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Development of Smartotc Mobile Application with Clinical Decision Support System (CDSS) to Support Pharmacists in Managing Common Cold

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ABSTRACT

Common cold is a highly prevalent self-limiting respiratory illness and a frequent reason for self-medication and community pharmacy consultations. Variability in pharmacists' clinical decision-making may affect the quality of care, highlighting the need for evidence-based decision-support tools. This study developed SmartOTC, a mobile application incorporating a Clinical Decision Support System (CDSS) to support pharmacists in managing common cold cases through symptom assessment, over-the-counter medication recommendations, patient education, and referral support. A pilot quasi-experimental before-and-after study was conducted among 10 community pharmacists in Indonesia as part of a preliminary evaluation of the application. The application was developed using Android Studio and a Python-based CDSS algorithm and evaluated through functional feasibility, task performance, usability, user experience, and expert validation assessments. SmartOTC demonstrated high technical performance, achieving a 92.73% success rate, a 0% crash rate, and a mean response time of 2.89 seconds. Significant improvements in task performance and response times were observed following implementation. However, these findings should be interpreted within the context of a pilot study with a limited sample size.
The application demonstrated positive user experience and strong content validity, while usability outcomes suggested opportunities for further improvement. The findings are further limited by the single-site study setting and the absence of patient-level outcome evaluation. SmartOTC shows promise as a digital decision-support tool to support pharmacists in the management of common cold cases and warrants further evaluation in real-world pharmacy practice.

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1. INTRODUCTION

Common cold, also known as an upper respiratory tract infection (URTI), is one of the most prevalent acute illnesses worldwide and remains a major cause of healthcare consultations and self-medication practices [1]. The condition is primarily caused by viral pathogens, including rhinoviruses, coronaviruses, adenoviruses, and respiratory syncytial virus (RSV), and is characterized by symptoms such as nasal congestion, rhinorrhea, sore throat, cough, sneezing, and mild fever [2]. According to the Global Burden of Disease (GBD) Study 2019, upper respiratory infections accounted for approximately 17.2 billion cases worldwide, representing a substantial proportion of the global disease burden [3]. In Indonesia, the prevalence of the common cold remains high, affecting approximately 2.5% of the population annually [4]. Because the disease is generally self-limiting, many patients seek treatment directly from community pharmacies and rely on over-the-counter (OTC) medications for symptomatic relief. Consequently, community pharmacists play a critical role in assessing patients' symptoms, recommending appropriate therapies, providing patient education, and identifying cases that require medical referral [5].

Despite the important role of pharmacists in common cold management, several challenges remain in ensuring consistent and evidence-based pharmaceutical care [6]. The wide range of available over-the-counter (OTC) products, overlapping symptom presentations, and the increasing complexity of medication information may contribute to variability in pharmacists' recommendations [7]. Inappropriate self-medication practices remain prevalent, particularly the misuse of antibiotics for viral respiratory infections, which contributes to the growing threat of antimicrobial resistance [7]. Furthermore, variability in counseling practices, time constraints during patient consultations, and inconsistencies in clinical decision-making may compromise the quality of self-care services [8]. Given the high frequency of common cold cases encountered in community pharmacies, tools that support pharmacists in making rapid, accurate, and evidence-based decisions are increasingly needed to improve patient outcomes and promote rational medicine use [9]. To address these challenges, SmartOTC incorporates evidence-based OTC recommendations, referral criteria, and patient education messages to support rational medicine use and discourage inappropriate antibiotic use for self-limiting viral respiratory infections. The common cold was selected as the initial use case for SmartOTC because it is one of the most frequently self-managed conditions in Indonesia and a leading reason for community pharmacy consultations. Effective management of this condition requires pharmacists to assess patients' symptoms, recommend appropriate OTC medications, provide patient education, and identify cases requiring medical referral. Therefore, common cold management represents an appropriate clinical scenario for implementing and evaluating a pharmacist-oriented clinical decision support system (CDSS) within Indonesian community pharmacy practice.

Recent advances in digital health technologies have highlighted the potential of CDSS to improve healthcare delivery and medication management [10]. CDSS can provide real-time evidence-based recommendations, reduce decision-making variability, improve workflow efficiency, and support guideline adherence [11]. Previous studies have increasingly explored digital health technologies and decision-support tools to enhance pharmacists' clinical practice and respiratory disease management. For example, the eHealthResp platform was developed to improve pharmacists' awareness of inappropriate antibiotic use in upper respiratory tract infections and was reported to be useful and relevant to professional practice [12]. A mobile application supporting the assessment of upper respiratory symptoms also demonstrated favorable usability and user acceptance outcomes [13]. Similarly, a CDSS-based application for OTC therapy significantly improved pharmacists' knowledge, decision-making performance, and time efficiency [14]. Collectively, these findings indicate that digital health technologies can facilitate evidence-based pharmacy practice and improve the quality of patient care. Despite these advances, few studies have developed a pharmacist-oriented mobile CDSS specifically for common cold management in community pharmacy settings. The eHealthResp platform primarily focused on increasing pharmacists' awareness of inappropriate antibiotic use and supporting respiratory infection management through educational interventions, whereas the OTC-CDSS application mainly served as an educational tool to improve pharmacists' knowledge and decision-making regarding OTC therapy. In contrast, SmartOTC provides real-time clinical decision support during pharmacist consultations rather than functioning solely as an educational or awareness-oriented tool. The application integrates symptom assessment, evidence-based OTC medication recommendations, patient education, referral decision support, and consultation record management within a single mobile platform. Furthermore, SmartOTC was specifically tailored to Indonesian community pharmacy practice by incorporating locally relevant medication options and referral criteria. To the best of our knowledge, no previous study has integrated symptom assessment, evidence-based OTC recommendations, patient education,

referral decision support, and consultation record management into a single mobile application designed specifically for Indonesian community pharmacy practice.

This study aimed to develop and evaluate SmartOTC, a mobile application incorporating a CDSS to assist pharmacists in managing common cold cases. The application was designed to facilitate evidence-based symptom assessment, medication recommendations, patient counseling, and referral decision-making. The primary objective of this study was to evaluate the technical feasibility and preliminary performance of SmartOTC as a pharmacist-oriented CDSS for common cold management. Additionally, usability, user experience, and expert assessment of content validity were evaluated to provide a comprehensive assessment of the application.

2. METHODS

2.1. Study Design

This pilot study employed a quasi-experimental before-and-after design to develop and evaluate SmartOTC, a mobile application incorporating a Clinical Decision Support System (CDSS) for common cold management. The study consisted of two phases: application development and application evaluation.

2.2. Study Setting and Participants

The study was conducted in community pharmacies in Purwokerto, Indonesia. A convenience sampling approach was used to recruit 10 pharmacists for feasibility testing [15]. As a pilot study, the sample size was intended to support preliminary feasibility, usability, and performance evaluation rather than to provide definitive evidence of effectiveness or broad generalizability. Eligible participants were licensed pharmacists who had been practicing in community pharmacies for at least six months, owned an Android smartphone, and agreed to participate in all study procedures.

2.3. SmartOTC Development

SmartOTC was developed as a rule-based CDSS to support evidence-based OTC medication recommendations for common cold management. The application database was constructed using data collected from 10 community pharmacies and evidence obtained from national and international literature. Data collected from the participating pharmacies included information on commonly available OTC medications for common cold management, including medication names, dosage forms, strengths, and therapeutic categories. These data were incorporated into the application database to ensure that the recommendations reflected medications routinely available in Indonesian community pharmacy practice. Pharmacists from the participating pharmacies also participated in the application evaluation following system implementation. The resulting database contained medication names, therapeutic classes, dosage information, symptom indications, contraindications, and referral criteria.

The collected data were standardized, cleaned, and organized into a structured database. Clinical decision rules were then developed to generate medication recommendations, non-pharmacological advice, and referral alerts based on patient-reported symptoms and relevant clinical characteristics. The CDSS analyzes patient inputs, including symptoms, symptom duration, age, and other relevant clinical characteristics. Based on predefined decision rules, the system generates evidence-based OTC medication recommendations, patient education messages, and referral alerts when referral criteria are met.

2.4. Mobile Application Development and Validation

The application was developed using Android Studio, while the CDSS algorithm was implemented in Python and integrated through Chaquopy [16]. Core features included symptom assessment, medication recommendations, patient counseling information, referral alerts, and consultation record storage. The CDSS operates entirely offline on the user's device, with the medication database and decision rules stored locally within the application. This architecture enables the generation of recommendations without requiring an internet connection. Updates to the medication database and clinical decision rules are implemented through subsequent application updates.

System verification was performed to assess functionality, navigation, and recommendation accuracy. Content validation was conducted by six experts, comprising pharmacists, pharmacy academics, and information technology specialists. Expert feedback was used to refine the application through iterative development cycles.

2.5. Application Evaluation

Application performance was evaluated using functional feasibility testing, usability assessment, and acceptability assessment. Usability was assessed using the System Usability Scale (SUS), a widely used 10-item questionnaire for evaluating perceived system usability [17]. The SUS, uMARS, and SEQ questionnaires were administered in Indonesian using translated versions to ensure participant comprehension. As this was a pilot study, no separate psychometric validation of the translated instruments was conducted. Responses were rated on a five-point Likert scale, and SUS scores were calculated according to standard procedures and transformed to a scale ranging from 0 to 100. Scores were interpreted as poor (<50), marginal (50–69), good (70–84), and excellent (85–100). User experience was evaluated using the User Version of the Mobile App Rating Scale (uMARS) [18], which consists of five dimensions: engagement, functionality, aesthetics, information quality, and subjective quality. Each item was rated on a five-point Likert scale, with higher scores indicating a more favorable user experience. The internal consistency of the instrument was assessed using Cronbach's alpha, with values ≥0.70 indicating acceptable reliability. Perceived ease of use was assessed using the Single Ease Question (SEQ) [19], in which participants rated the difficulty of completing application-related tasks on a seven-point scale ranging from 1 (very difficult) to 7 (very easy). Mean SEQ scores were interpreted as low usability (1.0–3.9), moderate usability (4.0–5.9), and high usability (6.0–7.0). A before-and-after assessment was conducted to evaluate pharmacists' performance in managing common cold cases before and after using SmartOTC.

2.6. Statistical Analysis

Descriptive statistics were used to summarize participant characteristics and evaluation outcomes. Continuous variables were presented as mean ± standard deviation, while categorical variables were reported as frequencies and percentages. Task performance outcomes were summarized as participant-level performance scores and reported as mean ± standard deviation. Differences between pre- and post-intervention performance scores were analyzed using paired statistical tests according to data distribution. Statistical significance was established at $p < 0.05$. Expert validation was assessed using the Content Validity Index (CVI), including item-level CVI (I-CVI) and scale-level CVI (S-CVI/Ave).

2.7. Ethical approval

Ethical approval for this study was obtained from the Health Research Ethics Committee of Universitas Harapan Bangsa (Approval No. B.LPPM-UHB/1326/12/2025). All participating pharmacists provided informed consent prior to participation, and all study procedures were conducted in accordance with applicable ethical guidelines.

3. RESULTS AND DISCUSSION

3.1. Functional Feasibility Testing

The technical performance of SmartOTC was evaluated through functional feasibility testing across 60 testing sessions conducted by the participating pharmacists. During each session, all 11 core application functions were evaluated, resulting in a total of 660 function-level interactions (60 × 11). These sessions represented repeated assessments of application functionality and were used to evaluate technical performance and system stability. As shown in Table 1, the application demonstrated high technical stability, with no system crashes observed during testing (crash rate = 0%). Of the 660 evaluated interactions, 612 were completed successfully, resulting in an overall success rate of 92.73%. The mean system response time was 2.89 seconds, indicating satisfactory operational performance during application use.

Table 1. Functional Feasibility Test

Parameter	Formula	Calculation	Result
Crash Rate	0/60 ×100%	0%	0%
Success Rate	612/660 ×100%	92,73%	92,73%
Mean Response Time	1905/660	2,89 second	2,89 second

3.2. Comparison of Task Success Rates Before and After SmartOTC Implementation

Summarizes pharmacists' task success rates before and after SmartOTC implementation see Table 2. Task success was coded as an outcome (0 = unsuccessful, 1 = successful), and the values presented represent mean participant scores across each task scenario. Statistical comparisons were performed using paired pre- and post-

intervention scores from the same pharmacists, and repeated task observations were not treated as independent observations. Significant improvements were observed across all evaluated task scenarios (TR1–TR11). Baseline success rates ranged from 0.38 ± 0.49 to 0.57 ± 0.50, whereas post-intervention scores ranged from 0.87 ± 0.34 to 0.95 ± 0.22. All comparisons demonstrated statistically significant improvements ($p < 0.001$). The largest improvement was observed in TR6 (Non-Pharmacological Recommendations and Patient Education), where task success increased from 0.38 ± 0.49 to 0.95 ± 0.22 ($t = -7.790$, $p < 0.001$).

Table 2. Comparison of Task Success Rate Before and After Using SmartOTC

Assignment	Before (Mean ± SD)	After (Mean ± SD)	t-value	p-value
TR1	0.47 ± 0.50	0.87 ± 0.34	-5.269	<0.001
TR2	0.57 ± 0.50	0.95 ± 0.22	-5.349	<0.001
TR3	0.43 ± 0.50	0.92 ± 0.28	-6.600	<0.001
TR4	0.50 ± 0.50	0.87 ± 0.34	-4.658	<0.001
TR5	0.45 ± 0.50	0.93 ± 0.25	-6.978	<0.001
TR6	0.38 ± 0.49	0.95 ± 0.22	-7.790	<0.001
TR7	0.55 ± 0.50	0.88 ± 0.32	-4.511	<0.001
TR8	0.42 ± 0.50	0.90 ± 0.30	-6.600	<0.001
TR9	0.52 ± 0.50	0.93 ± 0.25	-6.088	<0.001
TR10	0.53 ± 0.50	0.90 ± 0.30	-4.888	<0.001
TR11	0.52 ± 0.50	0.93 ± 0.25	-6.088	<0.001

Note: T1 = Initial Screen & Splash Screen (ISSS); T2 = Patient Identity Input (PII); T3 = Patient Complaint Input (PCI); T4 = Symptom Analysis (SA); T5 = Pharmacological Therapy Recommendations (PTR); T6 = Non-Pharmacological Recommendations & Patient Education (NRPE); T7 = Patient Storage & Recording Feature (PSRF); T8 = Offline Mode Feature (OMF); T9 = Final Analysis Results Display (Diagnosis & Recommendations) (FARD); T10 = Menu Navigation & Page Views (MNPV); and T11 = Logout & Data Reset (LDR).

3.3. Comparison of Response Time Before and After SmartOTC Implementation

Presents the response time performance before and after SmartOTC implementation see Table 3. The response times reported in Table 3 represent pharmacists' task completion times for the evaluated scenarios before and after using SmartOTC. These measures are distinct from the application system response time reported in Table 1, which reflects the technical performance of the application. Across all evaluated tasks, mean response times were reduced following application use. Pre-intervention response times ranged from 1.90 ± 0.86 to 2.43 ± 0.72 seconds, while post-intervention response times ranged from 1.40 ± 0.59 to 1.58 ± 0.70 seconds.

Statistically significant reductions were observed for all evaluated tasks ($p \leq 0.022$). The greatest reduction was identified in RT11, where mean response time decreased from 2.40 ± 0.69 seconds to 1.50 ± 0.70 seconds ($t = 7.328$, $p < 0.001$).

Table 3. Comparison of Response Time Before and After Using SmartOTC

Assignment	Before (Mean ± SD)	After (Mean ± SD)	t-value	p-value
RT1	2.13 ± 0.77	1.40 ± 0.59	6.187	<0.001
RT2	2.17 ± 0.74	1.43 ± 0.67	5.742	<0.001
RT3	2.07 ± 0.82	1.58 ± 0.70	3.462	0.001
RT4	1.90 ± 0.86	1.57 ± 0.67	2.348	0.022
RT5	2.43 ± 0.72	1.52 ± 0.70	6.787	<0.001
RT6	2.08 ± 0.83	1.50 ± 0.70	3.986	<0.001
RT7	2.27 ± 0.80	1.48 ± 0.62	5.486	<0.001
RT8	2.22 ± 0.78	1.55 ± 0.68	4.984	<0.001
RT9	2.22 ± 0.80	1.45 ± 0.68	5.952	<0.001
RT10	1.95 ± 0.77	1.45 ± 0.65	3.748	<0.001
RT11	2.40 ± 0.69	1.50 ± 0.70	7.328	<0.001

3.4. Usability Assessment

Figure 1 illustrates the System Usability Scale (SUS) scores obtained from the 10 participating pharmacists. Individual SUS scores ranged from 37.5 to 100.0, with an overall mean score of 59.0. According to the standard SUS interpretation criteria, SmartOTC demonstrated marginal usability. These findings indicate that the application is generally usable; however, further improvements to the user interface and overall usability are needed to enhance user acceptance and satisfaction.

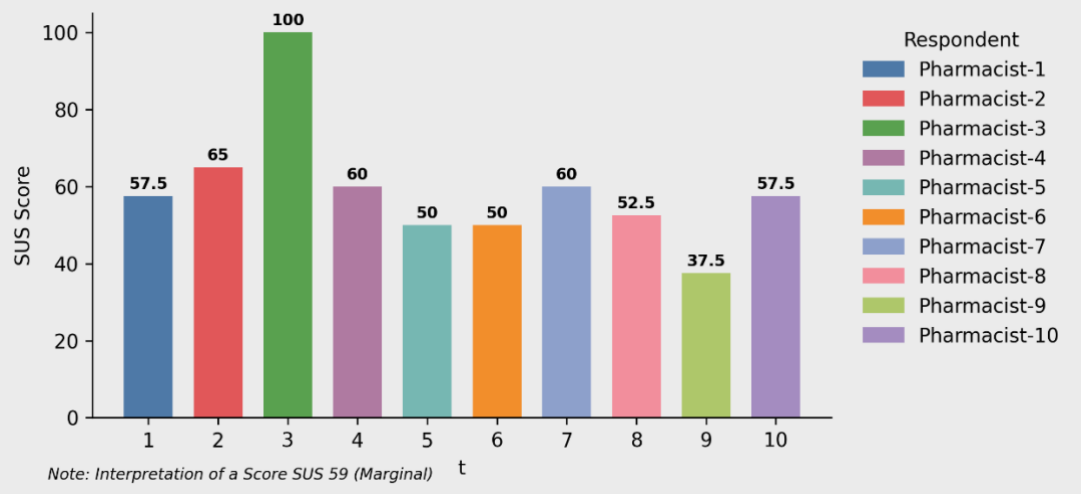

Fig 1. System Usability Scale (SUS) Scores Reported by Pharmacist Participants Following SmartOTC Use.

3.5. Reliability of the uMARS Instrument Usability Assessment

The internal consistency of the uMARS instrument was evaluated using Cronbach's alpha. As shown in Table 4, the questionnaire demonstrated excellent reliability, with a Cronbach's alpha coefficient of 0.961. This result indicates that the uMARS items consistently measured participants' perceptions of the application, supporting the reliability of the assessment instrument rather than the usability or effectiveness of the application itself.

Table 4. Reliability Analysis of the User Version of the Mobile App Rating Scale (uMARS) Instrument.

Parameter	Result
Number of Items	14
Cronbach's Alpha	0,961
Interpretation	Excellent Reliability

3.6. User Experience Evaluation

Presents the mean scores across the five uMARS dimensions, as shown in Figure 2. Engagement achieved the highest mean score (4.23), followed by Subjective Quality (4.18), Information Quality (4.07), Functionality (4.03), and Aesthetics (3.91). All dimensions achieved mean scores above 3.9, indicating favorable user evaluations across the assessed domains.

The uMARS results indicated positive perceptions of engagement, information quality, and functionality, these findings should be interpreted alongside the marginal SUS score, which suggests that further improvements in overall usability and interface design are needed.

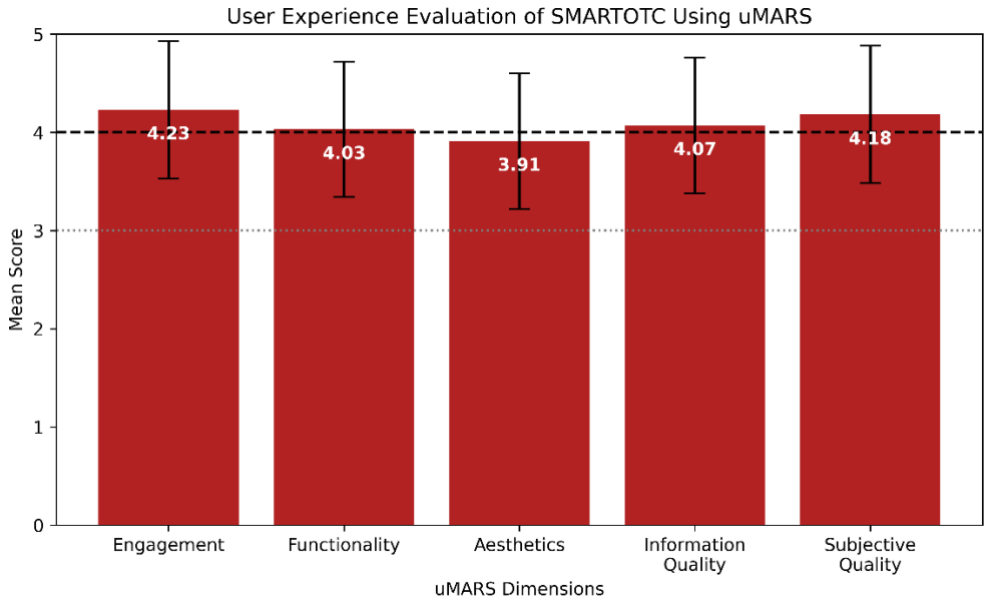

Fig 2. User Experience Evaluation of SmartOTC Across the Five uMARS Dimensions.

3.7. Single Ease Question (SEQ) Assessment

The usability of SmartOTC was further assessed using the Single Ease Question (SEQ). As shown in Figure 3, individual SEQ scores ranged from 3.0 to 6.0, with an overall mean score of 4.6. According to the established SEQ interpretation criteria, this result indicates a moderate level of usability.

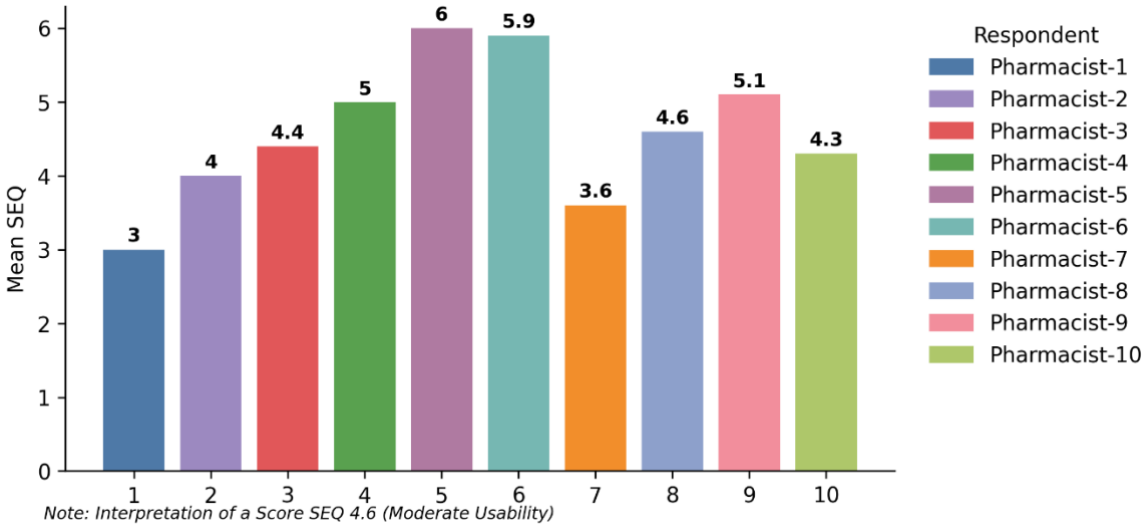

Fig 3. Single Ease Question (SEQ) Scores Reported by Pharmacist Participants Following SmartOTC Use.

3.8. Expert Validation

Expert validation was performed by six reviewers representing pharmacy practice, pharmacy academia, and information technology. The expert panel consisted of two practicing pharmacists, two pharmacy academics, and two information technology experts. All experts independently evaluated the application and completed the content validation assessment. Figure 4 presents the Item-Level Content Validity Index (I-CVI) scores for each evaluated component. I-CVI values ranged from 0.83 to 1.00. Perfect agreement (I-CVI = 1.00) was achieved for CDSS logic flow, OTC medication recommendations, referral indication detection, and overall application feasibility. Dosage recommendations and patient education components obtained I-CVI

scores of 0.83, indicating acceptable content validity. The overall scale demonstrated excellent content validity, with all evaluated components exceeding the recommended I-CVI threshold of 0.78.

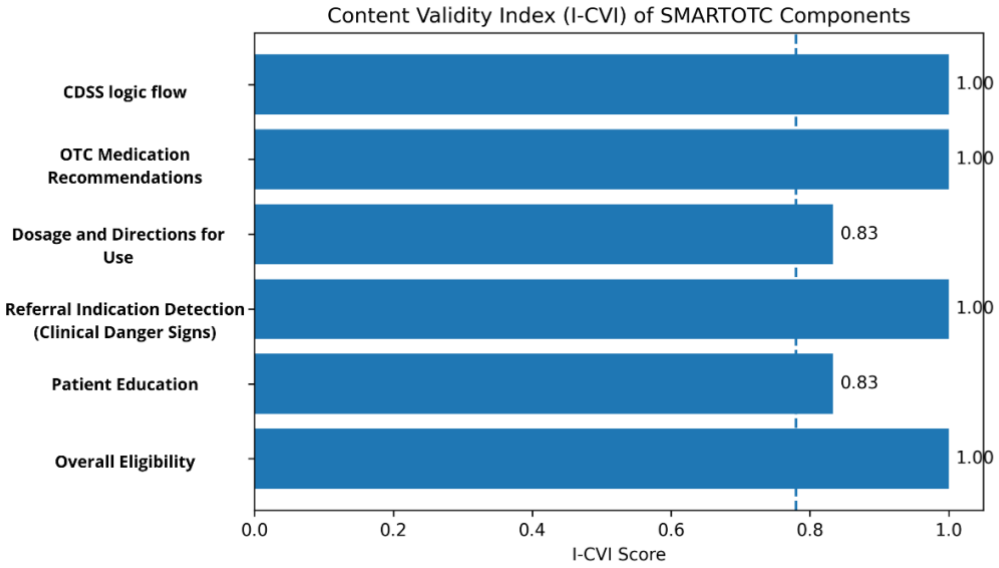

Fig 4. Expert Validation of SmartOTC Components Based on Item-Level Content Validity Index (I-CVI)

To the best of our knowledge, this is the first study to develop and evaluate a pharmacist-oriented mobile clinical decision support system (CDSS) specifically designed to support common cold management in Indonesian community pharmacies. The findings demonstrated that SmartOTC achieved high technical feasibility, significantly improved pharmacists' decision-making performance and workflow efficiency, reduced response times, received favorable usability and user experience evaluations, and demonstrated strong content validity. These findings suggest that SmartOTC has the potential to support evidence-based clinical decision-making and promote more consistent management of common cold cases in Indonesian community pharmacy practice.

The functional feasibility testing showed that SmartOTC exhibited excellent technical performance, as reflected by a 0% crash rate, a success rate exceeding 90%, and a mean response time of less than three seconds [20]. These findings indicate that the application was technically stable and capable of operating consistently during routine use [21]. Technical reliability is a critical determinant of digital health technology adoption because pharmacists are unlikely to use systems that are unstable or disrupt workflow [22]. Similar findings were reported by Moura et al. (2021), who found that the eHealthResp application demonstrated good usability and functional performance for respiratory problem management [13]. Likewise, Paydar et al. (2023) [14] reported that their OTC-CDSS application functioned reliably and was well accepted by pharmacists. The strong technical performance observed in SmartOTC supports its suitability for implementation in community pharmacy settings where rapid access to clinical information is essential [23].

Significant improvement in task success rates was observed following SmartOTC implementation [24]. Improvements were identified across all evaluated tasks, including symptom assessment, therapeutic recommendation, patient education, referral identification, and application navigation [25]. These findings are consistent with those reported by Paydar et al. (2023), who demonstrated that CDSS-assisted OTC management significantly improved pharmacists' knowledge and performance [14]. The observed improvement may be explained by the structured decision pathway embedded within SmartOTC, which guides pharmacists through a standardized assessment process and provides evidence-based recommendations at the point of care [26]. By reducing reliance on memory and individual experience, the application may enhance consistency in clinical decision-making and improve the quality of pharmaceutical services [27].

Addition to improving task completion performance, SmartOTC significantly reduced response times across all evaluated functions [28]. Faster response times may be attributed to the automated processing of symptom information and the immediate generation of recommendations by the CDSS algorithm [29]. Pharmacists could obtain therapeutic recommendations, patient counseling information, and referral alerts within a single platform [30]. This finding aligns with previous evidence suggesting that CDSS technologies

can improve workflow efficiency and reduce cognitive workload among healthcare professionals [31]. Improved efficiency is particularly important in community pharmacies where pharmacists frequently manage large patient volumes while maintaining clinical responsibilities [32].

The usability assessment yielded a marginal System Usability Scale (SUS) score, suggesting that further interface optimization may be beneficial [33]. This finding should be interpreted within the context of a pilot study involving first-time users. Previous studies have shown that usability scores often improve following iterative refinement and increased familiarity with digital health applications [34]. For example, Perwirani and Puspita Sari (2022) reported a SUS score of 83 for a CDSS designed to identify drug-drug interactions, although their system underwent extensive user-centered development and was implemented within a hospital environment [35]. Therefore, the current SUS findings should be considered a baseline for future improvement rather than an indication of poor usability [17].

The positive user experience findings obtained through uMARS further support the acceptability of SmartOTC [14]. All evaluated dimensions achieved favorable scores, with engagement receiving the highest rating. These results suggest that pharmacists perceived the application as useful, relevant, and potentially beneficial for daily practice [36]. Positive ratings for information quality indicate that users considered the recommendations and educational content clinically meaningful, while favorable functionality scores suggest that the application was easy to operate [37]. Similar findings were reported by Magalhães et al. (2022), who found that pharmacists perceived the eHealthResp digital platform as comprehensive, practical, and useful for supporting respiratory infection management . Unlike eHealthResp, which primarily focused on educational interventions, SmartOTC provides real-time clinical decision support during patient consultations, thereby extending digital support directly into pharmacy practice.

The expert validation results demonstrated strong content validity across all evaluated components, with I-CVI values ranging from 0.83 to 1.00. High levels of agreement were observed for the CDSS logic flow, OTC medication recommendations, referral criteria, and overall system suitability [38]. These findings are particularly important because the clinical credibility of a CDSS depends heavily on the quality and accuracy of its recommendations [39]. Similar concerns were highlighted by Durand et al. (2022), who reported considerable heterogeneity among existing CDSS tools and emphasized the need for standardized evaluation procedures [31]. The strong expert agreement observed in this study provides preliminary evidence that the knowledge base and decision rules embedded within SmartOTC are clinically appropriate and aligned with evidence-based common cold management principles.

The findings of this study have important implications for pharmacy practice. Common cold is among the most frequently encountered conditions in community pharmacies and is often managed through self-medication [40]. Variability in counseling quality and therapeutic recommendations remains a persistent challenge. By integrating evidence-based recommendations, patient education materials, and referral criteria into a single platform, SmartOTC may help pharmacists deliver more consistent and standardized care [41]. Application supports the broader digital transformation of pharmacy services by translating clinical guidelines into actionable recommendations delivered at the point of care. Digital health technologies continue to evolve, pharmacist-oriented CDSS applications may play an increasingly important role in promoting rational medicine use and enhancing the quality of self-care services [42].

This pilot study was limited by its small sample size, single-site setting, and short evaluation period. In addition, SmartOTC focused exclusively on common cold management, and patient-level outcomes were not assessed. Future multicenter studies involving larger populations and longer follow-up periods are warranted to further evaluate the effectiveness and implementation potential of SmartOTC.

4. CONCLUSION

The findings support the preliminary feasibility of SmartOTC as a pilot CDSS for common cold management, demonstrating high technical performance, improved pharmacist performance and workflow efficiency, as well as favorable evaluations of usability, user experience, and content validity. The integration of symptom assessment, evidence-based OTC medication recommendations, patient education, and referral decision support within a single platform highlights the potential of SmartOTC to support pharmacists' clinical decision-making and promote more standardized management of common cold cases in community pharmacy settings. Future studies involving larger and more diverse pharmacist populations are warranted to further evaluate the effectiveness, scalability, and real-world implementation of SmartOTC, as well as its potential impact on pharmacist decision-making, healthcare delivery, and patient outcomes.

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