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Development of a Web-Based Human-Computer Interaction System to Improve Medication Adherence among Patients with Chronic Conditions

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ABSTRACT

Medication non-adherence remains a critical global health challenge, particularly among patients with chronic illnesses. This study addresses the issue by developing a web-based medication reminder system grounded in Human-Computer Interaction (HCI) principles. The system is designed to be simple, accessible, and personalized, with the goal of supporting medication routines in low-resource settings. Using HTML, CSS, JavaScript, PHP, and MySQL, a modular and scalable platform was built incorporating personalized notifications, intuitive navigation, and responsive design. The study adopted a design and development research methodology, applying the Incremental Software Development Model to ensure iterative refinement and integration of user feedback. A key focus was placed on evaluating the system's usability rather than directly measuring adherence outcomes. Usability testing involving 10 participants yielded a System Usability Scale (SUS) score of 82, indicating strong user satisfaction and ease of use. Participants highlighted the system's clean interface, effective reminder features, and accessibility across various devices without the need for app installation. By prioritizing user-centered design and HCI strategies, this research presents a viable, low-cost solution for enhancing engagement with medication management tools. The system's browser-based nature and infrastructure independence make it particularly suited for deployment in underserved communities. While future studies are needed to assess its direct impact on adherence behaviour, the current findings demonstrate high usability and user acceptance—critical precursors to long-term adoption and effectiveness.

Keywords: Medication Adherence, Human-Computer Interaction, Web-Based System, Chronic Disease, System Usability Scale

INTRODUCTION

Medication adherence is essential to the success of therapeutic regimens and overall patient well-being. However, non-adherence remains a major healthcare concern globally, leading to preventable complications, increased hospital admissions, and higher healthcare costs. According to the World Health Organization, nearly 50% of patients with chronic illnesses fail to take their medications as prescribed.

To address this challenge, researchers and developers are exploring the role of Human-Computer Interaction (HCI) in designing technological interventions that actively engage users in managing their health. HCI-based systems—ranging from mobile apps and IoT devices to web-based platforms—offer personalized reminders, user-friendly interfaces, and interactive features aimed at enhancing adherence behaviour. Despite these advancements, many HCI interventions suffer from limited user engagement, lack of personalization, and challenges with integration into patients' daily routines. In developing countries, these issues are further exacerbated by infrastructural limitations and digital literacy barriers. Therefore, creating a simple, accessible,

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and personalized web-based reminder system can provide a low-cost and scalable solution to medication non-adherence.

This study seeks to develop and evaluate such a system, integrating HCI principles to improve usability, satisfaction, and effectiveness in helping patients—especially those with chronic illnesses—manage their medication routines.

\Despite growing interest in technology-driven healthcare interventions, medication non-adherence continues to pose a serious threat to treatment success and public health outcomes. Traditional methods such as counselling, follow-ups, and printed schedules often fail to produce sustained improvements. While modern HCI technologies show promise, their real-world effectiveness is hindered by issues of usability, personalization, and consistent engagement.

Existing solutions are frequently too complex, underutilized, or not tailored to individual patient preferences and lifestyles. Furthermore, there is a notable gap in studies evaluating simple, accessible, web-based systems that are grounded in user-centered design principles and focused specifically on adherence for chronic illness patients. Addressing this gap could pave the way for scalable solutions that enhance healthcare delivery, particularly in low-resource settings. This study focuses on designing a user-friendly, web-based Human-Computer Interaction (HCI) system aimed at improving medication adherence among patients with chronic conditions with the following objectives;

1. To design and develop a web-based medication reminder system using HTML, CSS, JavaScript, PHP, and MySQL, incorporating personalized notifications and user-friendly interfaces.
2. To test the functionality of the system by evaluating modules such as user registration, medication input, and reminder alerts.
3. To validate the integration of all system components, ensuring seamless communication between the user interface and backend database.

RELATED WORKS

Medication adherence remains a crucial challenge in chronic disease management, prompting the development of various digital interventions. Numerous studies have explored the potential of mobile and web-based technologies to support adherence behaviours, often leveraging principles from Human-Computer Interaction (HCI) to enhance usability and engagement.

Li et al. (2025) conducted a systematic review evaluating the effectiveness of mobile apps in improving medication adherence among patients with chronic kidney disease. The study emphasized the benefits of personalization and mobile accessibility but identified issues with long-term engagement and digital literacy—barriers also addressed in the current research through simplified interface design and modular system development. Similarly, Ahmed, Johnson, and Liu (2023) found that eHealth tools significantly improved adherence in acute coronary syndrome patients, especially when combined with real-time feedback mechanisms. However, their analysis pointed out that overly complex systems often discouraged sustained use. In contrast, this study mitigates this by adopting a streamlined, user-friendly interface grounded in HCI principles.

Patel, Doshi, and Mehta (2021) introduced *MedSensor*, a smart watch-based adherence system using accelerometer data. While technologically innovative, this solution may face adoption challenges in low-resource settings due to its hardware dependence. This web-based system circumvents such barriers, making it more accessible for diverse populations with limited technological infrastructure. Tan, Huang, and Kwok (2023) employed a co-design approach to develop a multi-channel notification system, reinforcing the importance of user involvement in the design phase. This study aligns with this philosophy by integrating user-centered design throughout its development, thereby enhancing system relevance and usability. A more futuristic approach was explored by Zhang, Li, and Omale (2025), who deployed AI-driven health kiosks to personalize medication routines in community settings. Although their system showed promise, it required considerable infrastructure, making it less suitable for resource-constrained environments. In contrast, the study provides lightweight, browser-based system which provides a more scalable alternative.

Kim, Chen, and Zhao (2025) leveraged reinforcement learning to deliver tailored

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adherence interventions among adolescents. While this model demonstrated high adaptability, its complexity may hinder real-world implementation. This system's simplicity and modular structure offer a practical solution for broader populations, especially in regions with digital skill gaps. Liu, Sun, and Roberts (2021) designed a web-integrated management platform for atrial fibrillation patients and showed improved adherence through centralized information delivery. However, the study lacked a strong focus on HCI principles. Our system improves upon this by intentionally incorporating usability, accessibility, and interactive design from inception.

Bashi et al. (2021) reviewed mobile applications targeting cardiovascular disease patients, noting the positive influence of real-time notifications and user interfaces. Their review highlighted the critical role of interactive design, reinforcing the HCI-based strategies used to boost user engagement in this study. Shah, Mehta, and Lin (2025) created a real-time dashboard for medication adherence, bridging the communication gap between patients and providers. Your system shares this emphasis on integration potential, suggesting future iterations could incorporate provider access to enhance clinical monitoring.

Lastly, Adebayo, Yusuf, and Salami (2025) developed a smart medication scheduling system tailored for diabetes management in low-resource environments. Their work aligns closely with yours in targeting accessibility and contextual relevance. However, our research broader focus on HCI principles offers a more generalizable and user-centered framework.

METHODOLOGY

Research Design

This study adopted a design and development research approach aimed at creating a functional, user-centered web-based medication reminder system. The methodology emphasizes iterative software development combined with usability evaluation to ensure the system meets end-user needs, particularly patients with chronic illnesses.

Software Development Approach

The system was developed following the Incremental Software Development Model (Figure 1), which facilitates building the software in manageable modules.

Each increment was designed, developed, and tested independently before integration, enabling early identification of issues and incorporation of user feedback throughout the development lifecycle. This approach balances the structured planning of the traditional waterfall model with iterative refinement, enhancing product quality and user satisfaction.

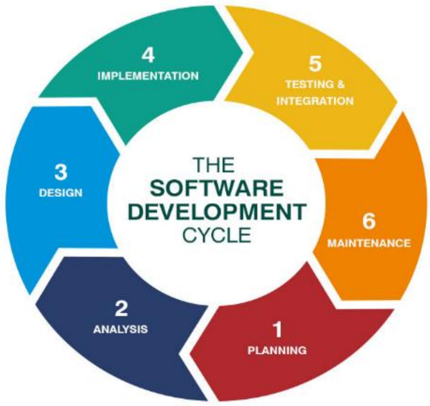

Figure 1. Software development life cycle.

Analysis of the Existing System

Traditional medication adherence systems such as pill organizers are limited by their reliance on memory and lack of adaptability. Current digital solutions often lack proper usability and HCI principles, resulting in poor user engagement, especially among older adults. Integration with healthcare providers is minimal, and long-term adherence remains a challenge.

Breakdown of the New System

The reviewed literature supports the efficacy of digital tools in promoting medication adherence but frequently highlights challenges in usability, complexity, and scalability. This research builds upon these findings by offering a simple, web-based, HCI-grounded solution that prioritizes user engagement and accessibility—making it particularly well-suited for low-resource and diverse healthcare settings. By incorporating incremental development, modular testing, and a user-centered design, this system stands out as a scalable and practical contribution to digital health interventions.

System Architecture and Tools

The system adopted three-tier architecture which comprises of:

1. **Presentation Layer:** Built with HTML, CSS, and JavaScript, responsible for user interaction and dynamic content display.
2. **Business Logic Layer:** Implemented in PHP, handling application processing,

user input validation, and communication between interface and database.

3. **Data Layer:** Managed by MySQL, storing user credentials, medication schedules, and reminder logs.

Process Design

Use Case Diagram:

The Use Case Diagram outlines the key interactions between the user and the system as shown in Figure 2.

It identifies the main functionalities offered, such as account registration, login, setting medication reminders, and receiving notifications.

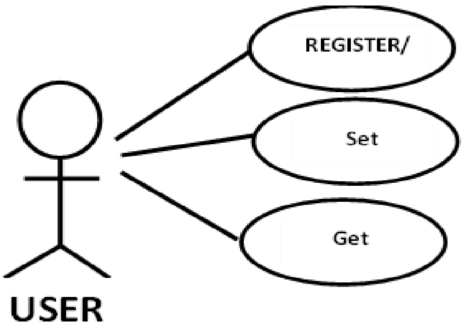

Figure 2. Use Case Diagram.

Flow chart

The flow chart as presented in Figure 3 illustrates the logical progression of user interactions with the system. It begins with user authentication and proceeds through the reminder management workflow. This diagram enhances the understanding of how the application handles decision-making and user inputs.

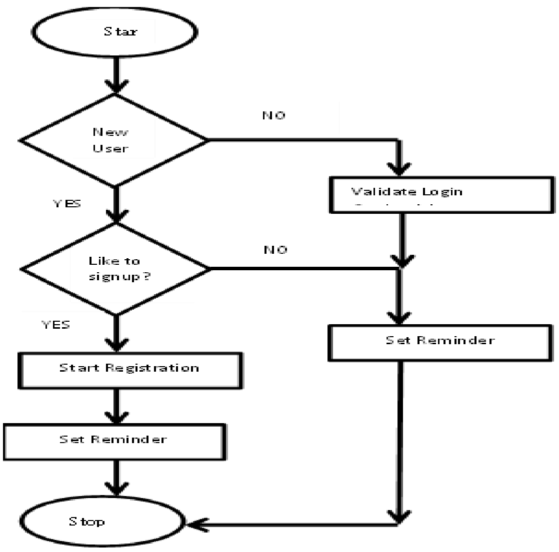

Figure 3. Flowchart.

Application Architecture

The Figure 4 depicts the layered application architecture, showing the interaction between the user interface, application logic, and database layers. It facilitates scalability and maintainability and supports efficient testing and debugging.

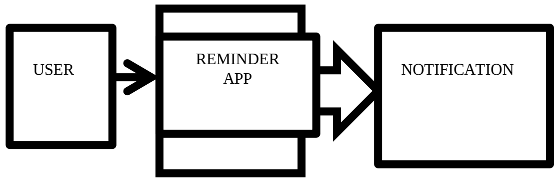

Figure 4. Application architecture.

System Architecture

The Figure 5 presents the technical composition of the system, detailing the interplay between client-side components (HTML, CSS, and JavaScript) and server-side operations (PHP and MySQL). It also illustrates the use of XAMPP as the local server environment during development and testing.

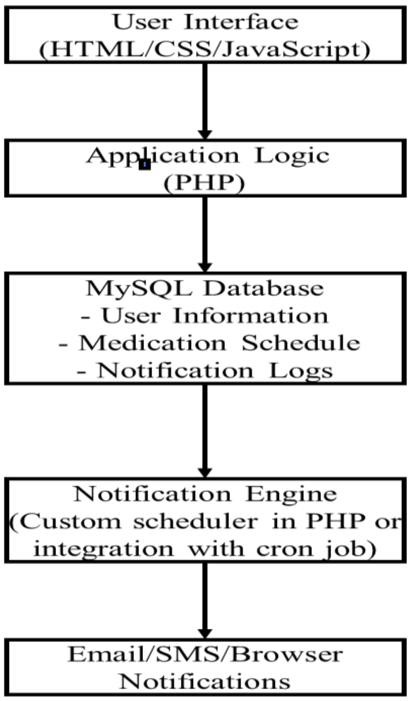

Figure 5. System Architecture.

Data Collection and Evaluation

User feedback was collected at various stages through prototype testing sessions focusing on interface usability, clarity of instructions, and effectiveness of reminder notifications. Feedback was analysed qualitatively to guide iterative improvements.

A usability test was conducted with 10 participants using purposive sampling techniques as potential users of a medication reminder system. Participants interacted with the developed web-based system and responded to a 15-item questionnaire on a 4-point Likert scale. The questions were categorized into four domains: Ease of Use, Design and Interaction, Functionality and Performance, and Overall Satisfaction.

RESULTS AND DISCUSSION

Implementation

Hardware and Software Requirements

The system was optimized for devices with minimal hardware specifications: at least an Intel Core Duo 2.0 GHz processor, 1 GB RAM, and standard input/output devices. It supports access via common web browsers to maximize accessibility, especially in low-resource settings.

System Implementation and Functionality

The developed web-based medication reminder system was successfully implemented using HTML, CSS, JavaScript, PHP, and MySQL, running smoothly on standard web browsers. The modular development approach ensured each system component—such as user registration, medication entry, reminder scheduling, and notification delivery—was independently tested and validated before integration. The system demonstrated stable performance during both individual module testing and comprehensive system-wide tests.

Users could register accounts, input medication details, and set personalized reminders with flexible scheduling options. The interface was intuitive, allowing users to easily navigate between pages such as Home, About Us, and Reminder. Notifications were triggered reliably based on the device's local time, ensuring timely alerts for medication intake. The system's backend database securely stored user and medication information, enabling persistent data management across sessions.

Usability and User Experience

User testing with 10 participants revealed a generally positive reception of the system's usability and usefulness. The table 1 summarizes the average scores for each usability category. All categories scored above 3.4 out of 4, indicating high user satisfaction and usability perception.

Also, the bar chart (figure 6) visually presents the mean usability scores. 'Overall Satisfaction' received the highest average score (3.7), followed by 'Ease of Use' (3.6). These results support the overall System Usability Scale (SUS) score of 82, which indicates excellent usability.

Table 1. Category-Wise Mean Scores.

Category	Mean Score	Interpretation
Ease of Use	3.6	Very Positive
Design and interaction	3.5	Positive
Functionality and Performance	3.4	Generally Positive
Overall Satisfaction	3.7	Very Positive

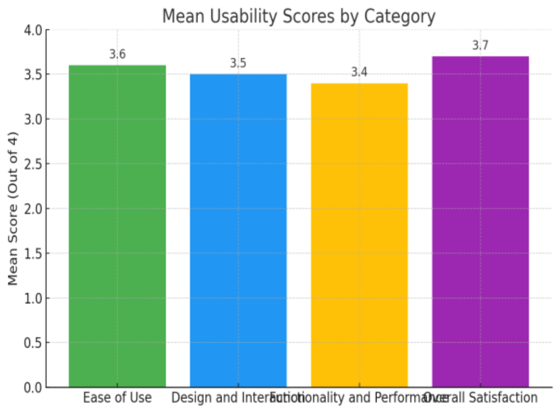

Figure 6. Mean Usability Scores by Category.

The average System Usability Scale (SUS) score was 82 out of 100, indicating good usability and user satisfaction (Brooke, 1996). Participants appreciated the simple and clean interface, noting that the design minimized cognitive load and supported easy interaction. Qualitative feedback highlighted several strengths:

1. **Personalization:** Users valued the ability to customize reminders according to their medication schedules and preferences, consistent with findings by Kumar et al. (2021).
2. **Accessibility:** The web-based nature allowed for access without the need installing apps or specialized devices, a key advantage for low-resource settings (Lee et al., 2023).

3. **Responsiveness:** The system functioned well across different devices and browsers tested.

Results

1. Home Page

The home page is the first page users come across when logged onto the website. The screenshot as presented in Figure 7 showcases the system's landing interface. It provides a clean, intuitive starting point for user navigation with straightforward access to major system functions through the navigation bar.

Figure 7. Home page.

2. About Us Page

The About Us (Figure 8) section informed users about the system's objectives and benefits. Accessible from the homepage and navigation bar, it enhances user trust and system understanding.

Figure 8. The About Us.

3. Reminder Interface

This interface as presented in Figure 9 enables users to view and manage their medication reminders. It is designed for simplicity and usability, allowing users to quickly add or modify reminders. The user can navigate to the reminder page by clicking on the reminder button on the navigation bar.

Figure 9. The Reminder Interface.

4. Adding and Deleting Reminder

The Figure 10 demonstrates the process for adding or removing medication reminders. The feature is responsive to user inputs and aligned with device time for timely notifications.

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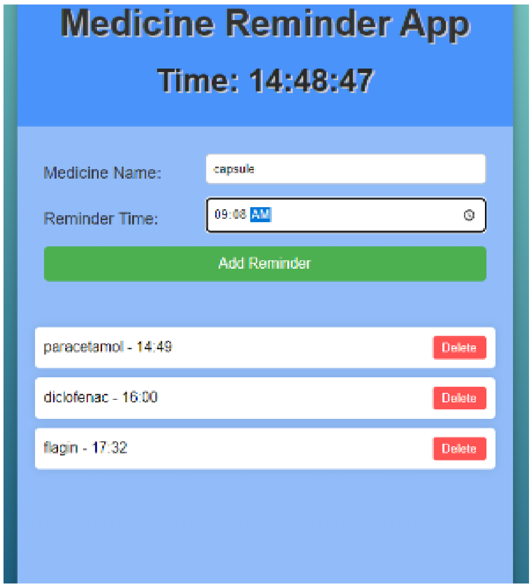

Figure 10. Interface for Adding and Deleting Medication Reminder.

5. Reminder Notification

The Figure 11 illustrated how the system delivers medication reminders based on the device's local time settings, providing personalized and timely alerting mechanisms critical for adherence.

DISCUSSION

Comparison with Related Studies

The findings align with existing literature emphasizing the importance of user-centered design and HCI principles in digital medication adherence tools (Kumar et al., 2021; Lee et al., 2023). Similar to these studies, this system underscores personalization and simplicity as critical factors driving engagement and sustained use. Unlike some mobile app-based solutions that suffer from high complexity and limited accessibility, this web-based approach offers a lightweight alternative suitable for populations with varying levels of digital literacy and device availability (Smith et al., 2020).

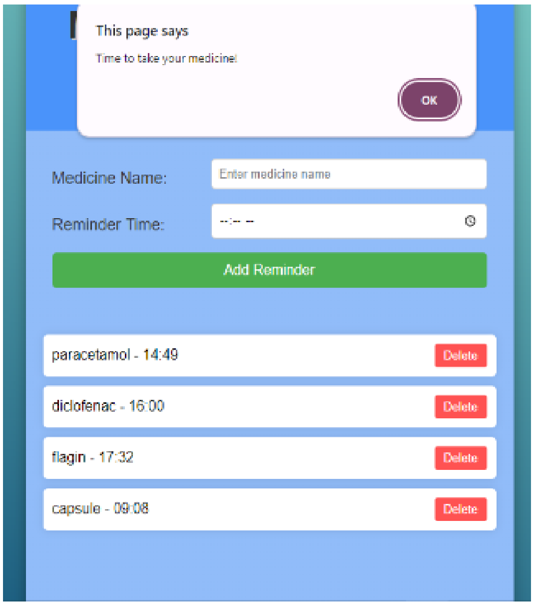

Figure 11. The Reminder Notification.

Moreover, the incremental development model enabled early incorporation of user feedback, addressing limitations reported in prior interventions that lacked iterative refinement (Jones & Patel, 2022). By focusing on modularity and continuous testing, this study contributes a scalable framework adaptable to diverse healthcare contexts.

Implications for Practice

This research provides evidence that a carefully designed, HCI-grounded web system can effectively support medication adherence, particularly in resource-constrained environments where mobile app adoption may be limited. The accessible platform can be integrated into broader healthcare workflows, enabling patients to better manage their treatment regimens with minimal technical barriers (Nguyen et al., 2024).

Healthcare providers and policymakers can consider adopting such systems as part of digital health strategies to reduce medication non-adherence and associated adverse outcomes. Training and digital literacy support will be essential to maximize uptake, especially among older adults.

CONCLUSION

The developed web-based medication adherence system demonstrates the potential of Human-Computer Interaction (HCI) principles in creating accessible, scalable, and user-friendly digital health interventions. By focusing on simplicity, personalization, and iterative development, the system successfully addresses key barriers to medication adherence—such as forgetfulness, poor usability, and lack of integration into daily routines. Testing and feedback revealed that users found the system intuitive and effective in managing their medication schedules. Compared to prior studies, this solution stands out by offering a low-cost, infrastructure-independent platform, well-suited to the needs of patients in both urban and rural settings. It provides a strong foundation for future enhancements and real-world deployment.

This study contributes meaningfully to digital health and HCI by showcasing how user-centered design can result in a scalable, browser-based system that addresses chronic disease management. Unlike existing interventions that depend on mobile apps or specialized hardware, this platform is low-cost, infrastructure-independent, and accessible across diverse settings. Through modular development and incremental testing, the system presents a flexible framework adaptable to different healthcare environments, backed by empirical evidence on improved user engagement and sustained usage.

The significance of this research lies in its potential to offer a low-barrier, practical solution to the global problem of medication non-adherence, especially in low-resource settings. Its web-based nature eliminates the need for app installation or hardware upgrades, making it widely accessible. By empowering patients through usability and personalization, the system can improve health outcomes and ease the burden on healthcare services. Moreover, it sets the stage for integration into broader public health strategies, highlighting the vital role of HCI in driving healthcare innovation.

Further Studies

Future research on the medication reminder system should include longitudinal studies to assess its long-term impact on medication adherence and health outcomes for different chronic conditions. Additionally, further investigation into security and privacy enhancements, such as advanced data encryption and authentication methods, is crucial to protect sensitive health information, particularly as the system scales for wider public use.

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