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https://doi.org/10.5109/7395544

出版情報：Proceedings of International Exchange and Innovation Conference on Engineering & Sciences (IEICES). 11, pp.377-382, 2025-10-30. International Exchange and Innovation Conference on Engineering & Sciences
バージョン：

Web-based Portfolio Management System for Technology Transfer and Licensing Offices

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Abstract: *The Technology Transfer and Licensing Office (TTLO) of Caraga State University (CSU) currently faces challenges in streamlining the intellectual property (IP) protection application process, ensuring timely data access, and maintaining robust security protocols. This study aims to address the challenges mentioned by developing a web application to improve the application process and workload management, as well as ensure secure data access. The researchers utilized NextJS—a JavaScript framework and PostgreSQL database for the development, and ISO 9241-11 as the usability testing framework, focusing on three key metrics: effectiveness, efficiency, and satisfaction. Findings revealed 70.5 and 78.0 out of 100 usability scores with "Good" ratings for clients and administrators, respectively, in which they encountered minimal issues while using the web application, and feedback indicated a moderate degree of satisfaction with its usability and performance. The web application would still benefit from further refinement, particularly the user interface, to optimize the user experience.*

Keywords: IP Portfolio; Portfolio Management; web-based

1. INTRODUCTION

The swift advance of digital technology has made it possible to enable the essential change in the distribution and accessibility of knowledge in many spheres of research. Data integrity, authenticity, and secure management of intellectual property (IP) assets are therefore also challenged by this widening access to information. Organizations adopt modern tools and frameworks that balance openness with protective measures to ensure responsible information management [1][2].

Numerous research institutes are working on different projects in fields including technology, education, and agriculture, underlining the great relevance of creativity and research in promoting development. Both commercially and academically, these activities produce notable intellectual property results that highlight the need for conscious protection of such intellectual assets. Thus, since these entities support the procedures of IP registration, safeguarding, and commercialization, establishing specialized offices targeted at technology transfer and licensing is absolutely vital to this mission. Transforming scientific discoveries into profitable businesses and hence supporting continuous innovation depends on well-organized licensing processes[3]. One of the

The Technology Transfer and Licensing Office (TTLO) plays an important part in the formalization and licensing activities of research-oriented institutions and interested individuals. The office is committed to providing intellectual property (IP) documentation in readily accessible formats, along with thorough consultations to properly assess IP research and innovations. Supported with detailed documentation. The office also makes use of collaborative tools, including Google Docs and Google Sheets; with that said, it was identified that there is an opportunity for improved workflow efficiency and technological advances in data management solutions.

The existing system of TTLO works fine, as evidenced by the patented Starch Extractor machine, yet there is observable potential in improving the current workflow, and for this reason, having data spread out and reliant on various platforms may cause issues with transparency, accessibility, and adaptability when dealing with IP applications [4][5]. Tools that are not integrated or unified can make it hard for TTLO to track status, manage documents, and check data. The hybrid approach could lead to data duplication, slow IP tracking updates, and hinder operational efficiency upon interruption of untracked projects. TTLO also conducts a patent search to identify the novelty of a device or machine, such as Cacao pod crushers [6][7].

Studies on web-based portfolio management systems have been very positive, revealing some fundamental solution spaces for operational problems. The centralized digital tracking can greatly improve administrative productivity, data consistency, and decision-making. While online management systems are effective in managing data transparency [8]. Setyawati [9] also points out that they can simplify the process and involve stakeholders. It follows that if the TTLO switches to an online system that is centralized on the web, this might improve its operational efficiency.

A custom web-based system for TTLO's operations is presented here. The system will handle client registration, task submission, task assignment, as well as centralized monitoring of status. It will be of assistance in the management of IP portfolios in all stages of IP projects. The most important components are digital forms with validation, secure data access control, and role-based user management. The technology stack used to develop the system in this study is almost entirely NextJS and Postgres.

The ISO 9241-11 usability framework will be used to evaluate the proposed system's effectiveness, focusing on user satisfaction, effectiveness, and efficiency as key metrics[10]. This evaluation will include a number of metrics, such as task success rates and error frequencies, time-related efficiency metrics, and user satisfaction ratings (from structured testing scenarios). These metrics

will help to validate the design of the system and provide insights into how well it fits within the operational dynamics of the TTLO.

Developing a web-based IP portfolio management system that responds to constantly shifting TTLO needs. Utilizing centralized data management, secure access systems, and automation, the project seeks to improve administrative efficiency and speed of processing[11]. By fixing present operational bottlenecks, this platform helps the institution to maximize chances for knowledge management going forward.

2. OBJECTIVES

The study aimed to accomplish the following objectives: To develop a centralized web-based application to streamline the intellectual property (IP) protection application process and a relational database management system (RDBMS) for efficient data management, implement a User Management system (UMS) to enhance application management and workflows, enhance user authentication mechanisms and access controls to prevent unauthorized data access and breaches, and evaluate the system using the ISO 9241-11 usability standards.

3. METHODOLOGY

The study used a combination of methods in requirements gathering and analysis, such as individual interviews and evaluation sheets.

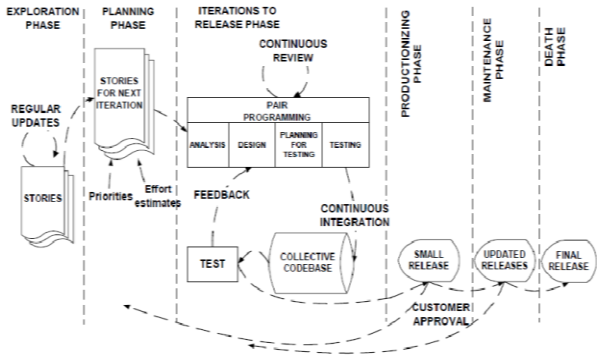

Fig. 1 ARABIC 1 Agile Methodology (Programming Life Cycle)

The development follows a software development lifecycle anchored in agile methodology, as observed in Fig. 1, emphasizing an iterative process and including stakeholder feedback. Because of its iterative nature, emphasis on working together with stakeholders, and flexibility in responding to changing user requirements, the Agile methodology was chosen as the fundamental structure for software development. Agile's flexibility made it feasible to make frequent system changes and improvements with ongoing feedback during the stages of development, which made sure the system aligned with the TTLO's process of operation. The Agile System Development Life Cycle (SDLC) directed the project's development through the following phases: planning, design, implementation, testing, and review.

The study employed a combination of quantitative and qualitative methods to identify the system's requirements. To find challenges with the current manual procedures, TTLO employees participated in interviews and discussions. In addition, usability tests and surveys were used to gather measurable data regarding user preferences and interactions. To ensure a user-centered design, these details were combined to document, rank, and improve system features. For improved maintainability and scalability, the system architecture used the Model-View-Controller (MVC) design pattern, a three-tier structure with a presentation layer (user interface), a business logic layer (functional processing), and a data layer (database access). Each of the layers has a specific purpose, depicted on Fig. 2.

High-fidelity wireframes created with Figma and Unified Modeling Language (UML) diagrams were among the tools utilized to accurately represent and model system components, providing a visualization of how users would use and interact with the system. Regular discussion between the development team and the TTLO staff was made easier by these techniques for modeling and visualizing. Entity Relationship Diagrams (ERDs) and use case diagrams, which illustrate how different user roles interact with the system's functionality, as well as define the system architecture and data design.

The developed system was evaluated using the ISO 9241-11 usability framework, an international standard that defines usability according to three primary criteria: user satisfaction, effectiveness, and efficiency. This framework provides a systematic method of assessing how well users can use the system to complete tasks, how easily and precisely they can do so, and how satisfied they are with the experience overall. This approach was applied in the evaluation of the developed system to ensure an adequate understanding of the user experience. Since task success and error rates demonstrate how accurately and effectively users were able to complete their tasks when interacting with the system, they were used to evaluate its effectiveness. A couple of metrics were used to evaluate how well users interacted with and used the system to complete the tasks assigned to them, including time on task, time-based efficiency, and overall relative efficiency. Post-task comments were used to evaluate satisfaction using the System Usability Scale (SUS), a ten-item questionnaire used for evaluating subjective user experience and determining a usability score out of 100. These usability testing methods and metrics are important for knowing the system's performance by identifying areas of strength and pointing out areas for improvement.

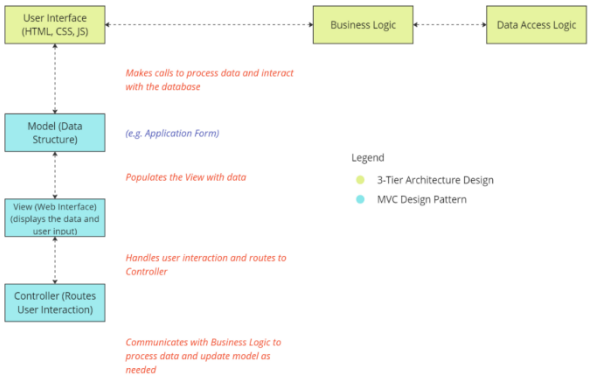

Fig. 2 Design of the System Architecture

Table 1: Client-Side Task Scenario Titles

Task ID	Task Description	Time Allotted
T1	Submit Profile Form	4 mins
T2	Submit Deed of Assignment	2-3 mins
T3	Track Application Status	2 mins
T4	Review of IP Guidelines	< 1 min
T5	View News and Updates	< 1 min

Table 2: Admin Side Task Scenario Titles

Task ID	Task Description	Time Allotted
T1	Submit Profile Form	2 mins
T2	Submit Deed of Assignment	1-2 mins
T3	Track Application Status	2 mins
T4	Review of IP Guidelines	1 min
T5	View News and Updates	< 1 min

4. RESULTS AND DISCUSSION

The usability of the web-based IP portfolio management system was evaluated using the ISO 9241-11 framework, focusing on three key areas: effectiveness, efficiency, and user satisfaction. Two user groups - clients and admin/staff - were observed while completing five role-specific tasks, each with varied time allotments based on expert pilot testing time logs and task complexity. Metrics were derived from task completion observations, time logs, and a post-test usability questionnaire.

4.1 Effectiveness

Task success rates and error rates for each of the five role-specific tasks assigned to clients, staff/and admin helped determine effectiveness. Clients showed consistently high success and low error rates across all tasks, completing tasks 2, 4, and 5 with 100% and 0% respective results, as Table 1 shows. Due to small input errors and difficulties navigating tasks, tasks 1 and 3, which included profile submission, minor processing input mistakes, and untracked status form progress based on the earlier, showed a somewhat lower success rate of 80%.

Nevertheless, the client group kept an overall success rate of 92.67% and a correspondingly low average error rate of 7.33%. Particularly in tasks involving document submission, data retrieval, and IP information dissemination, these outcomes reflect the great usability of the system for outside users or client users, particularly the CIPC.

With complete success in four of five tasks, the administrative/staff group also performed quite well. With a 60% success rate, Task 3 (Manage Application Phases) indicated difficulties completing the task linked to phase creation and adding subtasks due to the intermittent placement of interface elements and sequential input. For most of the 8.67% total error rate seen in the group, this work also helped. Nonetheless, the average success rate of 91.33% indicates that, especially for jobs like staff assignment, calendar scheduling, and user account management, the system helped administrative processes to be effectively supported. These findings indicate that although more particular improvements to some task flows, such as those with multi-step or dynamic content, would lead to more consistent completion results, overall, UI design is effective for both user roles.

Table 3. Client Task Success and Error Rates

Task ID	Task Description	Success Rate (%)	Error Rate (%)
T1	Submit Profile Form	80	20
T2	Submit Deed of Assignment	100	0
T3	Track Application Status	80	20
T4	Review of IP Guidelines	100	0
T5	View News and Updates	100	0
Avg		92.67	7.33

Table 4. Admin Task Success and Error Rates

Task ID	Task Description	Success Rate (%)	Error Rate (%)
T1	Assign Staff to Application	100	0
T2	Review IP Deed Submissions	100	0
T3	Manage Application Phases	60	40
T4	Schedule Event on Calendar	100	0
T5	Manage User Accounts	100	0
Avg		91.33	8.67

4.2 Efficiency

Efficiency was measured by the time to complete tasks and Time-Based Efficiency (TBE) scores. These indicators provide insight into how intuitively and quickly users interact with the interface.

4.2.1 Time Allotment

Unambiguous benchmark durations for every task should be established for a meaningful efficiency assessment. Based on the findings of expert performance trials carried out by the developers, the developers

allocated specific amounts of time for each task in this research.

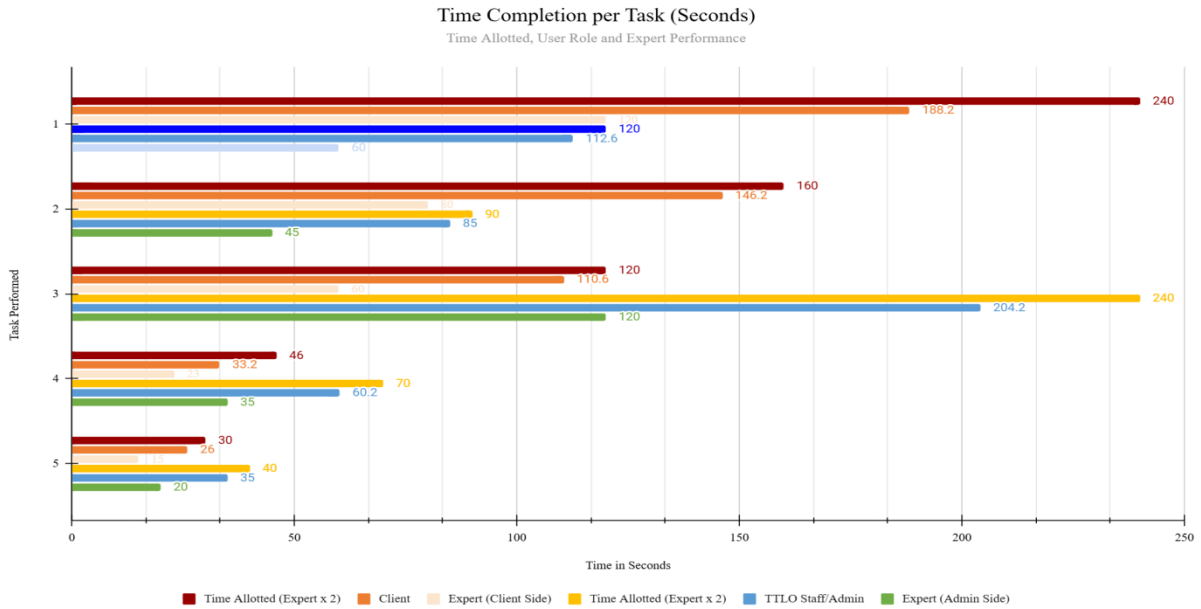

Fig. 3. User Average Time Completion vs Expert Pilot Completion (Time taken x 2)

The average time spent on each task by expert users familiar with the system's workflow was determined based on several reliable trial runs. The maximum allowable completion time, which was used as the standard for assessing participant efficiency, was subsequently estimated by multiplying these averages by two.

This approach adheres to the ISO 9241-11 usability standard, which emphasizes assessing system usability within a "specified context of use" that comprises defined users, tasks, and environments. Instead of mandating external or industry-wide performance standards, ISO 9241-11 promotes context-sensitive evaluation methods considering system objectives and user circumstances. Benchmarking against internal expert performance ensured realistic and pertinent thresholds based on the intended operational environment, which is crucial because the developed system is highly specialized for TTLO processes.

By aligning task time constraints with internally validated performance, rather than external metrics, the study maintained the integrity and applicability of the efficiency evaluation. This approach allowed the usability test to capture practical outcomes for TTLO staff and clients, offering a reliable basis for determining whether users could complete tasks effectively and within expected time boundaries.

4.2.2 Time on Task

Task completion time was recorded across five standardized tasks for both clients and admin/TTLO staff. As visualized in Figure 1, each task's completion time was compared against the expert benchmark (doubled to define the maximum allowable duration). Client users recorded the longest average time on Task 1 (188.2s), involving multi-field form entry and file uploads, which required more cognitive load and interaction steps. They gradually improved in Tasks 4 and 5, which involved simpler content viewing and navigation, clocking in under 40 seconds.

On the admin side, the most time-intensive task was Task 3 (204.2s), which involved managing application phases like adding a new phase or main task and creating subtasks afterwards. This module requires multiple clicks, validations, and updates across different panels or interface elements. However, like the clients, admin users also showed improved performance in later tasks such as scheduling calendar events (Task 4, 60.2s) and managing user accounts (Task 5, 35.0s), indicating increasing familiarity with the interface.

4.2.3 Time-based Efficiency (TBE)

Measuring the percentage of successful task completions in relation to the total time invested allowed one to determine Time-based Efficiency (TBE). Compiled in Table 3, the data shows that both user groups completed more effectively on simpler, well-guided tasks. While administrative users peaked at Task 4 (0.05), client users obtained the highest TBE in Task 5 (0.06). These results imply that in low-complexity tasks with minimalistic interface design and panels to navigate effectively reduced pointless interaction steps. TBE was lower in tasks involving heavy data interactions, including form completion and phase management, where additional time was used to navigate and perform the creation of subtasks and verifying the content.

4.2.4 Overall Relative Efficiency (ORE)

Computed at 100%, the Overall Relative Efficiency (OR) for client and administrative user roles confirmed that all tasks were completed within the maximum permissible time duration as noted in Table 3. This means that, while some tasks took longer than others, testing revealed no noticeable delays or bottlenecks. The system therefore met the high task throughput in a reasonable amount of time, successfully meeting the usability goal for both user groups.

This result is notable, especially when combined with the efficiency scores based on time. In other words, the system maintained a balanced trade-off between task complexity and interface support. Even in the presence of disjointed system behavior, for example, system lag due to ongoing system development, compiling, and processing activities, as well as confusion with some of

the interface modules, users were still able to complete their assigned tasks. The fact that all tasks were completed within expert-defined thresholds means that the system was fair to the users and even captured delays appropriate to the task. The absence of serious and complicated errors, such as inability to perform a simple task and navigation, further underscores the potential for reliable real-world use of this interface by both new and experienced users at TTLO.

Table 3. Client & TTLO Staff/Admin TBE and ORE

Task ID	Client TBE	Admin TBE	Client ORE (%)	Admin ORE (%)
T1	0.01	0.01	100	100
T2	0.01	0.01	100	100
T3	0.02	0.01	100	100
T4	0.04	0.05	100	100
T5	0.06	0.03	100	100

4.3 Satisfaction

User satisfaction was gauged using the System Usability Scale (SUS), which was administered post-test. The SUS results were analyzed according to standard interpretation scales.

Table 4. SUS Scores and Ratings

Role	SUS Score	Grade	Rating
Client	70.5	B	Good
Admin	78.0	B	Good

The System Usability Scale (SUS) scores, which are shown in Table 4, provide an overall indication of user satisfaction with the web-based IP portfolio management system. The SUS score was 70.5 for clients and slightly higher at 78.0 for admin users. Using the standardized SUS interpretation framework, both of these scores were rated in the "Good" category, equating to a B rating for usability, which indicated that a generally positive user experience was achieved for both groups. These results indicated that users were able to successfully use the system to perform their tasks and found it intuitive enough to use. The consistent gradings in terms of usability show that the system has met its goal of providing an interface that is accessible and role-based, with a clear visual and functional design.

Client users, while generally positive, scored slightly lower on the System Usability Scale (SUS), which was consistent with some of the usability problems we saw in the earlier data entry and application tracking tasks. Much of this can be attributed to initial confusion with interface elements, particularly form navigation and subtask labeling, in tasks such as profile submission and status tracking. Administrative users, on the other hand, were using modules for more sophisticated operations like assigning tasks, navigating a calendar, and managing application phases, but still found the system to be highly usable. Their feedback, from the SUS and direct observation, showed a strong positive response to the centralized dashboard and workflow controls being intuitive. The SUS scores indicate a high level of satisfaction with the system's ability to handle TTLO's operational needs in an easy-to-use way.

5. CONCLUSION AND RECOMMENDATIONS

This section discusses the overall findings of the study, recommendations for further improvements, and future research.

This study has accomplished its main objectives and developed a web-based portfolio management system for technology transfer and licensing offices, streamlining the application process, improving data management, and workflow. Both client-side and admin-side showed satisfactory results in the evaluation with further improvements, particularly on the user interface design. It suggests a more minimal design with appropriate icons and clear instructions to avoid overwhelming new users, implement synchronized data fields and dropdown selections to reduce data entry redundancy, and review the database for refinement. Moreover, the implementation of the system can make a significant positive impact on the operations of technology transfer and licensing offices and clients, thereby helping encourage innovation in the community. It should be noted that each office has a unique workflow and must cater to its needs. Thus, the implementation may differ for other offices. This research will serve as groundwork for future improvements.

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