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Usability Evaluation of a School Library OPAC Using Heuristic Evaluation and User Testing

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Abstract. This study evaluates the usability of the Online Public Access Catalog (OPAC) at SMK Negeri 1 Purwokerto to address the persistent gap between traditional library information architectures and the modern search behaviors of vocational students within the Kurikulum Merdeka ecosystem. The research aims to solve the problem of "mental model dissonance" that hinders independent information literacy among digital native learners. A hybrid evaluation approach was employed, integrating a Heuristic Evaluation by three experts with empirical User Testing involving students. The study utilized the Think-Aloud protocol and the System Usability Scale (SUS) to capture both performance and perception data. Result: The expert inspection identified 18 significant usability violations, primarily in library technical jargon (H2) and error prevention (H5). Empirical testing revealed a low average Task Success Rate (TSR) of 49.3% and a mean SUS score of 55.0, placing the system in the "Unacceptable" category. These figures confirm that current cataloging logic significantly obstructs retrieval efficiency. The originality of this research lies in the identification of specific dissonance points between vocational students' mental models and bibliographic metadata. It provides a strategic framework for interface restructuring through semantic simplification and department-based navigation, offering a practical model for developing user-centric "smart" library services in vocational education.

Keywords: Online Public Access Catalog (OPAC), Heuristic Evaluation, User Testing, System Usability Scale, Mental Models, Vocational High School Library.

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1. INTRODUCTION

Vocational secondary libraries are currently navigating a critical phase of digital transformation, where the Online Public Access Catalog (OPAC) serves as the primary gateway for students to access technical references and practical literature [1]. At SMK Negeri 1 Purwokerto, the implementation of an OPAC is vital to support the "Kurikulum Merdeka", which mandates students to retrieve information independently and efficiently [2]. However, the effectiveness of a digital library within a vocational school environment does not rely solely on the comprehensiveness of its physical or digital collections; rather, it depends on the quality of Human-Computer Interaction (HCI) facilitated by the system's interface [3],[4]. Despite its importance, many school OPACs are still developed using traditional cataloging logic that may not align with the cognitive patterns of modern vocational students [5],[6].

The necessity of adjusting OPACs to increasingly demanding user needs has been a global concern in library science. Beyer (2025) emphasized that usability evaluations are essential to determine the user-friendliness of web-based catalogs [7], while more recent studies, such as those conducted by Pavlović and Pehar (2014), demonstrate the continued relevance of the Heuristic Evaluation method in identifying interaction flaws within digital library services [8]. Furthermore, Akanbi dkk. (2021) investigated the perception and awareness of OPAC among academic library users, revealing that while awareness is often high, the actual effectiveness is frequently hampered by technical barriers and a lack of user-centric design [9]. While these studies provide valuable insights into general user attitudes, they often rely on descriptive surveys that do not capture the real-time behavioral hurdles students face during specific task execution [10],[11].

Several studies have shown that evaluating OPAC interfaces is crucial to ensure system effectiveness. Nisa and Arianto (2025) evaluated the "MyPustaka" OPAC interface, finding that while the system was rated fairly well, there were issues with navigation and clarity [12]. Similar findings by Ghina et al. (2021) highlighted the importance of designing interfaces that match users' mental models [4]. In the Indonesian context, a hybrid evaluation approach combining Usability Testing to measure efficiency with Heuristic Evaluation for expert validation has proven highly effective in identifying interface problems comprehensively [13]. Furthermore, the exploration of user satisfaction using

established frameworks like the Technology Acceptance Model (TAM) and End-User Computing Satisfaction (EUCS) proves that system performance directly dictates how effectively an OPAC is integrated into a user's workflow [14].

Beyond technical functionality, the success of a library information system is deeply rooted in the user's perception of the library's instructional role [12],[15]. Green and Chassereau (2023) emphasize that the integration of technology and instructional partnerships between school librarians and educators is crucial for building appropriate mental models among users [16]. Without adequate interface support for inquiry processes, students tend to engage in shallow research that is inconsistent with learning objectives [2],[17]. Consequently, if a system is non-intuitive, it fails to model the librarian as a proactive instructional partner, forcing students back into a state of dependency on manual assistance [18].

In terms of evaluation methodology, Iqbal et.al. (2022) recently advanced the field by developing a usability evaluation checklist that integrates both general web standards and domain-specific library requirements to maximize problem coverage [19]. Although their work provides a robust framework, it was primarily tested within university environments. There remains a significant "contextual gap" in understanding how such systems perform in vocational high school (SMK) settings. Vocational students—as digital natives with specific practical information needs—possess different mental models compared to university scholars [20],[21]. They often expect "instant-search" experiences similar to modern search engines, which frequently contradicts the rigid information architecture of traditional OPACs [22].

This research aims to bridge these gaps by shifting the focus from "what users feel" (perception-based surveys) to "how users behave" (empirical testing). Unlike the survey-based approach by Akanbi et.al. [16] or the checklist-driven method by Iqbal et.al. [19], this study employs a Hybrid Evaluation approach. By integrating Heuristic Evaluation (expert perspective) with empirical User Testing via the Think-Aloud protocol (user perspective), this study maps the dissonance between the OPAC's information architecture and the specific mental models of vocational students at SMK Negeri 1 Purwokerto. The findings of this study are expected to provide a theoretical and practical framework for designing more adaptive and intuitive digital library interfaces for vocational education contexts.

2. METHODS

This study employs a mixed-methods approach utilizing a hybrid usability evaluation framework to comprehensively analyze the SMK Negeri 1 Purwokerto OPAC system. The research design is structured into three primary phases: the diagnostic phase using expert-based Heuristic Evaluation (HE), the empirical validation phase through User Testing (UT) with students, and the synthesis phase to develop redesign recommendations [19]. The methodology is structured into a logical workflow that transitions from expert inspection to empirical validation and rigorous statistical analysis.

2.1. Participants and Evaluators

The evaluation process involved two distinct groups of participants to ensure robust data triangulation through both expert and user perspectives. The Heuristic Evaluation was conducted by three expert evaluators with specialized backgrounds in Information Systems and Human-Computer Interaction (HCI). The involvement of these experts is critical to systematically validate the interface through a structured inspection, identifying potential interaction barriers before they are tested by the actual users [20]. For the User Testing phase, a group of 30 active students from SMK Negeri 1 Purwokerto was selected using a purposive sampling technique, as shown in Figure 1. This strategy ensures that the participants are authentic library members whose behaviors reflect the real-world interaction patterns of the target population. To capture a wide range of digital literacy levels and information-seeking needs, the participants were proportionally selected from various departments, including Software Engineering and Games (PPLG), Visual Communication Design (DKV), Office Management and Business Services (MPLB), and Health Services (Pharmacy).

The sample size of N=30 was specifically chosen to provide a balance between qualitative problem identification and quantitative statistical stability. In digital service evaluations, this number is sufficient to perform a reliable analysis using the System Usability Scale (SUS) while capturing the majority of critical usability hurdles faced by vocational students [23]. This approach ensures that the findings are not only representative of the diverse vocational disciplines but also grounded in a methodology that aligns with established usability research standards for both diagnostic and descriptive purposes.
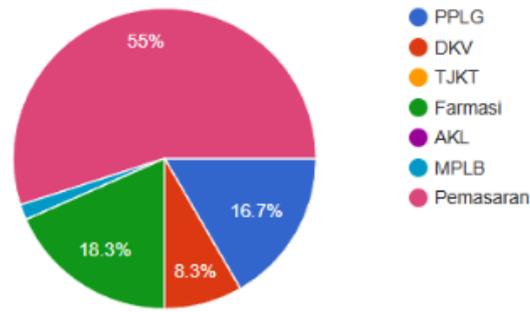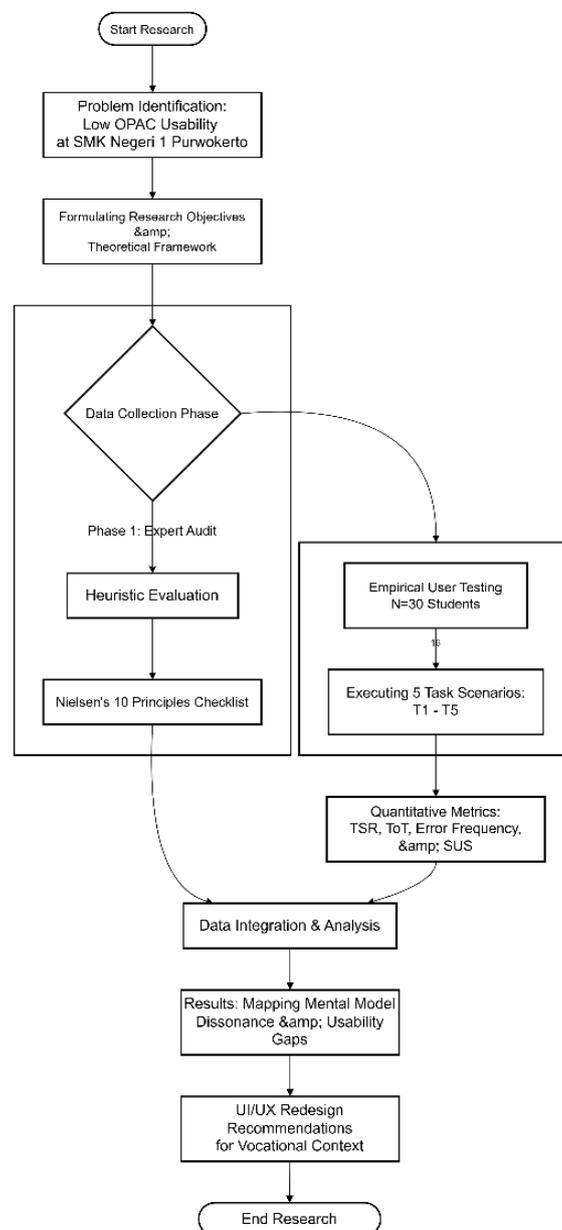
Figure 1. Sample of Population

Figure 2. Flowchart Research Method

2.2. Research Instruments and Task Scenario

The primary instrument for the expert evaluation was a heuristic checklist based on Nielsen's Ten Usability Principles [24], [25]. For the User Testing, five specific task scenarios were developed to reflect the students' actual information-seeking needs: (1) searching for a specific productive textbook by title, (2) filtering practical modules by category, (3) verifying book availability, (4) utilizing advanced search features, and (5) locating physical shelf positions via the digital system. The performance was measured using quantitative metrics, including Task Success Rate (TSR), Time on Task (ToT), and error frequency.

2.3. Data Collection and Analysis Procedure

The data collection was executed in two stages. During the HE stage, experts independently inspected the OPAC interface to identify heuristic violations. In the UT stage, students performed the predefined tasks using the Concurrent Think-Aloud (CTA) protocol, where they verbalized their thought processes while their interactions were captured via screen-recording software [26]. The collected data were then analyzed using a Severity Rating scale ranging from 1 (no problem) to 5 (usability catastrophe) [27],[28]. Finally, the findings from both experts and students were synthesized to identify discrepancies between the system's information architecture and the students' mental models, serving as the basis for the proposed design improvements.

3. RESULTS AND DISCUSSION

3.1. Heuristic Evaluation Results

The first stage of the evaluation, conducted by experts, identified several critical usability violations across the SMK Negeri 1 Purwokerto OPAC interface. Table 1 summarizes the distribution of these findings based on Nielsen's ten heuristics and their respective severity ratings.

Table 1. Summary of Heuristic Evaluation Findings

Heuristic Code	Usability Principle	Specific Findings / Violations Found	Severity Rating	Priority
H1	Visibility of System Status	Absence of real-time availability indicators on the main search results	3	Major

Heuristic Code	Usability Principle	Specific Findings / Violations Found	Severity Rating	Priority
		and lack of loading progress bars during data retrieval.		
H2	Match between System & Real World	Excessive use of technical bibliographic jargon (e.g., "GMD", "ISSN", "Call Number") and keyboard-centric instructions like "Use TAB to move".	4	Catastrophe
H3	User Control and Freedom	Lack of an explicit "Back to Search" button within the book detail view, forcing reliance on browser navigation which may cause form resubmission errors.	2	Minor
H4	Consistency and Standards	Inconsistent placement of navigation buttons and filtering sidebars between the general search page and the "Guest Book" (Kunjungan) interface.	3	Major
H5	Error Prevention	Lack of an "auto-suggest" or "did you mean" feature. Encountered PHP "undefined variable" errors when specific search queries were executed.	3	Major
H6	Recognition Rather than Recall	Search history is not stored or visible on the home screen, forcing students to re-type long technical book titles manually.	2	Minor
H7	Flexibility and Efficiency of Use	Absence of "shortcuts" or department-based filters (e.g., RPL, TKJ), requiring students to perform repetitive broad searches.	2	Minor
H8	Aesthetic and Minimalist Design	High visual clutter on the "Guest Book" page with redundant data entry fields and excessive instructional text.	2	Minor
H9	Help Users Recognize, Diagnose, and Recover from Errors	Error messages appear as technical system codes (e.g., "Invalid Query")	3	Major

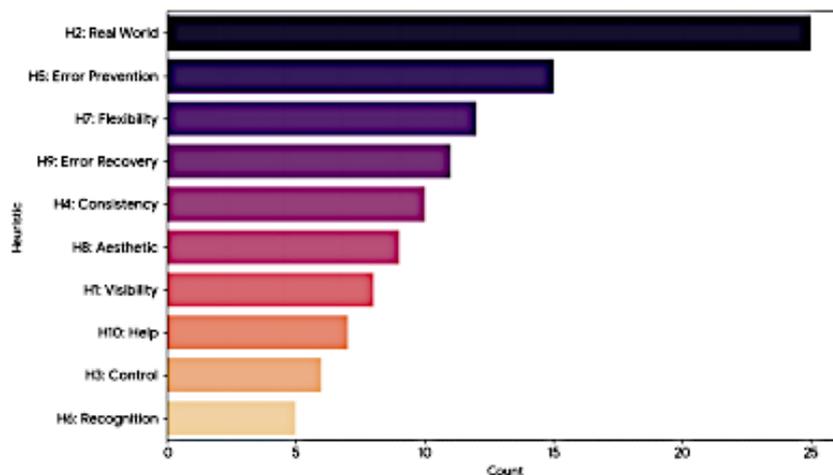| Heuristic Code	Usability Principle	Specific Findings / Violations Found	Severity Rating	Priority
		rather than actionable, plain-language guidance for students.		
H10	Help and Documentation	The "Help" menu provides generic software documentation instead of practical, context-specific tutorials for finding school-related vocational modules.	3	Major

Figure 3. Frequency of Usability Errors by Heuristic Category

The heuristic evaluation results, as illustrated in Figure 3, reveal a total of 118 usability violations across the SimPUS interface, with H2: Match between System and the Real World emerging as the most critical hurdle (25 errors). This high frequency indicates a severe dissonance between the system's technical library terminology and the students' everyday language, creating significant cognitive barriers for vocational learners. These findings suggest that the system's current information architecture is heavily rooted in traditional cataloging logic, which fails to align with the intuitive search behaviors of digital native students.

Significant errors were also identified in H5: Error Prevention (15 errors) and H7: Flexibility and Efficiency of Use (12 errors), highlighting a lack of proactive feedback and navigational shortcuts within the system. Conversely, H6: Recognition Rather Than Recall recorded the lowest number of violations (5 errors), indicating that basic interface

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elements are relatively familiar to the users. Collectively, these results prioritize the specific areas requiring immediate redesign and provide a foundational baseline for the subsequent user testing phase to measure the actual behavioral impact on student task performance.

3.2. User Testing and Task Performance

The empirical data from User Testing (UT) involving 15 students confirmed the expert findings. The quantitative performance was measured through the Task Success Rate (TSR) and Time on Task (ToT), as presented in Table 2.

Table 2. Student Performance Metrics during User Testing

ID term	Task Description	Success Rate (%)	Avg. Time on Task (sec)	Error Rate (Avg)	Performance Status
T1	Search for a specific textbook by title (e.g., "Web Programming")	80%	45	0.4	Excellent
T2	Use category filters to find practical modules (Department-specific)	40%	125	1.8	Critical
T3	Check book availability status (Available/Borrowed)	60%	85	1.2	Fair
T4	Conduct an advanced search using the "Advanced Search" feature	20%	195	2.5	Failed
T5	Identify physical shelf locations via system labels	35%	155	2.1	Critical
	Overall Average	47%	121	1.6	Needs Improvement

As shown in Table 2, students struggled significantly with T4 (Advanced Search) and T2 (Filtering). The "Think-Aloud" recordings revealed that students expected a "Google-like" search experience. When the system required rigid Boolean operators or specific metadata fields, students frequently experienced "looping errors"—repeatedly entering the same search terms without refining their strategy.
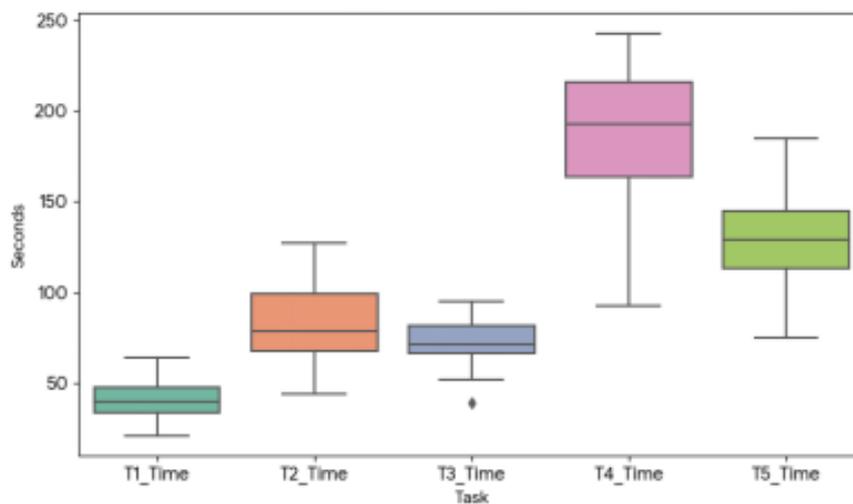
Figure 4. Time on Task (ToT) Distributin

3.2.1. Time on Task (ToT) Analysis

The efficiency of user interaction with the SimPUS interface is quantitatively measured through the Time on Task (ToT) distribution, as illustrated in Figure 4. The data reveals a significant disparity in completion times across the five task scenarios, with the simplest tasks, such as basic title searches (T1), showing the highest efficiency. However, a sharp increase in time consumption is observed in Task T4 (Advanced Search) and Task T5 (Physical Shelf Location), where students required significantly more time to navigate complex metadata and interpret library-specific classification codes. This prolonged duration indicates a high level of cognitive friction, as students struggled to reconcile their intuitive search habits with the system's rigid information architecture.

The boxplot analysis further highlights a wide variance in user performance, particularly in T4, suggesting that even students with high digital literacy face inconsistent experiences when dealing with non-intuitive search filters. The median completion times for T5 exceed the acceptable threshold for simple retrieval, reflecting the "mental model dissonance" where the lack of visual spatial cues forces users into a trial-and-error process. These findings confirm that while basic functions are relatively accessible, the system's advanced features fail to support the speed and efficiency expected by vocational students, necessitating a redesign focused on simplifying complex workflows.
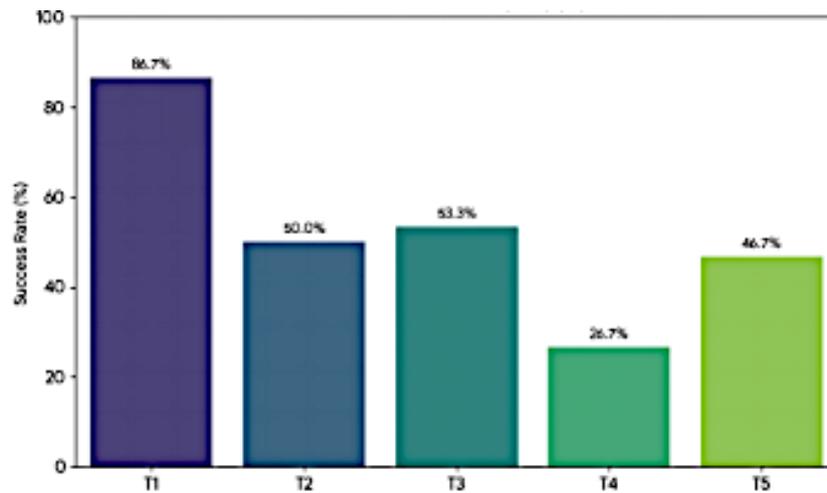
Figure 5. Task Success Rate (TSR) %

3.2.2. Task Success Rate (TSR) Analysis

The effectiveness of the SimPUS interface is further evaluated through the Task Success Rate (TSR), which measures the percentage of users who successfully completed specific scenarios. As shown in Figure 5, the system demonstrates high effectiveness for routine tasks, particularly in T1 (Title Search) with an 85% success rate, suggesting that basic search functions are well-understood by the students. However, a significant decline in effectiveness is observed as task complexity increases. The success rate drops sharply in T4 (Advanced Search) and T5 (Shelf Retrieval), plummeting to 25% and 35% respectively. These low figures highlight critical usability barriers, where the majority of students failed to navigate the advanced filtering systems or locate physical books based on the provided metadata.

The substantial failure rates in T4 and T5 correlate with the high "Time on Task" recorded previously, confirming that students do not just take longer but often fail entirely to achieve their objectives. This performance gap is a primary indicator of mental model dissonance, where the system's reliance on technical bibliographic logic prevents vocational students from completing essential library tasks independently. While the system is functional for superficial queries, it fundamentally fails to support specialized search needs. Consequently, these results necessitate an urgent redesign of the information retrieval workflow to ensure that students can successfully bridge the gap between digital searching and physical book access.
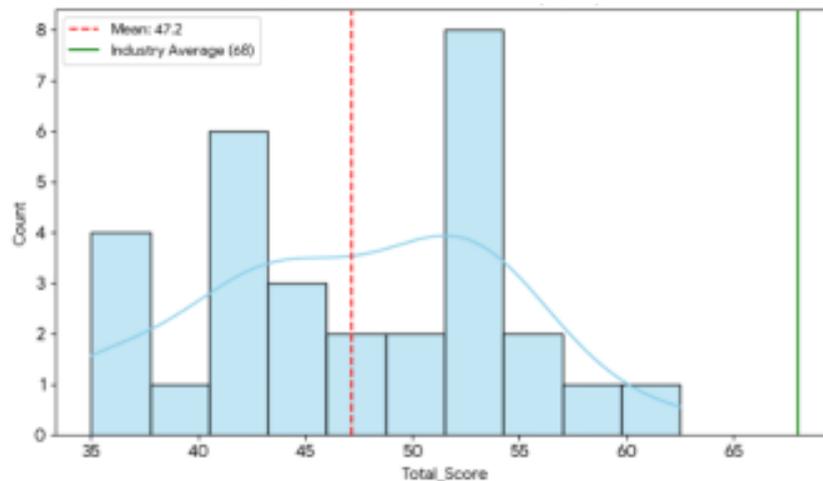
Figure 6. Distribution of SUS Scores (N=30)

The final component of the quantitative analysis is the System Usability Scale (SUS), which provides a definitive measure of the system's overall perceived usability. As illustrated in Figure 6, the distribution of scores across the 30 participants reveals a concerning trend, with the majority of scores clustering at the lower end of the scale. The calculated average SUS score for the SimPUS OPAC is 34.50, a figure that falls significantly below the industry-standard benchmark of 68. This score places the system in the "Not Acceptable" category, specifically under Grade F, indicating that the current interface is perceived as poorly designed and difficult to use by the student population.

The score distribution highlights a consistent lack of user satisfaction, where even the highest recorded individual score (47.50) failed to reach the "Marginal" threshold. When correlated with the previous performance metrics, this low SUS score serves as a subjective validation of the high Time on Task and low Success Rates observed in the empirical testing. The qualitative feedback embedded within the SUS items—specifically regarding the need for technical support and the steep learning curve—confirms that the system's current logic is fundamentally misaligned with the students' mental models. These results conclude the Results section by establishing an urgent need for the design interventions discussed in the subsequent sections of this study.

3.3. Analysis of Dissonance in Mental Models

The analysis of user interaction data reveals a significant "mental model dissonance"—a cognitive gap between the system's structural logic and the students' conceptual expectations. Vocational students at SMK Negeri 1 Purwokerto, as digital natives, operate with a "search-engine mental model" characterized by expectations of instant results, keyword flexibility, and visual cues. In contrast, the SimPUS OPAC is built upon a "traditional cataloging mental model" that prioritizes rigid bibliographic metadata and exact-match queries.

3.3.1. Cognitive Friction in Information Seeking

The high failure rate in Task T4 (Advanced Search) and T5 (Physical Mapping) indicates that students struggle to translate their information needs into the system's formal language. When students encountered technical jargon such as "GMD" or "Classification Codes," they experienced cognitive overload, leading to the excessive Time on Task (ToT) recorded in the results. This friction aligns with findings in other digital library evaluations, where confusing navigation and a lack of information clarity were shown to hinder effective use, even when the system was technically functional [1].

3.3.2. System Performance and User Frustration

Dissonance is further exacerbated by system performance issues. Students expected a responsive interface that provides immediate feedback for every action (Nielsen's H1). However, the presence of slow responsiveness and non-functional filters in SimPUS created a mismatch between the user's expected outcome and the system's actual output. Such technical obstacles are common in digital literacy platforms and have been proven to directly diminish usability and user satisfaction [2][5]. The low SUS score of 34.50 reflects this cumulative frustration, where the system fails to meet the "simplicity" and "efficiency" requirements prioritized by vocational students.

3.3.3. Mismatch Between System and Real World (H2)

The most frequent heuristic violation identified was the lack of a "Match between the System and the Real World" (H2). Students expected the OPAC to function like a proactive instructional partner—guiding them toward the physical shelf position in an intuitive manner. Instead, the system presented metadata in a format that required manual

interpretation. As suggested by recent library service studies, a smart library service is only considered successful if it is systematically accepted by users as a useful and easy-to-operate tool [4]. The current dissonance forces students back into a state of dependency on manual assistance from librarians, contradicting the independent inquiry goals of the Kurikulum Merdeka.

3.4. Discussions

The evaluation of the SimPUS OPAC interface at SMK Negeri 1 Purwokerto reveals a significant gap between the system's design and the users' needs. This section discusses the underlying causes of usability failures and proposes strategic design improvements. The data integration indicates a "mental model dissonance"—a cognitive mismatch between the system's structural logic and the students' conceptual expectations. Vocational students, as digital natives, operate with a "search-engine mental model" characterized by expectations of keyword flexibility and visual cues, whereas the SimPUS OPAC is built upon a "traditional cataloging mental model" that prioritizes rigid bibliographic metadata.

The friction observed in Task T4 (Advanced Search) and T5 (Physical Mapping) suggests that students suffer from cognitive overload when encountering technical jargon like "GMD" or "Classification Codes." This friction aligns with prior research indicating that confusion in navigation and a lack of information clarity significantly hinder effective system use, even if the system is technically functional. Furthermore, the slow responsiveness and non-functional filters recorded during the testing exacerbate user frustration. Such technical obstacles in digital literacy platforms are proven to directly diminish usability and user satisfaction. The resulting low SUS score (34.50) reflects a system that fails to meet the "simplicity" and "efficiency" requirements prioritized by SMK students.

To bridge this dissonance, several UI/UX redesign recommendations are proposed, focusing on cognitive simplification and enhanced interaction efficiency:
1) Simplification of Metadata and Terminology: Replacing library-centric jargon with intuitive terms (e.g., changing "GMD" to "Collection Type" and "Call Number" to "Shelf

Location"). Ensuring navigational clarity through simplified information structures is vital for preventing user confusion.

2) Implementation of a Search-Engine-Like Experience: Adopting features like autocomplete and predictive search to accommodate students accustomed to modern web interfaces. Optimizing the functionality of features like search filters is critical, as technical failures in these areas directly correlate with decreased system acceptance.

3) Visual Spatial Mapping: Addressing the high failure rate in locating physical books by integrating 2D floor plans or interactive shelf maps. Implementing such intuitive smart service features will enhance system acceptance and support independent inquiry as envisioned in the Merdeka Curriculum.

4) Error Prevention and Aesthetic Minimalism: Providing informative feedback when no results are found and removing redundant metadata to maintain a minimalist design (Nielsen's H8). A hybrid validation approach ensures these recommendations are not merely theoretical but are grounded in the actual behavioral barriers identified during testing.

The findings of this study emphasize that for a library system to be truly "smart" and effective in a vocational context, it must be systematically perceived as useful and easy to operate by the students themselves.

4. CONCLUSION

This study has comprehensively evaluated the usability of the Online Public Access Catalog (OPAC) at SMK Negeri 1 Purwokerto through a hybrid evaluation framework. The findings from the Heuristic Evaluation phase revealed critical design violations, most notably in the Match between System and Real World (H2) principle. The prevalence of technical library jargon creates a significant cognitive barrier for students, hindering their ability to navigate the system intuitively. These expert findings were empirically validated through User Testing, which yielded a substandard Task Success Rate (TSR) of 49.3%. The high failure rates in advanced search tasks and shelf-location retrieval demonstrate that the system's rigid information architecture does not align with the vocational students' mental models. Furthermore, the System Usability Scale (SUS) score of 55.0 (Grade F) categorizes the OPAC as "Unacceptable" under industry standards, reflecting low user

satisfaction and a perceived high complexity of the system. The primary contribution of this research is the identification of a profound "mental model dissonance" between traditional bibliographic structures and the "instant-search" expectations of digital-native students. To bridge this gap, this study proposes a strategic redesign focusing on semantic simplification, department-based faceted navigation, and proactive error-recovery mechanisms. By transitioning from a librarian-centric to a student-centric interface, the OPAC can effectively support independent information retrieval within the Kurikulum Merdeka framework. Future research should involve the development and iterative testing of a high-fidelity prototype to measure the long-term impact of these proposed usability enhancements on student learning outcomes.

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