, the authors calculate the SUS evaluation data obtained with Microsoft Excel. Data processing was carried out by calculating the SUS score of each participant using the following formula where QX is the Xth SUS question:

$$\text{SUS Score} = \big((\text{Q1-1}) + (\text{5-Q2}) + (\text{Q3-1}) + (\text{5-Q4}) + (\text{Q5-1}) + (\text{5-Q6}) + (\text{Q7-1}) + (\text{5-Q8}) + (\text{Q9-1}) + (\text{5-Q10})\big) \times 2.5 \quad (1)$$

Details of the SUS evaluation data can be seen in Table A1. At the end of data processing, 74.8 was obtained as the average score of 41 participants. Conversion of the average number score to letter score received, the letter grade of SUS Exam Proctor Information System is B with the nature of "Good" the level of acceptance is "Acceptable" and the level of user satisfaction can be put into "Passive" [22]. In addition, by comparing the average value of the SUS score, the Exam Proctor Information System is above the average value of 68 [22].

The SUS evaluation highlights several key insights that provide a deeper understanding of the system's usability. Firstly, the SUS score of 74.8, classified as "Good" with a letter grade of B, indicates that users generally find the system intuitive and straightforward to navigate. Features such as the Repository and Notification, designed to address critical issues like miscommunication and the absence of centralized guidelines, resonate well with users. These features were specifically developed to tackle common pain points identified during interviews, suggesting that the system effectively meets many user needs. However, despite this positive reception, there are areas for improvement. The SUS score, while acceptable, categorized user satisfaction as "Passive", indicating that certain aspects of the system, such as interface design and responsiveness, could benefit from further refinement [22]. This suggests that while the system is functional and usable, there is potential to enhance the overall user experience by addressing these weaker areas. The SUS score also serves as an important benchmark for future development iterations. It clearly measures where the system currently stands and highlights growth opportunities. Future efforts should include usability testing with a broader and more diverse group of users to gather comprehensive feedback. This approach will allow for targeted enhancements that align more closely with user expectations, ultimately optimizing the system's usability and effectiveness. By integrating these findings into ongoing development, the system can evolve to meet higher user satisfaction and performance standards.

CONCLUSION

This study addresses the development of a KMS for exam supervisors at the Faculty of Computer Science, University of Indonesia, using a UCD methodology. By systematically addressing the research questions, the study identified critical challenges in managing exam supervisors, such as inefficiencies in communication, lack of centralized documentation, and inconsistencies in knowledge-sharing to answer RQ1. These challenges were mapped into 11 features that align with key knowledge management processes, forming the basis of the proposed KMS design to answer RQ2. The information architecture and high-fidelity prototype were developed to visualize the system, incorporating user personas, journeys, and flows to answer RQ3. The resulting design achieved a SUS score 74.8, demonstrating acceptable usability and potential alignment with user needs.

This research contributes to the body of knowledge by demonstrating the practical application of UCD in addressing operational inefficiencies and enhancing knowledge-sharing in higher education. The findings emphasize the importance of integrating user feedback to create centralized systems that improve collaboration, reduce administrative burdens, and maintain operational consistency. Beyond its immediate context, the proposed approach and findings have broader implications for developing similar solutions in other academic or organizational domains.

However, this study has limitations, including restricted user participation due to time constraints and the absence of iterative usability testing. Additionally, the focus on a single faculty necessitates adaptation for broader applicability. Despite these constraints, the research lays a strong foundation for future work. Future research could implement the high-fidelity prototype as a web-based application, conduct extensive usability testing for refinement, and explore alternative methodologies for system development. Expanding the context and validating the system in diverse settings will further enhance its relevance and impact.

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