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SmartOTC: Development of Mobile Application for Common Cold Self-Medication

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Abstract: *Common cold remains a highly prevalent condition worldwide, contributing significantly to healthcare visits and productivity loss. Despite its widespread impact, there is limited research on the use of mobile health (mHealth) tools integrated with Clinical Decision Support Systems (CDSS) for managing common cold therapy in pharmacy settings. This study aimed to evaluate the effectiveness of the SmartOTC mobile application, integrated with a CDSS, in supporting pharmacists' decision-making in managing common cold therapy. A quasi-experimental, before-after study was conducted in 10 pharmacies across Purwokerto, Indonesia, involving 10 pharmacists who conducted a total of 50 trials to assess the SmartOTC application's performance. Pharmacists' decision-making was measured using the uMARS scale, and the data were analyzed using paired samples t-test to compare pre- and post-application scores. The findings demonstrated that the SmartOTC application exhibited high system efficiency, with most tasks completed within 1-3 seconds. Significant improvements in uMARS scores were observed, with all comparisons showing p-values < 0.001, indicating enhanced decision-making and user experience. The findings in this study suggest that the SmartOTC application significantly improves pharmacists' user experience and perceived support in decision-making, indicating its potential as a supportive tool for providing timely and evidence-based OTC therapy recommendations for common cold management. Future research should focus on validating the long-term impact of the application in diverse pharmacy settings and exploring its broader clinical applicability.*
Keywords: *Clinical Decision Support System, Common Cold Therapy, Mobile Health, Over-the-Counter Drugs*

1. INTRODUCTION

Common cold, also known as upper respiratory tract infection (URTI), is one of the most prevalent diseases worldwide, leading to millions of primary healthcare visits each year [1]. This condition is primarily caused by a variety of respiratory viruses, with rhinovirus being the most common, and is characterized by symptoms such as sore throat, nasal congestion, cough, sneezing, and body aches [2]. The prevalence of common cold remains high, with approximately 17.2 billion cases globally, contributing to nearly 50% of the total disease burden, according to the Global Burden of Disease (GBD) Study 2019 [3]. The prevalence of common cold remains high at 2.5% across all age groups in Indonesia [4], and a significant proportion of cases are managed through self-medication with over-the-counter (OTC) products [5]. The economic burden of the common cold is substantial, with the global market for cold and cough remedies steadily increasing, from USD 29.2 billion in 2016 to USD 39.26 billion in 2022, projected to reach USD 53.1 billion by 2027 [6]. OTC cold medications account for 24.48% of total pharmacy sales in Indonesia, indicating a high demand for effective treatments [7]. However, the limitations of OTC treatments in fully addressing the symptoms of the common cold persist [8].

This widespread self-medication practice introduces the risk of irrational medication use, particularly the inappropriate use of antibiotics for viral infections, which contributes to the growing problem of antimicrobial resistance [9]. Studies in Thailand have shown that 20-60% of participants engage in incorrect self-medication [10], often due to factors such as inconsistent counseling, time limitations, and poor documentation practices [11]. Despite the availability of OTC treatments, their effectiveness remains limited, as they typically only provide symptom relief without accelerating recovery [8]. The integration of mobile applications in pharmacy practice offers a promising solution to enhance medication management. Such applications can simplify the selection of appropriate medications by providing evidence-based recommendations, thereby supporting

pharmacists in making faster and more accurate decisions [12]. The mobile applications can minimize medication errors and reduce inappropriate drug use, including the unnecessary use of antibiotics for viral infections. These systems can facilitate the systematic documentation of frequently used medications, enabling better tracking of therapeutic patterns and supporting data-driven decision-making [13]. Previous studies have demonstrated that Clinical Decision Support Systems (CDSS) improve pharmacists' decision-making and medication management outcomes [14], [15].

The study aimed to evaluate the development and potential application of a mobile-based CDSS for managing OTC common cold therapy. This research seeks to explore the effectiveness, usability, and impact of the SmartOTC application as a critical step toward the digitalization of evidence-based pharmacy services, with the ultimate goal of improving pharmacists' decision-making processes in managing OTC cold therapy.

2. METHOD

This study employed a quasi-experimental design with a before-after study approach to evaluate the effectiveness of the SmartOTC mobile application, integrated with a CDSS. The research was conducted in three primary stages: Data Collection Instruments, Population and Sample, and Data Analysis. The goal of the study was to assess the application's impact on improving pharmacists' decision-making ability in managing common cold therapy and to evaluate its usability and performance in a real-world pharmacy setting. The SmartOTC mobile application was developed using Python, Android Studio, and Chaquopy to integrate the CDSS. The dataset for this application was compiled from a survey conducted at 10 pharmacies, where OTC drugs used for treating the common cold were recorded and supplemented with relevant literature. Convenience sampling was used to select these pharmacies for the pilot study, which focused on the Functional Feasibility Test (FFT) [17]. The uMARS (mobile application rating scale) was employed to assess usability and user experience [16].

The before-after procedure was conducted in a structured sequence. In the initial phase (before intervention), participating pharmacists managed common cold cases using their usual practice without the SmartOTC application, and their baseline performance was assessed using the uMARS instrument. In the intervention phase, pharmacists were introduced to and trained in the use of the SmartOTC application. Subsequently, in the after phase, pharmacists used the application to manage similar cases, and their performance was reassessed using the same uMARS instrument. This design enabled a direct comparison of pharmacists' decision-making performance before and after using the application.

The SmartOTC application was evaluated in real-world pharmacy settings through a series of trials aimed at assessing its initial performance. A total of 10 pharmacists participated in this study, each conducting five application trials, resulting in a total of 50 trials. This approach allowed for a comprehensive assessment of how the application functioned in actual pharmacy practice. Each trial represented a case of common cold management handled by the pharmacists using the application. The participating pharmacists were required to meet specific inclusion criteria, including at least six months of active work experience in a pharmacy, willingness to complete all study stages, and access to a smartphone with SmartOTC installed. Pharmacists who did not complete the trial or encountered technical issues were excluded from the study. The data gathered from the uMARS questionnaires were analyzed using SPSS 27.0, with a paired t-test applied to assess the difference in pharmacists' performance before and after using the application [16]. Descriptive statistics were also used to summarize the pharmacists' perceptions of the application's quality, ease of use, and functionality. The paired t-test was selected for its suitability in comparing pre- and post-application performance scores, providing a clear evaluation of the application's impact on pharmacists' decision-making abilities.

3. RESULTS AND DISCUSSION

To the best of our knowledge, this is the first research to demonstrate the development and evaluate the SmartOTC mobile application integrated with a CDSS to support pharmacists in managing common cold therapy. The response times for various system features (FFT1 to FFT11, where FFT stands for Functional Feasibility Test) were categorized into 1-3 seconds, 4-6 seconds, and 7-10 seconds. Figure 1 illustrates the majority of responses were within the 1-3 seconds category, indicating that most system functions were executed rapidly and efficiently. A smaller proportion of responses fell within the 4-6 seconds range, which remains acceptable for practical use, while only a limited number of responses required 7-10 seconds. Features such as FFT1, FFT2, FFT4, FFT5, and FFT6 demonstrated particularly strong performance, with a higher proportion of responses in the fastest category. The system as a whole demonstrated efficient performance, with minimal delays, ensuring its effectiveness in real-world pharmacy settings.

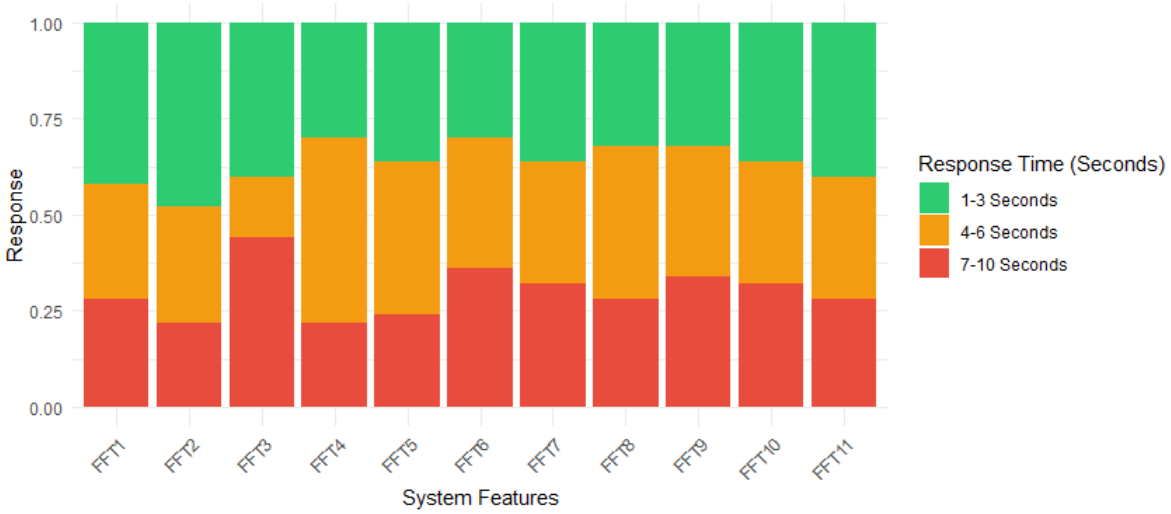

Figure 1: Response time distribution across system features.

Descriptive statistical analysis presented in Table 1 indicates that the mean scores for uMARS before (UB) increased markedly in uMARS after (UA) following the use of the SmartOTC application, from a baseline range of approximately 2.08–2.16 to 3.96–4.40. In addition, the standard deviation values were generally lower in uMARS after (UA) compared to uMARS before (UB), suggesting a more consistent response pattern among participants after using the application. These findings indicate that the application improved not only the overall user experience but also the consistency of user perceptions regarding its usability and functionality. This pattern suggests that, beyond improving average user experience, the application also reduced variability in user perceptions, indicating a more standardized and predictable interaction among pharmacists.

Table 1. Mean and standard deviation scores for each evaluation item.

Item	Before		After	
	Mean Statistic	Std. Deviation Statistic	Mean Statistic	Std. Deviation Statistic
U1	2.10	1.015	4.30	0.814
U2	2.10	1.015	4.40	0.782
U3	2.08	1.027	4.28	0.757
U4	2.10	1.015	4.08	0.922
U5	2.12	1.023	4.12	0.895
U6	2.08	1.027	4.14	0.904
U7	2.10	1.015	3.96	1.106
U8	2.12	1.023	4.02	1.097
U9	2.16	1.095	4.12	0.918
U10	2.08	1.027	4.14	0.833
U11	2.10	1.015	4.14	0.948
U12	2.12	1.023	4.22	0.932
U13	2.16	1.095	4.24	0.916
U14	2.16	1.095	4.32	0.768

Table 2. Paired Samples Test

Pair	t-value	Sig. (2-tailed)
UB1 - UA1	-13.612	< .001
UB2 - UA2	-12.849	< .001
UB3 - UA3	-12.491	< .001
UB4 - UA4	-11.472	< .001
UB5 - UA5	-10.435	< .001
UB6 - UA6	-9.866	< .001
UB7 - UA7	-8.777	< .001
UB8 - UA8	-10.354	< .001
UB9 - UA9	-8.934	< .001
UB10 - UA10	-11.634	< .001
UB11 - UA11	-12.437	< .001
UB12 - UA12	-10.808	< .001
UB13 - UA13	-9.742	< .001
UB14 - UA14	-10.549	< .001

The statistical significance of the differences between uMARS before (UB) and uMARS after (UA) is further confirmed by the paired samples t-test results presented in Table 2, where all comparisons showed highly significant differences ($p < 0.001$), indicating that the observed changes were unlikely to have occurred by chance and providing strong statistical evidence of improvement.

Table 3. Effect size (Cohen's d)

Item		Cohen's d
Paired 1	UB 1 -UA 1	1.143
Paired 2	UB 2 - UA 2	1.266
Paired 3	UB 3 - UA 3	1.245
Paired 4	UB 4 - UA 4	1.220
Paired 5	UB 5 - UA 5	1.355
Paired 6	UB 6 - UA 6	1.476
Paired 7	UB 7 - UA 7	1.498
Paired 8	UB 8 - UA 8	1.298
Paired 9	UB 9 - UA 9	1.551
Paired 10	UB 10 - UA 10	1.252
Paired 11	UB 11 - UA 11	1.160
Paired 12	UB 12 - UA 12	1.374
Paired 13	UB 13 - UA 13	1.510
Paired 14	UB 14 - UA 14	1.448

The magnitude of the differences between uMARS before (UB) and uMARS after (UA) was evaluated using Cohen's d, as presented in Table 3. The effect size values ranged from 1.143 to 1.551, which are

categorized as large effects. This indicates that the SmartOTC application had a strong practical impact on improving pharmacists' user experience, confirming that the observed improvements are not only statistically significant but also meaningful in real-world practice. These large effect sizes indicate that the improvement is not only statistically significant but also substantial in magnitude, suggesting that the SmartOTC application can meaningfully influence pharmacists' daily practice. This level of impact highlights the potential of the application to bring noticeable improvements in user-perceived support for decision-making processes. Taken together, the descriptive improvements (Table 1), statistically significant differences (Table 2), and large effect sizes (Table 3) provide consistent evidence that the SmartOTC application has a meaningful and measurable impact on pharmacists' user experience.

The predominance of rapid response times indicates that the system is capable of meeting the operational demands of community pharmacy workflows. Efficient system performance may reduce cognitive workload and waiting time, thereby enabling pharmacists to allocate more attention to patient-centered services such as counseling and clinical evaluation [18]. A significant improvement in user experience was observed, as indicated by the consistent increase in uMARS scores after the application was used. These improvements suggest that the application enhances usability, engagement, and functionality, which are important factors influencing the adoption of digital health tools in pharmacy practice [19]. While the integration of CDSS into a mobile platform may support pharmacists in making more efficient decisions regarding OTC therapy, it is important to note that the uMARS instrument primarily evaluates user experience and does not directly measure clinical decision-making accuracy.

The observed enhancement in user experience may also reflect increased user acceptance and confidence in the system. User acceptance represents a critical determinant in the successful implementation of digital health technologies, as systems that are perceived as useful and easy to use are more likely to be integrated into routine practice [20]. This highlights the practical relevance of SmartOTC as a user-friendly decision support tool.

These findings align with previous studies on CDSS implementation in pharmacy settings, research conducted in Iran reported improvements in pharmacists' knowledge and skills when using a mobile application for OTC therapy management [15]. Similarly, Portugal demonstrated the effectiveness of the eHealthResp platform in managing upper respiratory tract infections and reducing inappropriate antibiotic use [14], while a study in France emphasized the importance of adapting CDSS tools to local epidemiological contexts [21]. Consistent with these studies, the SmartOTC application provides a context-specific solution for managing common cold therapy, enhancing decision-making in community pharmacy settings.

The integration of CDSS within a mobile application framework may facilitate the standardization of clinical decision-making processes among pharmacists [22]. Variability in OTC therapy recommendations is a common challenge in community pharmacy practice, often influenced by differences in experience, knowledge, and time constraints [23]. By providing structured and evidence-based guidance, the SmartOTC application has the potential to reduce such variability and promote more consistent and rational medication use.

The use of digital decision support tools such as SmartOTC has the potential to improve public health outcomes. By helping pharmacists choose appropriate treatments for common conditions like the common cold, the application supports more rational and evidence-based decision-making [24]. This is important because it can reduce the unnecessary use of medications, especially antibiotics that are often inappropriately used for viral infections [25].

Despite these promising results, several limitations should be acknowledged. The study involved a relatively small sample size, consisting of 10 pharmacies and 50 trials, which may limit the generalizability of the findings. The study was conducted in a single geographic location, which may not fully represent other regions. Future studies should include larger and more diverse populations and assess the long-term impact of the application on patient outcomes and clinical practice instrument.

In addition, this study did not include a control group, which limits the ability to compare the intervention against standard practice under controlled conditions. However, the before–after design was considered appropriate for this pilot study to provide preliminary insights into the application's effectiveness in real-world settings.

4. CONCLUSION

The SmartOTC mobile application was successfully developed and demonstrated good performance in terms of usability and system functionality. The findings suggest that the integration of a CDSS into a mobile

platform has the potential to support pharmacists in managing common cold therapy and may enhance the efficiency and usability of OTC therapy recommendations. However, these findings are primarily based on user-reported outcomes and should be interpreted with caution in relation to clinical decision-making performance. Future research should focus on validating the long-term impact of the application on clinical outcomes and decision-making accuracy in larger and more diverse populations.

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