Manual Clustering Approach for User Group Mapping in Facility Management System UI/UX Design

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Abstract

The facility management process at Politeknik Caltex Riau is still conducted manually, using paper media and Excel records, which causes inefficiency, delays, and difficulties in monitoring real-time facility availability. To address these problems, a web-based information system was developed with a UI/UX approach using the Design Thinking method. The uniqueness of this study lies in the use of manual clustering as a user segmentation method during the initial stage, performed based on survey results. This technique resulted in three user groups: (1) active borrowers who need tracking and notifications, (2) infrequent borrowers who require clear information, and (3) non-borrowers who focus more on attractive and easy-to-use interface design. These clusters serve as the foundation for creating personas, defining problem statements, and designing key system features. This study was conducted in two cycles. The first cycle involved initial design and testing, while the second cycle involved iterative improvements based on previous evaluation results. Testing using the System Usability Scale (SUS) showed an increase in scores from 75 to 77. Meanwhile, the User Experience Questionnaire (UEQ) exhibited all dimensions in the positive range (>0.8), with the highest score in Stimulation (2.202) and the lowest in Novelty (1.721). These results demonstrate that the manual clustering approach is effective in identifying user needs contextually and supports the design of an efficient, relevant, and user-friendly system.

Keywords: Design Thinking, Manual Clustering, Facility Management, Web Based System, UI/UX

I. INTRODUCTION

The rapid development of information technology has transformed the way various sectors work, including educational institutions in managing their operations. One of the challenges faced by educational institutions that have various facilities is the process of facility management. This includes aspects such as borrowing queues, process transparency, quality assurance of facility resources, and others. Politeknik Caltex Riau (PCR) is one of the private educational institutions in Riau Province that has various multifunctional facilities available for the entire academic community. These facilities include an auditorium, sports arena (GOR), multipurpose building (GSG), as well as various supporting equipment. Facility management generally supports both academic and non-academic activities.

Currently, the management and borrowing of facilities at PCR still rely on paper media and Microsoft Excel, even though the demand for borrowing is very high and there is no standardized priority for borrowing approval. Students or borrowers must come directly to meet the responsible lecturers and the Facilities and Infrastructure division. This process not only consumes time but also causes other problems such as document loss, recording errors, unclear facility status, and lack of real-time tracking or availability information. As a result, schedule conflicts and delays in processing borrowing requests often occur. Other issues arising from this manual system include lack of transparency, absence of a notification system, and difficulty in managing priorities.

Therefore, a digital system capable of addressing these issues by utilizing current information technology is necessary. This system is expected not only to replace manual processes but also to provide efficient, transparent, and structured solutions in facility management. To design an effective and user-centered system, a very important initial step is to comprehensively collect user requirements.

To address this, an approach focused on deep user understanding is required, one of which is the Design Thinking method. This method places empathy as the foundation in designing solutions, enabling more accurate identification of user needs and characteristics. This method has been widely applied in various contexts such as education, community services, and asset management. Several previous studies show how Design Thinking is used to design solutions centered on user needs.

In the education field, Chairunnisa et al. designed a web-based e-learning UI/UX system to improve student learning motivation at vocational high schools. Data collection was conducted through observation and interviews, while testing was carried out using SUS (score 80.3) and UEQ with excellent category results [1]. Lestari et al. developed a web-based new student registration system at RA Qurrotul 'Uyun using Design Thinking. Data collection was done through interviews with prospective guardians, and the prototype was tested through SUS-based usability testing showing an interface that is easy to use for novice users [2]. Sodik et al. developed a web-based thesis monitoring system. Data was collected via observation and interviews, while UEQ evaluation results showed scores on the pragmatic aspect of 1.97 and hedonic aspect of 1.95, with an attractiveness rating of 1.71 classified as good [3].

In the context of community services, Manaek et al. developed a mobile-based community service application for Rupat District. Data was collected through interviews and field observations, with evaluation using SUS (score 91.15, Best Imaginable category) [4]. Maringka et al. also applied Design Thinking in designing a mobile sports facility booking application. User needs were obtained through observation and interviews, and prototypes were tested by prospective users through usability testing based on direct experience [5].

In management, Zulkifli designed a web-based asset information system using Design Thinking. Data was collected through interviews and document studies, and testing results showed an SUS score of 81 and excellent scores on UEQ [6]. Haryuda et al. designed UI/UX for the web-based Laportea Company e-commerce platform, using interviews and literature studies as the design basis. Evaluation was conducted with usability testing on three user groups (novice, regular, expert) and obtained scores of 91% and a total of 86.1% [7]. Aisyah et al. also applied the Design Thinking method in designing the UI/UX of the Rumah Tahfidz Akhwat Raudhatul Jannah website. Data collection was done through interviews, and the two resulting prototypes were then compared through A/B Testing, Cognitive Walkthrough, SEQ, and UEQ. Evaluation results showed that prototype B was superior in terms of ease of use and user experience [8].

Previous research applying Design Thinking to UI/UX design for facility or service management has largely relied on interviews, literature reviews, and observations to develop user personas. While these approaches offer valuable qualitative insights, they often suffer from subjectivity and lack clearly defined segmentation metrics. Few studies have explicitly incorporated manual clustering techniques alongside Design Thinking to segment users from both qualitative and quantitative survey data, limiting the accuracy of mapping user needs into actionable personas and system features.

This study addresses these limitations by introducing a manual clustering method early in the Design Thinking process to systematically categorize users. Instead of depending exclusively on subjective judgment, the grouping was supported using decision logic implemented in Microsoft Excel, producing more structured and data-informed segmentation. This approach aligns with recent advances demonstrating that integrating machine learning techniques such as clustering and sentiment analysis can enhance qualitative user feedback analysis in Design Thinking, thereby supporting the development of more evidence-based, user-focused solutions [9] .

Additionally, manual and rule-based clustering methods have been effectively applied to segment users in related fields, such as e-learning and small-scale design projects, emphasizing their continued value when handling limited data and prioritizing interpretability. Compared to these contexts, this research innovates by applying a manual clustering strategy specifically to facility management system design, where most previous work still depends heavily on qualitative grouping [10]. The resulting user clusters form the basis for creating targeted personas and designing relevant system features that ensure the facility management system is contextually appropriate and user centered.

II. THEORETICAL BACKGROUND

A. User Interface and User Experience

User Interface (UI) is the visual representation of a digital product commonly used in applications or websites. UI serves as the bridge between users and the product's functionality, facilitating the achievement of desired outcomes through human-machine interaction. UI consists of various elements such as grids, layouts, typography, colors, animations, and microinteractions, combined in a way that creates a good and intuitive interaction experience. Good information architecture is determined by User Experience (UX), which underpins UI design. UX aims to describe and analyze how easily users can use a product, whether in digital form, interface, navigation patterns, or communication. While UI designers focus on the look and feel, UX designers are responsible for defining how the product functions. Besides planning the information architecture, UX also involves various types of research such as surveys, A/B tests, interviews, workshops, and others [11].

B. Design Thinking

Design Thinking is an approach that can transform how we solve problems by focusing on humans, empathy, collaboration, and creativity. By understanding the core principles of Design Thinking, anyone can apply it to face challenges across various fields. Through Design Thinking, the emergence of new ideas, the development of innovative solutions, and the enhancement of user experience become possible. Design Thinking consists of five stages: Empathize, which involves understanding user needs through interviews and observations; Define, formulating the core problem based on findings; Ideate, generating various creative solution ideas; Prototype, creating early representations of the solution; and Testing, where prototypes are tested with users to gather

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feedback and conduct iterative improvements. This approach emphasizes an iterative, user-centered process [12].

C. Stratified Random Sampling

Stratified Random Sampling is a statistical method commonly used in data analysis to ensure a more accurate representation of a diverse population. In this technique, the population is divided into several subgroups or strata based on specific characteristics, such as age groups, income levels, or geographic locations. Each stratum or group is then independently sampled randomly. This technique aims to reduce variance in estimation and produce more reliable results than simple random sampling [13].

D. Manual Clustering

Clustering is a natural process of grouping objects based on the similarity of meaning or attributes. For small datasets and simple criteria, this process can be performed manually through iterative steps, such as matching similar elements and combining them [14]. While clustering-based segmentation techniques have been extensively utilized in recent studies, focusing primarily on algorithmic methods such as K-Means and hierarchical clustering [15][16], there is limited research that integrates Design Thinking with manual clustering to guide persona creation in facility management contexts. This study addresses this gap by employing manual clustering to connect survey-based user segmentation with persona development within the Design Thinking framework, marking its novelty in this domain.

III. RESEARCH METHODOLOGY

We employ a research methodology based on the steps of design thinking, as illustrated in Figure 1.

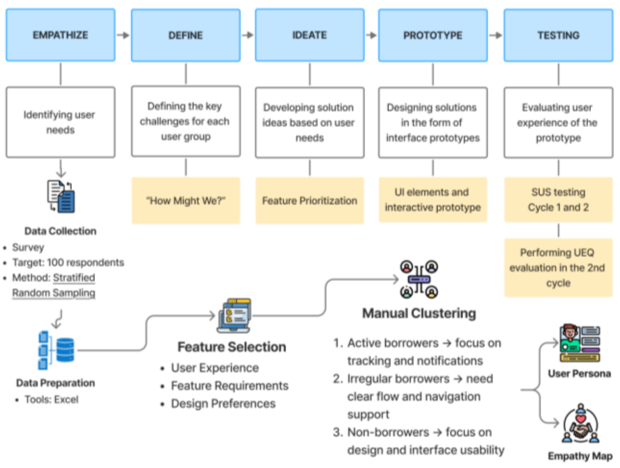

Figure 1. Steps of Design Thinking

A. Iteration 1

1) Emphatize

This stage aims to gain a deep understanding of the problems experienced by users and to identify their needs and expectations regarding the facility management system. The process involved several main steps:

i. Data Collection through Survey

Data collection was carried out using a Google Forms survey distributed to students at Politeknik Caltex Riau. The survey targeted students active in campus organizations during the 2023/2024 academic year, particularly those with experience borrowing campus facilities. The sampling method employed was Stratified Random Sampling, dividing the population into two groups: students who had borrowed facilities and those who had never borrowed.

With a total population of 577 students, the sample size was calculated using Slovin's Formula with a 10% margin of error as shown in Formula 1:

$$n = \frac{N}{1+N\,(e)^2} \tag{1}$$

$$n = \frac{577}{1+577\,(0.1)^2} \approx 85$$

To increase data variability and ensure representativeness, the sample was rounded up to 100 respondents. The sample was then proportionally distributed across the two strata:

- 65 students from the group who had borrowed facilities,
- 35 students from the group who had never borrowed facilities.

The survey consisted of 15 items, combining Likert-scale questions, multiple-choice selections, and open-ended responses. Sample questions included:

- "How frequently do you borrow campus facilities?" with options such as Often (>3 times per month), Sometimes (1–3 times per month), and Rarely (<1 time per month).
- "What is the biggest challenge you face when borrowing facilities?" (information about procedures, slow processes, difficulty tracking the status of borrowed facilities, and others).
- "If a digital system for borrowing facilities were available, which feature would you consider most important?" (facility information access, automatic notifications, easy facility search, and more).

These questions were designed to understand borrowing habits, obstacles encountered, and preferences regarding system features. The survey results later served as the foundation for the manual clustering process.

ii. Analysis with Manual Clustering

In this study, manual clustering is conceptualized as a systematic, rule-guided process for grouping respondents based on decision rules derived from survey data. By employing spreadsheet formulas such as IF, AND, and SEARCH, the segmentation is conducted in a transparent and replicable manner that remains accessible for interpretation, avoiding reliance on complex machine learning models. This approach aligns with content analysis principles emphasizing methodical and transparent procedures to interpret data meaningfully, especially in scenarios where dataset size and

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interpretability are crucial factors, as underscored in foundational research on content analysis methodology [17].

The clustering results identified three main user groups as shown in Table 1:

Table 1. Cluster Classification

Cluster	Main Criteria	User Description
Cluster 1	Frequent Borrowing, Difficulty Tracking Status, Need Notifications	Active users borrowing more than 3 times a month, struggling to track status, and needing automatic notifications.
Cluster 2	Infrequent Borrowing, Need for Clear Information	Users borrowing less than once a month and feeling the facility availability information is unclear.
Cluster 3	Never Borrowed, Focus on Interface and Design	Users who have never borrowed but prioritize visual aspects such as font and color.

To classify users from the survey, a decision-logic formula using nested IF, AND, and SEARCH functions was created in Microsoft Excel. This formula identified patterns across borrowing frequency, feature requirements, and design preferences. The decision to form three clusters was based on recurring data trends related to these dimensions, which reflect common UX segmentation criteria. The formula assigned respondents to Cluster 1 if they borrowed frequently and needed tracking or notifications, to Cluster 2 if they borrowed infrequently and required clear information, and to Cluster 3 if they never borrowed but focused on interface design. This semi-quantitative method balances consistency with interpretability and was further elucidated by a flowchart (Figure 2) illustrating the clustering logic visually.

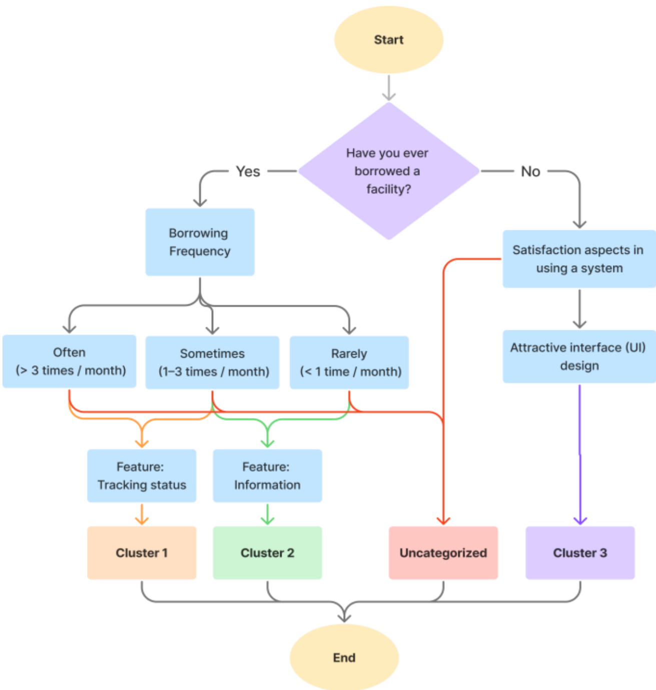

Figure 2. Flowchart of Manual Clustering Process

iii. Empathy Result

Each cluster was then detailed in the form of user personas and empathy maps. Personas include background, motivation, frustrations, and user goals, while empathy maps describe what users think, feel, say, and do, as well as their pains and gains in the borrowing process.

a. Persona

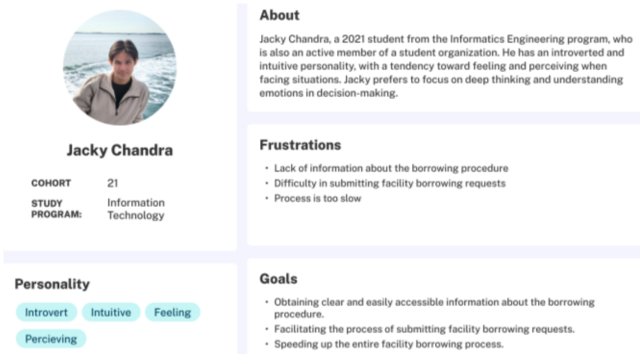

Figure 3. Sample Cluster of User Persona

The conclusions from the three user personas (Figure 3) are:

1. The user persona of Cluster 1 faces difficulties tracking borrowing status and lacks notifications during the process. They require solutions such as real-time status tracking features and automatic notifications for each borrowing stage.
2. The user persona of Cluster 2 suffers from inadequate clear information regarding procedures and facility availability. They need solutions like an informative digital borrowing workflow, transparent facility status, and easy-to-understand usage guidance.
3. The user persona of Cluster 3 has never borrowed a facility and requires a solution featuring a visually appealing, user-friendly interface with icons and labels that are easy to understand.

b. Empathy Map

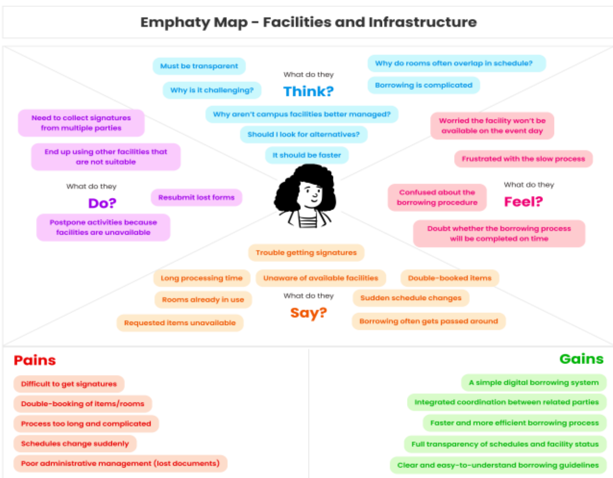

Figure 4. Empathy Map

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2) Define

In this study, the problem identification process was conducted by referring to the user segmentation results obtained through the manual clustering method. This technique produced three main user groups with different needs and characteristics, requiring a structured approach to formulate problems specifically and contextually.

As the output of the Define stage, three interrelated components were obtained: the Elevator Pitch, User Map, and Problem List. These components serve as the foundation for developing more targeted solutions in the next phase, Ideate.

a) Elevator Pitch

The elevator pitch is formulated as a brief narrative representing the main mission of the system being developed. This narrative summarizes who the users facing problems are, what problems they encounter, the solution offered, and the expected impact of implementing that solution. In this study, the formulated elevator pitch is a web-based campus facility management system that presents real-time information, availability status, and a fast and transparent submission process, supporting a more practical and efficient borrowing experience.

b) User Map

The user map is used to map the target users and their interactions with the designed system. This mapping identifies four main roles in the facility borrowing process: students, facilities staff, student executive board (BEM) management, and verifying lecturers/staff. Each role has different goals and responsibilities within the system flow. The map is based on the segmentation results from the previous stage to ensure interaction paths reflect the real needs of each role. For example, the flow begins with students accessing the system to make bookings, usage, and return of facilities. This flow intersects with verifying lecturers/staff who receive notifications to review and approve activity proposals. Finally, the flow reaches facilities staff who are responsible for approving the borrowing and performing final verification upon return. Mapping this chain of interactions allows the team to deeply understand how each role interacts with the system and identify potential points for feature improvement.

c) Problem List

The problems identified in the Empathize stage were categorized into four main groups based on common themes from interviews and questionnaires: Administration, Efficiency, Inventory, and Management. This classification aims to simplify the solution exploration process and ensure that all important aspects are systematically covered.

3) Ideate

Based on the problem statements formulated, the process of exploring and selecting the most relevant feature ideas was conducted. Features were prioritized according to user needs from each cluster. In this stage, potential ideas were systematically developed based on the main challenges formulated using the How Might We (HMW) approach. This approach allows the development team to view problems as opportunities and encourages various alternative solutions relevant to user needs.

Overall, five main outputs were produced in this stage: challenges, prioritization of challenges, UX attributes, potential solutions, and solution priorities.

a) From Problems to Challenges (How Might We)

The first output of the Ideate stage is the transformation of problems into design challenges using the How Might We approach. Challenges were formulated based on problem categorization from the Define stage, covering administration, efficiency, inventory, and management aspects. Problems faced by the related actors—students, BEM, lecturers/staff, and facilities staff—were converted into open-ended questions answerable through feature design. For example, how to provide a centralized system for borrowing documentation, speed up approval processes, display real-time facility availability, or provide notifications at each process stage. This approach ensures each challenge represents real user needs and can be a precise starting point for solution exploration.

b) Challenge Prioritization

The How Might We challenges were then mapped in a Challenge Matrix based on two aspects: impact (the extent of influence on user experience) and reach (the number of affected users). The mapping showed that the main priorities lie in the High Impact quadrants, both with Low Reach and High Reach. The High Impact, Low Reach quadrant includes simplifying signature processes, improving borrowing workflow for better systematics, and accelerating responsible party identification.

The High Impact, High Reach quadrant includes improving borrowing efficiency and transparency, reducing wait times, real-time information availability, conflict prevention in scheduling, data synchronization of availability, administrative simplification, transparent access to information, asset maintenance scheduling, and easing borrowing approvals. Focus on the High Impact quadrant was chosen because changes in this area are deemed to have the greatest effect on system improvement.

c) Solution Prioritization

Solutions were evaluated using a Solution Matrix based on effectiveness and complexity to prioritize development. Focus was placed on high-impact features. The High Effect–Low Complexity category includes available borrowing forms, email status notifications, real-time availability pages, and borrowing history. The High Effect–High Complexity category includes detailed facility search, tracking application status, automatic approval reminders, real-time asset maintenance, and centralized borrowing information. Low-impact features such as borrowing confirmation and institutional login (Low Effect–Low Complexity) or approval pages (Low Effect–High Complexity) were recorded but given lower priority, with the main focus on High Effect features to deliver maximum benefit to users.

4) Prototype

The prototype was developed based on the results of the Ideate stage and tailored to the characteristics of each user cluster obtained through the manual clustering process. The features prioritized in the previous stage were translated into user interface (UI) elements and interactive prototypes using the Figma software. This prototype was designed to reflect an initial solution that could be directly tested by users, taking into account the specific needs and preferences of each user group.

a) Wireframe

The wireframe is an early representation of the user interface layout, depicting the basic structure of the system without full visual elements. Each wireframe was designed to facilitate validation with users before proceeding to an interactive prototype version.

b) Style *Guideline*

The style guideline was compiled to ensure visual consistency of the system interface across all pages. This guide includes elements such as color palette, typography, and UI components, determined based on user preferences from the Empathize stage survey results. These visual elements not only enhance appearance but also strengthen the user experience in interacting with the system.

c) Color

The main color selection was based on user preference survey results, where the majority of respondents chose Color 2 as the primary palette (Figure 5).

Figure 5. Color Palette

d) Typography

Typography was selected based on the survey, where most respondents preferred sans-serif fonts. Among three sans-serif font options available, Poppins was chosen to be applied in the system.

e) Components

Visual components include icons, buttons, menus, status chips, alerts, and layout structure. These components were designed to maintain coherence and facilitate user recognition of functions across pages.

f) User Flow

User flow describes the user's interaction paths with the system to complete specific tasks. In this project, four main user flow scenarios were designed based on manual clustering results and persona grouping. Each flow outlines logical steps users must take to achieve specific system goals.

i. User Flow for Viewing Facility Availability

This flow depicts how users (students) search for and view available facilities. Users select the facility category (Item or Room), apply filters to narrow choices, and the system displays results according to preferences.

ii. User Flow for Borrowing Submission

This flow shows the stages students undergo when submitting borrowing requests. Starting from selecting a facility, filling out the form, until the system displays the submission status and estimated processing time.

iii. User Flow for Borrowing Confirmation and Usage Information

After submission is accepted, users receive a notification to confirm. Students fill in borrowing details, the system displays usage status, and users are then directed to the borrowing information page. If rejected, the system redirects back to the submission form.

iv. User Flow for Usage History

This flow explains how users view their facility borrowing history. Users access the History menu, and the system displays a list of previous borrowings for documentation and activity tracking.

g) High Fidelity

The High Fidelity stage is an iterative process within the Design Thinking method that aims to develop a visual design of the system with a high level of detail and close to the final form of the actual system. The system design focuses on the lending feature as the main component of the system, with two design iterations adjusted based on evaluation results and user feedback.

i. Iteration 1

In the first iteration, the prototype design was developed based on the previously formulated wireframe and style guide. The design focused on validating basic interaction flows and obtaining early user feedback. The interactive prototype can be accessed via the link https://bit.ly/PrototypeDesainIterasi1

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ii. Iteration 2

The second iteration was developed based on initial testing results and user input. In this iteration, color adjustments were made to follow the visual identity of Politeknik Caltex Riau to enhance consistency and user comfort.

5) Testing

The prototype was tested through two testing cycles. In the first cycle, testing was conducted using the System Usability Scale (SUS), and in the second cycle, design iterations and retesting were performed using both SUS and the User Experience Questionnaire (UEQ). This evaluation helped validate how well the solution met user needs.

During the first cycle prototype development, testing was performed on the prototype from the first design iteration, involving 26 active students of Politeknik Caltex Riau as respondents. The evaluation method used was the System Usability Scale (SUS), which is an instrument designed to quantitatively measure users' perceptions of a system's ease of use. The test results showed an average SUS score of 75, which falls within the Acceptable Range with a grade of C.

Based on user feedback analysis, three main areas for improvement were highlighted by respondents:

a) Addition of Labels, Colors, and Tooltips

Information on the borrowing form was deemed insufficiently clear. Therefore, it was recommended to add more explicit labels, use color as visual indicators, and incorporate tooltips to explain the function of each interface element.

b) Interactive Dashboard

Users desired a more dynamic and informative dashboard. This feature is expected to display borrowing status, real-time notifications, and a concise yet comprehensive summary of activities.

c) Item Status Information and Borrowing Log

A feature to track the condition of items before and after borrowing, as well as documentation of borrowing history (log), is needed. This feature is considered important to enhance transparency and accountability in facility management.

Although the SUS score indicates the system is reasonably acceptable, user feedback suggests that visual elements, clarity of the borrowing flow, and the display of submission status still need refinement. This feedback became the primary basis for conducting further iterations and development in the second iteration.

B. Iteration 2

This iteration was conducted to deepen and revalidate the problems and user needs identified in the first cycle. The second cycle was based on the first cycle's test results which showed that the system still needed improvement, especially regarding information clarity and feature completeness. The second cycle used the Focus Group Discussion (FGD) method involving all stakeholders simultaneously. This approach aimed to gain a more comprehensive understanding and ensure that the developed solutions truly met user needs.

1) Re-Emphatize & Re-Define

The Re-Empathize stage was conducted to rediscover a deeper understanding of user needs, obstacles, and expectations through a qualitative group discussion approach. In this stage, FGD was used as a medium to identify challenges that were not revealed in the previous cycle. User needs exploration results were then reanalyzed in the Re-Define phase, aiming to reformulate problem statements, set design priorities, and sharpen system focus based on input from cross-user groups.

a) Data Collection

The objectives of data collection in this phase were to:

i. Identify deeper root problems in the facility borrowing process,
ii. Explore specific user needs and preferences for the digital system,
iii. Seek collaborative solutions from various stakeholders to improve the facility management system.

The method used was Focus Group Discussion (FGD), a qualitative approach to collecting information via guided group discussions aimed at identifying problems and collaboratively formulating solutions. Participants included representatives from Student Organizations (BEM, Himpunan, and UKM), Facilities and Infrastructure Division, and lecturers and staff involved in borrowing validation. These three groups were chosen because they directly interact in the submission, management, and approval processes of facility borrowing.

b) *Findings*

The FGD was conducted in three main stages: preparation of questions and participant invitation on March 18, 2025; discussion session on March 19, 2025; and analysis of discussion results on March 20, 2025, to formulate key findings. The main findings from FGD are:

a. No system for real-time checking of facility availability, causing scheduling conflicts among users.
b. Many students do not follow official procedures and directly submit borrowing requests to the facilities division.
c. No borrowing history or recap system is available for evaluation purposes.
d. Borrowing workflows are poorly understood among student generations due to lack of clear SOPs.
e. No dashboard exists that transparently displays facility usage schedules.
f. The system is not integrated with PCR's SSO login, complicating user authorization

c) Re-Emphatize and Re-Define Results

i. Pain and Gain

FGD results were mapped into two main categories: pain points and gain points. Pain points represent major user obstacles, while gain points represent user hopes for the system. Pain & Gain mapping showed key problems including limited facilities, complicated and conflicting borrowing procedures, mismatches between quality and borrowed facilities, and suboptimal scheduling administration by BEM. Expected solutions include providing clear descriptions of activity types/categories and facilities, borrowing document search via BLM, clear borrowing flow feature, error handling mechanisms for scheduling conflicts through prioritization and BEM curation, standard facility data per room, verified borrowing proof, a return deadline of H+2, and standard BLM-compliant borrowing procedures.

ii. User Map

User maps were created for each key role: students, BEM, lecturers/staff, and facilities division. The mapping visualizes interaction flows, challenges, and goals of each role in the system context. Briefly, students begin by accessing the system, selecting activity types, uploading proposals if required, and booking. Submissions are verified by BEM and then the Facilities Division before facilities are used and returned. Lecturers/staff follow a similar flow without BEM verification. BEM verifies and approves initial submissions, while Facilities Division verifies the final stage and gives final approval for event execution.

2) Re-Ideate and Re-Prototype

The Re-Ideate and Re-Prototype stage reorganizes system solutions based on new needs found from the second cycle FGD. The main focus here is refining system designs to correspond with real-world usage contexts and revising user flows to better reflect actual field processes. Outputs include: a list of additional needs, system feature clustering, style guideline refinement, and user flow adjustments.

a) List of New Needs

Based on FGD results, a list of new requirements was compiled reflecting problems and user hopes for the facility management system. Needs include features for searching facilities by category, activity type, or requirement; structured borrowing flows with visual guides and clear steps; and automatic filling of standard facility data for each room. The system also needs automatic conflict detection with prioritization mechanisms, tiered approval with special access rights for BEM to manage scheduling and event curation, and recommendations for alternative rooms based on needs and capacity, including room relocation options based on priority.

b) Feature Classification

Based on gathered needs, system features were grouped into ten main functional categories: facility search and availability; borrowing flow and guidance; automation and conflict detection; approval and access rights; room recommendations and flexibility; document and borrowing proof management; notifications and reminders; discussion and approvals; monitoring and usage statistics; and access and security. This clustering aims to ease design processes, ensure feature interrelation, and guide prioritization based on urgency and user impact.

c) Style Guideline

Style guideline updates were made in the second iteration to align system design with the campus's visual identity and improve comfort and consistency. The guide covers key elements such as color, typography, and UI components.

1. Color

   Adjustments were made to the secondary color to better match Politeknik Caltex Riau's logo colors.
2. Components

   Several main visual components were added and refined to support easy navigation and strengthen information hierarchy within the system.

d) User Flow

User flows describe the interaction paths from beginning to end and are adjusted per user role. The mapping ensures the system process reflects real needs and actual procedures in the field.

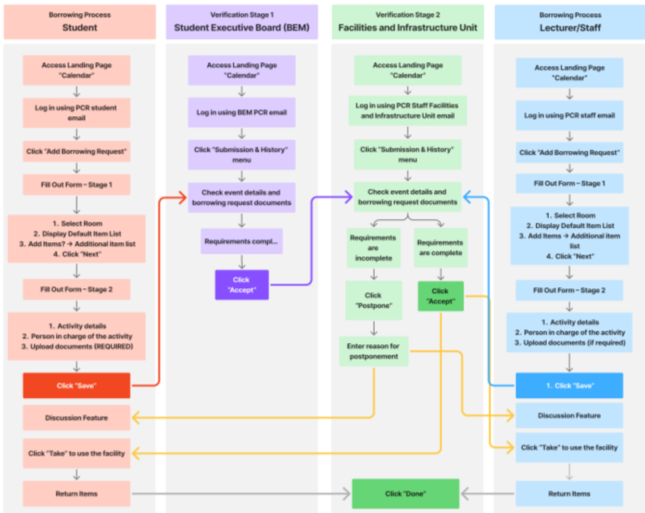

Figure 6. User Flow

The flow visualization shown in Figure 6 illustrates the differences in processes among students, the Student Executive Board (BEM), lecturers/staff, and the Facilities and Infrastructure Division.

1. Students access the system via the landing page, log in with their institutional email, then fill out a two-step form (selection of room/item and activity details). The submission is verified first by BEM, then by Facilities, before the facility usage and return take place.
2. BEM verifies the completeness of documents and event details submitted by students in the initial stage, then forwards approved submissions to the Facilities Division.
3. The Facilities Division performs the final verification for students and a single verification for lecturers/staff. Complete submissions are approved, the user receives a notification, and the process concludes after the confirmation of the return.
4. Lecturers/staff follow a similar flow to students, but only go through a single verification stage by Facilities.

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3) Final Prototype

The final prototype was developed based on refinements from the first and second cycles which involved need identification, design, and user testing (Figure 7). This prototype development incorporated various inputs obtained from students, lecturers/staff, and the Facilities Division, both in terms of interface appearance and system usage flow.

The refinement focused on key features previously considered suboptimal, such as multi-level verification for student borrowing requests, an interactive calendar-based facility occupancy dashboard, and simplification of interface components to make them more intuitive and easier for all users to understand. Besides functional aspects, the visual design was also aligned with the institutional identity to ensure consistent appearance and enhance comfort when using the system.

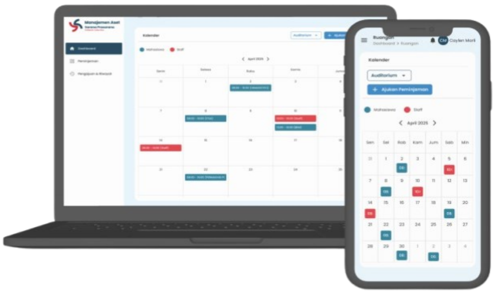

Figure 7. High Fidelity of Iteration 2

IV. RESULT AND DISCUSSION

1) Comparison of SUS Scores

The testing results show an increase in the score from 75 in the first cycle to 77 in the second cycle (Table 2). Although both scores fall within the Acceptable category with a grade of C, the addition of +2 points indicates a positive improvement in usability as a result of design adjustments in the second iteration.

Table 2. Comparison of SUS Scores Between Iteration 1 and 2

Aspect	Iteration 1	Iteration 2
Number of Respondents	26	26
Average SUS Score	75	77
Interpretation	Acceptable	Acceptable
Grade	C	C
Change	-	+2 points

2) UEQ Score Results

UEQ testing was only conducted in the second cycle (Table 3). All UEQ dimensions showed positive scores, with the Stimulation dimension receiving the highest score. This indicates that users feel the developed system is enjoyable, efficient, easy to understand, and visually appealing.

Table 3. Summary of UEQ Scores in Cycle 2

Dimension	Average Score	Category
Attractiveness	2.045	Good
Perspicuity	2.067	Good
Efficiency	1.971	Good
Dependability	2.125	Good
Stimulation	2.202	Excellent
Novelty	1.721	Good

3) Comparison of Qualitative Findings

The comparison of qualitative findings shows that the feedback from students in the first cycle focused on clarity of flow and visual needs, whereas feedback from lecturers and staff in the second cycle emphasized technical aspects and system integration (Table 4).

Table 4. Summary of Qualitative Findings

Qualitative Aspect	Iteration 1 (Students)	Iteration 2 (Lectures/Staff)
Flow Visualization	Confusing, needs additional tooltips and labels	Formal SOP and multi-level approval system recommended
Real-Time Information	No dashboard available	Real-time dashboard and borrowing history recap needed
Supporting Features	No borrowing log, status unclear	Verification system and email integration needed

In addition to the quantitative findings, each user cluster showed unique feedback regarding the system features. Cluster 1, consisting of frequent borrowers, appreciated the real-time tracking and notification functions, as these directly addressed their key concerns. Cluster 2, made up of infrequent borrowers, valued the clearer borrowing process and improved facility information pages, which enhanced their understanding of how to use the system. On the other hand, Cluster 3, representing non-borrowers, responded positively to the visual design changes and incorporation of the institution's color scheme, which increased their interest in trying the system. These results suggest that manual clustering not only helped develop distinct personas but also informed the prioritization of features that effectively served different user groups.

However, this method has limitations, including potential bias from researcher-defined grouping rules and reduced efficiency with larger datasets compared to automated clustering. Future studies could validate manual clustering results against machine learning methods or involve multiple evaluators to minimize bias in rule creation.

V. CONCLUSION

This study demonstrates that applying the Design Thinking method through two iterative cycles involving students, lecturers, and staff effectively produces a facility management system interface catering to diverse user needs. Integrating manual clustering within the Design Thinking process enhanced persona development by identifying distinct user groups, guiding the design of features tailored to those segments. Usability improved significantly, evidenced by increases in System Usability Scale (SUS) scores and positive User Experience Questionnaire (UEQ) outcomes, particularly in the Stimulation dimension. Strategic system enhancements, focusing on improving real-time monitoring, user feedback, accessibility, and streamlined workflows, contributed to greater transparency, accuracy, and operational effectiveness. Methodologically, this research confirms that rule-based manual clustering offers a transparent, interpretable, and viable user segmentation approach in UX studies with limited data. Practically, the system was customized for different user clusters, increasing relevance and usability. Future work should evaluate manual clustering against algorithmic techniques to validate and improve segmentation accuracy, involve multiple evaluators to reduce subjectivity in rule definition, and more deeply embed manual clustering insights in iterative Design Thinking cycles to refine persona accuracy and system alignment. Testing the approach on larger datasets and diverse user groups would further establish its scalability and general applicability in facility management system design.

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