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Designing an Information System Model for Project-Based Learning Management and E-Showcase Using Design Thinking

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Abstract
The Department of Electrical Automation Engineering manages Project-Based Learning (PjBL) through several separate media. This condition makes it difficult for users to browse documents, monitor progress, access assessment rubrics, and publish project results. This study designs an information system model for PjBL and e-Showcase management using a Design Thinking approach. Carrying out the Empathize, Define, Ideate, Prototype, and Test stages. Then, data is collected through observations and interviews with 12 students and 4 lecturers. Processing the findings into 17 initial codes, 10 themes, 10 functional requirements, and 4 non-functional requirements. Determine the impact-effort score through discussions with developers who understand the level of difficulty of each feature. Then, an interactive prototype is created and tested on 19 users, consisting of 12 students, 4 lecturers, and 3 admins. The test resulted in 139 task implementations. Participants completed 131 tasks, or 94.2%, without instructions, and 8 tasks, or 5.8%, with general instructions regarding menu locations. The average task ease of use was 4.38 out of 5, while the System Usability Scale score was 79.61, falling into the acceptable category. The Yangyang model is designed to support document management, progress monitoring, rubric transparency, cross-semester archiving, and project publication through e-Showcase. However, the prototype still requires improvements in menu naming, button visibility, and guide search before the system is implemented.

Keywords: Design Thinking; E-Showcase; Project-Based Learning; Information Systems; Usability

1. Introduction

The Department of Electrical and Automation Engineering (DTEO) implements Project-Based Learning (PjBL) from the first semester through the final project. Students work on projects in groups. Lecturers, administrators, and industry partners support the planning, document collection, progress monitoring, assessment, and publication of work. Currently, PjBL administrators use Google Drive, OneDrive, MyITS Classroom, WhatsApp, and physical documents separately. This situation makes it difficult for users to search project history, check document completeness, and ensure valid information.

Setyadi and Mardhiyyah showed that digital monitoring systems help instructors track practical activities [1]. Nur et al. showed that web-based systems support monitoring student activities [2]. Bon et al. explained that integrated academic systems connect services and users in higher education [3]. Firmansyah et al. found that perceived ease and usefulness influence system acceptance [4]. Ahsyar et al. emphasized the importance of usability measurements in academic systems [5]. Rahman et al. placed needs analysis as the basis for academic system development [6]. Albats et al. showed that digital platforms expand knowledge exchange between higher education and industry [7]. O'Dwyer et al. explained that collaboration between universities and industry requires clear communication and division of responsibilities [8]. These findings support the DTEO's need for a single system that can manage PjBL and display project results.

Academic systems need to follow the way users work because each role has different needs. Alao et al. suggest that designers need to connect user needs with interface decisions [9]. Bhandari explains that Design Thinking connects problem understanding, idea development, and solution testing [10]. Luo et al. suggest using Design Thinking to address complex and cross-disciplinary problems [11]. Alahmari and Anandhavalli position Design Thinking as a relevant approach for information systems development [12]. This study uses this approach to trace user needs and produce a tested prototype.

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1.1. Previous research

Table 1 compares the five studies most closely related to this research topic. The table lists the research focus, approach, strengths, limitations, and gaps.

Table 1. Summary of previous research and research gaps.

No	Study and title	Focus and approach	Strengths and limitations	Research gaps
1	Dahlan et al. (2024) [13] EffiESGen: A User-centric Web Application for Efficient Exam Scheduling and Collaboration in Education	The study discusses exam scheduling, which is still done manually and is prone to conflicts. The study developed a user-centric web application with automated scheduling, real-time updates, and collaboration features.	Studies have shown that user-centered design can help solve problems in academic services. However, these studies only address exam scheduling and do not cover inter-unit services.	This research still needs to discuss broader and more contextual academic services.
2	Jabour (2024) [14] Integrating Health and Disability Data into Academic Information Systems: Workflow Optimization Study	This study addresses the lack of integration between health and disability data. It explores user needs and develops workflows that address privacy, communication, automation, and support for people with disabilities.	The study showed that redesign should be based on stakeholder needs. However, the study stopped at workflow recommendations and failed to test a prototype.	Research still needs to continue the recommendations into a testable prototype.
3	Mostefai et al. (2025) [15] Enhancing User Experience in E-learning Systems: A New User-centric RESTful Web Services Approach	This study examines an e-learning system that focuses more on system requirements than user needs. It develops RESTful architecture for multiple roles and evaluates the UX using UEQ.	Studies emphasize the importance of role-based design and a user-centered approach. However, these studies focus on service architecture and have not addressed the issue in depth within a single academic unit.	Research still needs to connect specific academic services into one workflow.
4	Netinant et al. (2025) [16] Bridging System Development Perspectives and Quantitative Analysis of User Adoption in Educational Information Systems	This study examines factors influencing long-term educational system adoption. It uses three years of usage data and 550 surveys to build an adoption model.	This study used real-world data and demonstrated the influence of digital capabilities and system quality on usage. However, it assessed adoption after the system was in use and did not address user-focused design.	Research still needs to connect user problems, solution design, prototyping, and testing.
5	Ko and Hughes (2026) [17] Value-sensitive Design in Action: Designing Student-centered Intelligent Tutoring Systems with Community College Students and Instructors	This study examines AI-based learning systems that neglect user safety, trust, and freedom. The study uses Value-Sensitive Design to connect user values with technical decisions.	This study involved multiple stakeholders and considered human values in educational design. However, it focused on AI-based tutors and did not address operational academic services.	This research still needs to apply a user-centered approach in daily academic management.

Table 1 shows that previous research has used a user-centered approach. However, each study still addresses a specific aspect of educational services. This study connects user evidence, needs formulation, impact-effort prioritization, role-based prototyping, and quantitative evaluation in a single flow. This study also combines PjBL management with publication of work through e-Showcase.

1.2. Novelty and contribution of research

The research contribution lies in the development of a traceability framework that connects each Design Thinking artifact, starting from user needs identification, theme analysis, system requirements formulation, feature prioritization using an impact-effort matrix, prototype development, and evaluation using task scenarios and the System Usability Scale (SUS). Unlike previous research that generally reports the Design Thinking stages or final prototype results separately, this research demonstrates how each design decision can be traced back to user needs and supported by empirical evidence. Thus, the contribution of this research is not in the development of a new method, but rather in providing a more systematic, transparent, and traceable design decision-making framework.

2. Method

2.1. Research design

This research uses five stages of Design Thinking: Empathize, Define, Ideate, Prototype, and Test. Each stage has sequential objectives, tools, and procedures. Data from one stage is used to inform decision-making in the next. Figure 1 shows the research flow, while Table 2 summarizes the tools and procedures for each stage.

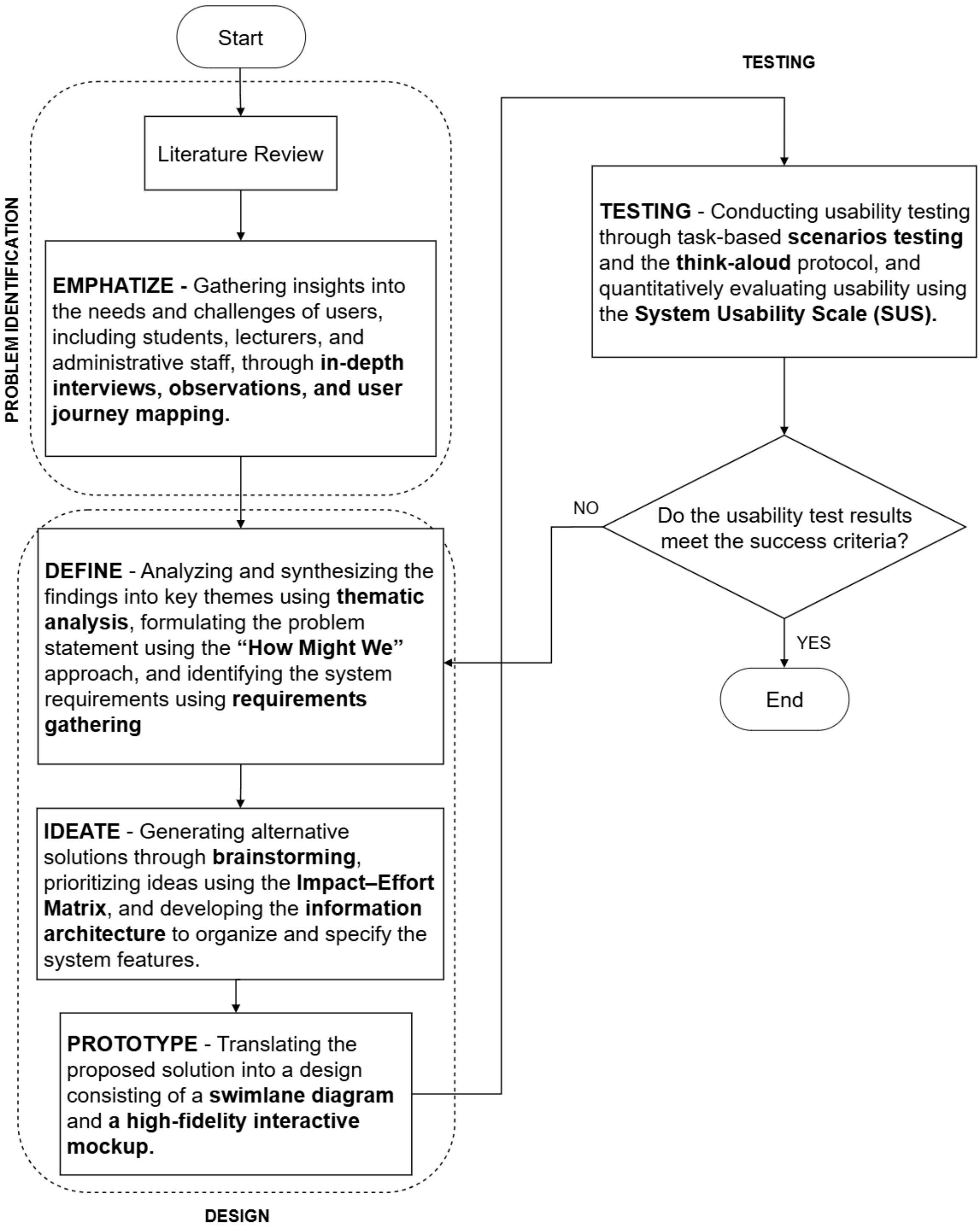


Figure 1. Research workflow and evidence traceability based on Design Thinking.

Table 2. Stages, tools, and procedures of the Design Thinking process.

Stage	Tools used	Procedures and objectives
Empathize	Observation, in-depth interviews with 12 students and 4 lecturers as stakeholders, and User Journey Map	Identify PjBL processes, user experiences, needs, and pain points.
Define	Thematic Analysis, How Might We (HMW), and Requirement Gathering	Coding data, grouping themes, formulating HMW, and compiling Functional Requirements and Non-Functional Requirements.
Ideate	Brainstorming, Impact–Effort Matrix, and Information Architecture	Develop alternative solutions, determine priority needs, and design the system information structure.

Stage	Tools used	Procedures and objectives
Prototype	Swimlane and High-Fidelity Interactive Mockup	Map out flows based on user roles and create interactive prototypes.
Test	Task Scenario Testing, Think Aloud question-based written feedback, and System Usability Scale (SUS)	Measures task completion, need for instructions, barriers to use, perceived ease of use, and overall usability.

2.2. Empathize and Define Stage

Conducted observations at DTEO and interviewed 12 students from the 2022–2025 intake and 4 lecturers as stakeholders in PjBL management. This study used purposive sampling because all informants had direct experience in the PjBL process.

Interview data were analyzed using Thematic Analysis by coding the answers, combining similar codes into themes, formulating How Might We questions, and compiling Functional Requirements through Requirement Gathering.

2.3. Ideate Stage

At the Ideate stage, Brainstorming is used to develop two alternative solutions for each need, then select one main alternative to be assessed through the Impact–Effort Matrix, then use Information Architecture to structure the information based on user roles.

The impact assessment uses interview data, User Journey Maps, issue frequency, and the feature's impact on the PjBL process. The effort assessment uses technical considerations, such as changes to modules, databases, access rights, storage, and system testing.

Information Architecture encompasses Web Planning, Web Strategy, and Web Architecture. Web Planning is used to define system objectives and user groups. Web Strategy is used to determine information management and access rights. Web Architecture is used to structure menus, pages, features, and the relationships between pages.

2.4. Prototype Stage

In the Prototype phase, the sequence of user activities and responsibilities is mapped using Swimlane. This mapping forms the basis for developing the interface flow and access rights for each role.

A high-fidelity interactive mockup was created using Figma. Saputra et al. showed that designers need to structure the flow and interface based on user needs [18]. Sefira et al. showed that user testing results need to be the basis for interface improvements [19]. Escamilla et al. emphasized user involvement in determining interaction features [20]. Stewart et al. used user feedback to gradually improve the user experience [21]. Soufan et al. showed that Design Thinking can unify diverse user needs in one platform [22]. Zulvi et al. emphasized the importance of user evaluation in digital education services [23].

2.5. Test protocols and scenarios

The prototype was tested both in person and online with 19 participants: 12 students, 4 lecturers, and 3 administrators. Each participant performed tasks according to their role. Students and lecturers each ran seven scenarios, while administrators ran nine. Table 3 summarizes the participant composition and scope of the task scenarios.

Table 3. Participant composition and task scenario coverage.

Role	n	Tasks per participant	Scope of activities
Student	12	7	Login; announcements; guides and templates; upload documents; submission status; rubrics and grade estimates; e-Showcase submission
Lecturer	4	7	Login; announcements; status monitoring; document checking; cross-semester archives; guides and templates; assessments
Admin	3	9	Login; user data; announcements; templates and documents; archives; sections; submission status; e-Showcase verification; public contact

Before the test, respondents were required to understand the objectives, task sequence, rating scale, and support rules. Each participant attempted to complete the tasks without step-by-step instructions. The only clues were menu locations when participants couldn't find a feature. The moderator didn't directly display buttons or actions.

After completing each task, participants filled out a Google Form. The form included a success rate, an ease score, comments, and the question: *"While working on this task, tell me what you were thinking, the steps you took, and any areas you felt confused or unsure about."* Participants wrote down their answers after completing the task. The ease scale used a value of 1 for very difficult and a value of 5 for very easy.

Table 4. Operational definitions of task completion outcomes.

Category	Operational definition
Succeed without help	Participants achieve the scenario goals without any guidance from the moderator.
Success with instructions	Participants reach the goal after the moderator provides general instructions regarding the section or menu.
Fail	Participants did not achieve the scenario goal after receiving general instructions.

This study did not record task duration, so the study did not measure time efficiency. Berni and Borgianni explained user experience through user understanding and response to the system [24]. Koohang placed ease of learning and use as elements of usability [25]. Lewis and Sauro assessed usability based on effectiveness, efficiency, and satisfaction [26]. Allam et al. emphasized recording problems during interactions [27]. Luther et al. included organizational context and user behavior in UX studies [28]. This study measured effectiveness through task success and measured perceived ease of use through a 1–5 scale and SUS.

Participants answered 10 System Usability Scale (SUS) questions using a 1–5 Likert scale. The questions included:

1. I think I will use this system again
2. I find this system complicated to use
3. I find this system easy to use
4. I need help from another person or technician in using this system.
5. I feel like the features of this system are working as they should.
6. I feel like there are a lot of things that are inconsistent.
7. I feel like other people will understand how to use this system quickly.
8. I find this system confusing
9. I feel there are no obstacles to using this system.
10. I need to get used to it first before using this system

The score contribution for odd items is calculated by subtracting 1 from the answer score, while the score contribution for even items is calculated by subtracting 5 from the answer score. All contributions are summed and multiplied by 2.5 to produce an individual SUS score on a scale of 0–100. The average SUS is calculated by summing the SUS scores of all participants and dividing by the number of participants. Bangor et al. used the SUS to assess system acceptability [29].

3. Results and Discussion

3.1. Empathize and Define Results

Table 5 presents findings from student interviews, with numerical data and 12 students as the denominator. Each student could address more than one theme, allowing the percentages to exceed 100%.

Table 5. Frequency of findings from student interviews.

No	Findings	Frequency	Percentage (%)	Implications
1	Students support the publication of work through e-Showcase	10/12	83.3	e-Showcase requirements and approval flow
2	Students receive different templates or formats	8/12	66.7	Centralized repository of guides and templates

No	Findings	Frequency	Percentage (%)	Implications
3	Students do not know the assessment criteria or weighting	6/12	50.0	Transparent assessment rubric
4	Students receive sudden announcements of schedules or formats	4/12	33.3	Centralized announcements and latest information bookmarks
5	Students say information is sinking on WhatsApp	3/12	25.0	One-stop official information source
6	Students cite reimbursement or procurement as a sticking point	3/12	25.0	Managerial findings beyond the scope of the prototype
7	Students assess that the composition of the high school/vocational school groups is not balanced.	3/12	25.0	Group formation policy notes
8	Students experience difficulties with communication or visibility of progress	3/12	25.0	Clearer progress dashboard and communication
9	Students consider the course correlation guidelines to be unclear	2/12	16.7	Correlation report guide and templates
10	Students need to be equipped with basic technical skills	2/12	16.7	Academic findings outside the scope of the prototype

Table 5 shows that support for e-Showcase and template differences was the two most frequently encountered findings. These findings form the basis for the work publication feature, document repository, guides, and rubrics within a single system.

Interview results indicate that user needs to extend beyond document storage. Users also require easily accessible information, consistent guidance, and a more structured publication process. This is evident in the high demand for e-Showcase and template repositories. Therefore, this study not only designed new features but also structured information flows so that the entire PjBL process could be managed within a single system. Table 6 summarizes the findings from interviews with four lecturers. The findings are presented as a summary because the lecturer interview data was not calculated in terms of frequencies per informant.

Table 6. Summary of findings from lecturer interviews.

No.	Findings	Impact on PjBL management	System implications
1	Group coordination and monitoring are not yet centralized	It is difficult for lecturers to monitor the progress of the entire group through one source of information.	Document progress and status monitoring dashboard
2	Document storage is not yet integrated	Lecturers find it difficult to trace documents and project history from previous semesters.	Cross-semester document and archive repository
3	The assessment rubric is not yet presented transparently	Users have not received the same information about the assessment criteria.	Assessment rubrics that can be accessed according to user rights

These three findings complemented the student interview results and formed the basis for developing monitoring, archiving, and assessment features. Analysis in the Define stage yielded 17 initial codes, 10 themes, 10 functional requirements, and 4 non-functional requirements. Findings regarding reimbursement, unequal group distribution, and the need for technical training were classified as managerial or academic findings outside the scope of the prototype.

3.2. Ideate results and system model

Table 7 presents the impact–effort scores for 10 functional requirements. These scores are used to sequence development, not to test statistical relationships.

Table 7. Impact–effort scores for functional requirements.

ID	Need	Impact	Effort	Quadrant
FR-01	Document repository and template builder	5	4	Major Projects
FR-02	Account announcement and notification dashboard	5	3	Quick Wins
FR-03	Transparent rubric and score estimation	4	4	Major Projects
FR-04	Cross-semester project archives and search	2	5	Time Wasters
FR-05	PjBL information and guidance center	4	2	Quick Wins
FR-06	Correlation guide and template repository	4	2	Quick Wins
FR-07	Upload e-Showcase independently	5	4	Major Projects
FR-08	Lecturer approval and admin verification	4	4	Major Projects
FR-09	Document status and delay dashboard	4	4	Major Projects
FR-10	Direct contact with the project team, admin, or lecturer	2	1	Fill-ins

Table 7 places three needs in the Quick Wins quadrant, five needs in the Major Projects quadrant, one need in the Fill-ins quadrant, and one need in the Time Wasters quadrant. FR-04 is retained because cross-semester archives support academic track records, requiring large storage capacity and access rights management.

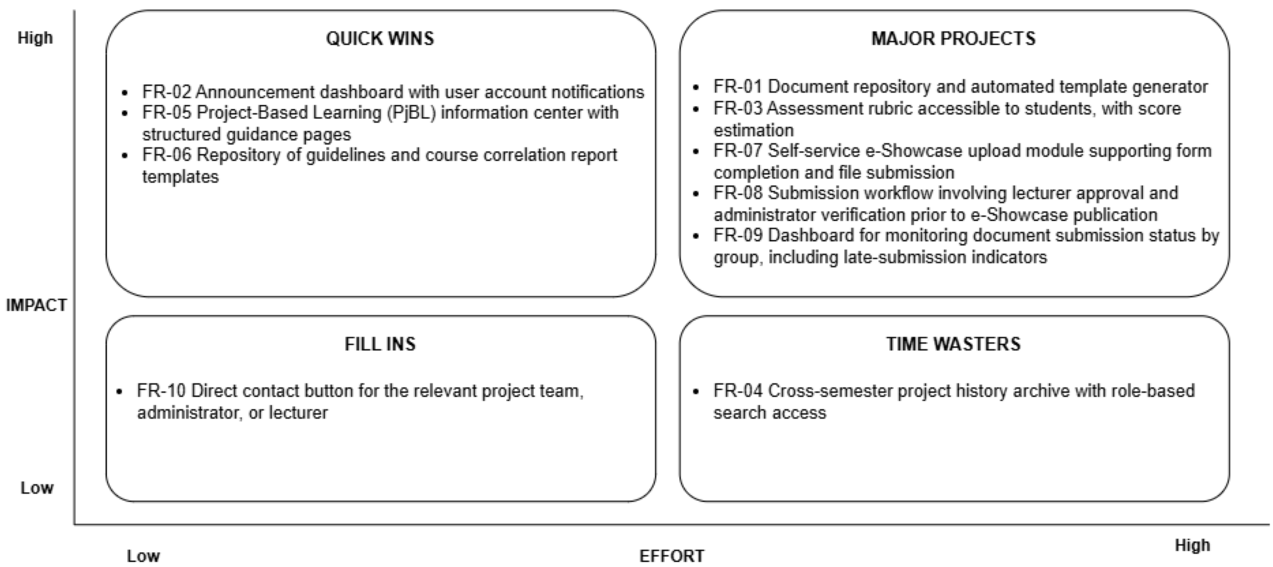


Figure 2. Impact–effort matrix for functional requirements

The impact-effort analysis results show that most user requirements fall into the Major Projects category. This means that the most needed features are also the most complex to develop. Conversely, features in the Quick Wins category can be implemented more quickly because they require less effort. These results help determine the development sequence so that the system can be built more gradually according to user needs and developer capabilities. Figure 3 shows the system information structure for the public, students, lecturers, and administrators.

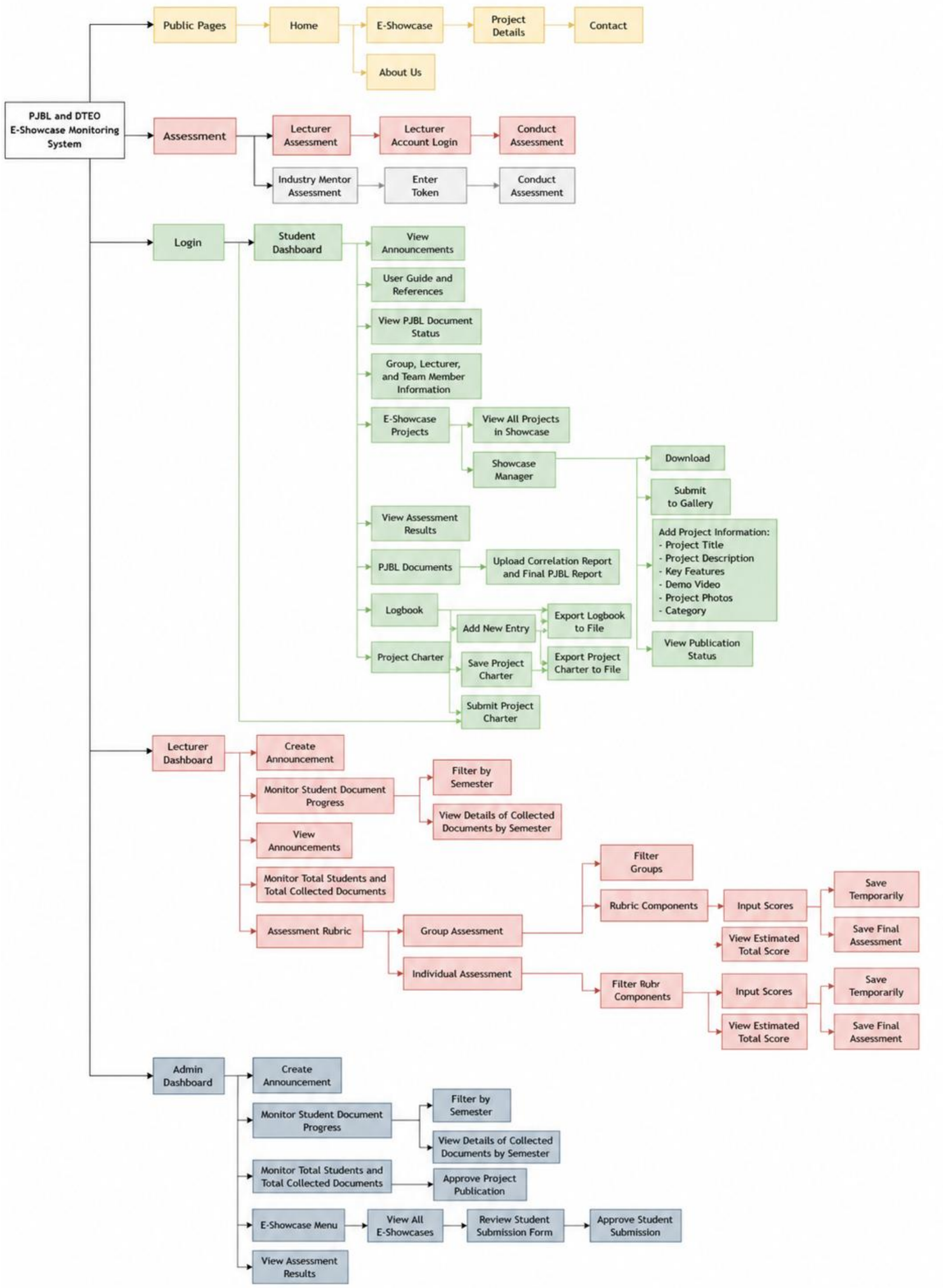
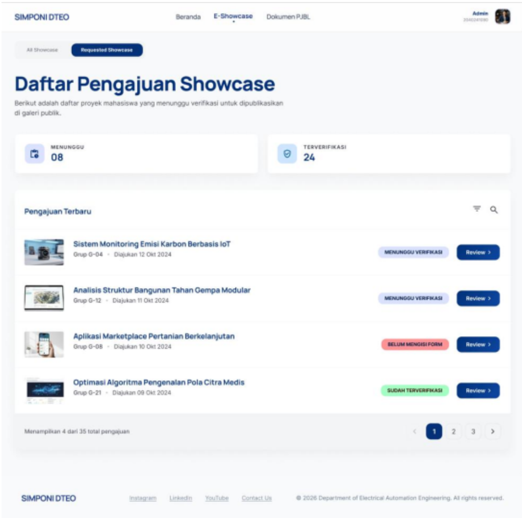


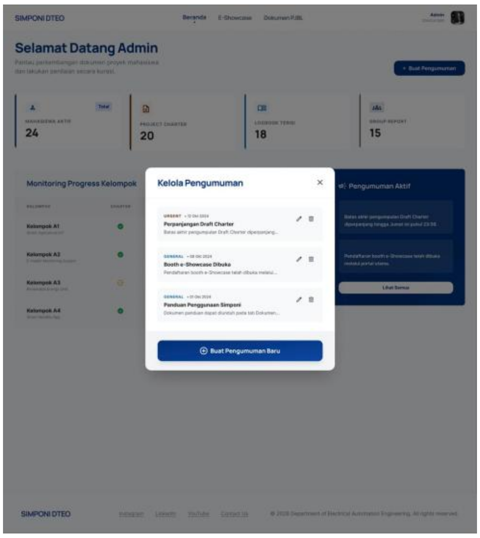
Figure 3. Role-based PjBL management and e-Showcase information system model.

3.3. Prototype Results

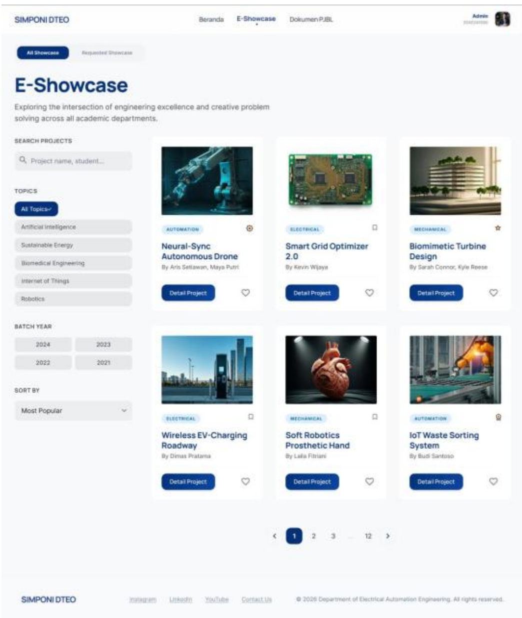
The Prototype phase produced a role-based flow and a High-Fidelity Interactive Mockup. The prototype incorporated announcements, guidelines, project documents, progress status, rubrics, cross-semester archives, e-Showcase submissions, approvals, publications, and project contacts. Figure 4 shows sample interfaces for e-Showcase verification, announcement management, public galleries, and the system profile page.



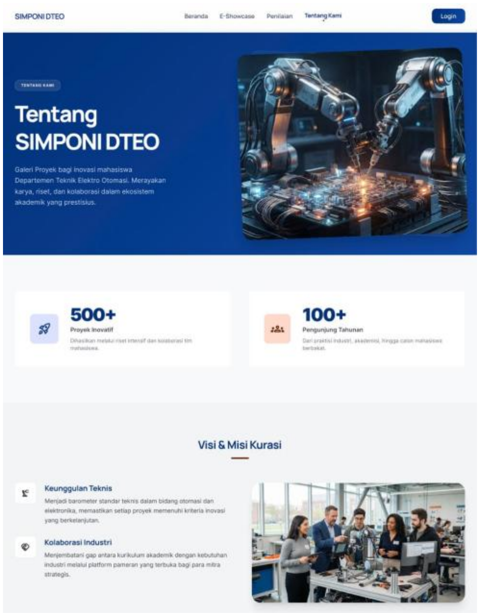
(a) Showcase submission verification



(b) Announcement management



(c) Public e-Showcase gallery



(d) System profile page

Figure 4. Examples of the high-fidelity interactive mockup for the PjBL and e-Showcase information system.

3.4. Task scenario test results

The test resulted in 139 task executions. Table 8 presents the task completion results by user group. Percentages are calculated based on the number of tasks in each group.

Table 8. Task completion results and ease-of-use scores by user role.

Role	**n**	**Execution of tasks**	**Without any clue**	**With instructions**	**Fail**	**Average ease**
Student	12	84	76 (90.5%)	8 (9.5%)	0 (0%)	4.38
Lecturer	4	28	28 (100%)	0 (0%)	0 (0%)	4.36
Admin	3	27	27 (100%)	0 (0%)	0 (0%)	4.41
Total	19	139	131 (94.2%)	8 (5.8%)	0 (0%)	4.38

All participants were able to complete the assigned tasks. However, students still needed some guidance to find certain features, while lecturers and administrators did not. These results indicate that the system's functionality is understandable, but some menus are still difficult for new users to find. Therefore, further improvements will focus more on simplifying navigation, menu naming, and button placement rather than adding new features.

3.5. System Usability Scale Results

Table 10 presents the answers to Q1–Q10 and the SUS scores for each respondent. R1–R12 came from students, R13–R16 from lecturers, and R17–R19 from administrators.

Table 10. SUS item responses and scores for each respondent.

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
R1	4	2	3	2	3	2	2	2	4	1	67.5
R2	5	2	3	2	5	1	4	2	4	2	80.0
R3	5	2	4	1	5	3	3	2	5	2	80.0
R4	4	1	3	1	5	2	3	2	4	2	77.5
R5	4	2	4	1	4	1	4	2	3	4	72.5
R6	3	1	4	1	4	2	4	2	3	1	77.5
R7	3	1	4	1	3	1	4	2	4	1	80.0
R8	5	3	5	1	5	2	5	2	4	1	87.5
R9	3	2	4	1	4	2	5	1	4	2	80.0
R10	5	1	3	1	5	2	4	1	4	2	85.0
R11	4	1	4	2	5	2	4	2	4	2	80.0
R12	5	1	5	2	4	2	3	1	5	1	87.5
R13	3	2	5	1	4	2	5	3	4	3	75.0
R14	5	2	5	1	4	3	4	2	3	2	77.5
R15	5	3	5	2	5	2	4	1	4	2	82.5
R16	5	2	5	1	4	3	5	2	4	1	85.0
R17	4	3	5	2	5	2	4	1	5	3	80.0
R18	5	1	4	2	5	2	5	2	3	3	80.0
R19	4	2	4	2	4	1	4	2	4	2	77.5

The total SUS score for all respondents reached 1,512.50. The average SUS score of 79.61 was obtained by dividing this number by the 19 respondents. Individual scores ranged from 67.50 to 87.50, with a median of 80.00 and a standard deviation of 4.88. According to Bangor et al., these scores are considered acceptable [29]. However, the SUS results need to be interpreted in conjunction with the task scenario results. Although all tasks were successfully completed, eight of the 139 task executions still required instructions, particularly when participants were looking for guides and templates. This finding indicates that users can understand the system flow, but some menus are still difficult to find. Therefore, future improvements need to focus on menu naming, terminology consistency, button visibility, and search features so that users can find information without assistance.

3.6. Comparison with previous research

Table 11 compares this study with the five studies in Table 1. The comparison shows differences in scope, research flow, and evaluation form.

Table 11. Comparison between this study and previous studies.

Studies	Focus on previous studies	The difference in this research
Dahlan et al. [13]	One exam scheduling process	This research combines announcements, documents, monitoring, assessments, archives, and e-Showcase.
Jabour [14]	Needs analysis and workflow recommendations	This research proceeds from needs to priorities, interactive prototypes, task testing, and SUS.
Mostefai et al. [15]	E-learning service architecture and UEQ	This research focuses on the academic flow of PjBL in the context of the unit and the access rights of each role.
Netinant et al. [16]	System adoption after three years of use	This research builds traceability from user issues to pre-implementation testing.
Ko and Hughes [17]	User ratings on AI-based intelligent tutoring systems	This research applies user-centered principles to AI-free academic services and publication governance.

This comparison demonstrates that the difference between these studies lies not in the use of Design Thinking, but in how each stage is connected. This study demonstrates how interview results are translated into system requirements, prioritized using an impact-effort matrix, and then retested through prototypes and user evaluations. This ensures that every design decision has a clear and traceable basis.

3.7. Implementation and evaluation plan

The prototype is not yet a fully functional operational system. Therefore, the development team needs to implement the system in stages. Table 12 presents the initial implementation phase and evaluation indicators.

Table 12. System implementation and evaluation plan.

Stage	Time	Activity	Indicator
1. Preparation	Before the trial semester	Improve labels, buttons, guides, sections, and menu structure.	The issue list is complete; all scenarios can be run on the revised prototype.
2. Independent pilot	One semester	The department uses a system with limited coverage and self-storage.	Active users; document completeness; task success; ease score; SUS; amount of assistance.
3. Periodic evaluation	At the end of each semester	Repeat scenario testing, written retrospective feedback, ease scales, and SUS.	Inter-semester comparison and new improvement priority list.

3.8. Research limitations

This study has four limitations. First, the prototype is not yet a fully functional operational system. Second, the testing involved only 19 participants from one department. Third, participants wrote feedback retrospectively, so the data did not capture the entire thought process during the interaction. Fourth, the study did not record task completion times. These limitations limit generalization and measurement of time efficiency. However, the data still demonstrates a relationship between user needs, design decisions, and testing results.

4. Conclusions

This research produces an information system model that connects PjBL management with e-Showcase through five stages of Design Thinking. Interviews revealed the need for work publication, uniform templates, transparent rubrics, centralized information, and cross-semester archives. These needs were translated into 10 functional and 4 non-functional requirements, then prioritized through impact-effort discussions with developers.

A total of 19 users performed 139 tasks. Participants completed 131 tasks without instructions and 8 tasks with general instructions about menu locations. The average ease-of-use rating was 4.38 out of 5, while the average SUS score was 79.61. These results indicate that users were able to accept the prototype and complete the main flow of the system. However, these results do not indicate that all features were easy to use. The guide and template search scenario required the most instructions, with 4 out of 12 students needing them. Therefore, developers still need to improve menu names, terminology consistency, button visibility, and the document search feature.

Further research should implement the system gradually, increase storage capacity, and evaluate its use at the end of each semester. Subsequent evaluations should record task completion times and utilize concurrent Think Aloud when testing conditions permit.

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