

Automated Medicine Reminder Device

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Abstract. This study developed and evaluated an Automated Medicine Reminder Device designed to assist individuals in adhering to their prescribed medication schedules through automated reminders and a dispensing mechanism. Specifically, the device aimed to address common medication management problems, including missed doses, incorrect timing of medication intake, and inconsistent adherence among patients requiring regular medication. Using a developmental research design, the device was developed and subjected to pilot evaluation to determine its workability, effectiveness, usability, and safety. Findings revealed that the Automated Medicine Reminder Device demonstrated highly workable performance, providing accurate scheduling, timely audio-visual notifications, and reliable medication dispensing. The device was also evaluated as very effective in reminding users to take their medications on time and dispensing the correct medication accurately. Participants rated the device as very usable because of its simple design, clear instructions, and ease of operation, allowing users to manage their medications independently. In terms of safety, the device exhibited stable performance, secure components, and minimal operational risks. Overall, the Automated Medicine Reminder Device proved to be a reliable and user-centered solution for medication management, with strong potential to improve medication adherence and support better health outcomes. The study recommends further enhancement of the device by incorporating additional features and conducting large-scale evaluations among diverse patient populations to validate its long-term effectiveness and usability.

Keywords: Automated; Medicine; Notification; Reminder Device; Usability

Introduction

Taking prescribed medications on time plays important role in preventing serious future complications and health issues. Taking medication for illnesses that do not cause symptoms can sometimes feel discouraging, but there is a significant purpose behind it. For example, even if you do not experience any symptoms of high blood pressure, leaving it untreated may eventually result in serious conditions such as heart attack or stroke (Berger, 2023).

Prevention of health complications often requires individuals to take several oral or inhaled medications every day, even when they do not feel any symptoms (Heid, 2022). Taking medication consistently each day can be difficult, especially when multiple medicines are involved. Forgetfulness is commonly identified as one of the main reasons why people find it hard to follow treatment plans for chronic conditions (Drabble, O’Cathain, and Wildman, 2019).

To address this issue, technology offers viable solutions through the integration of automated reminder systems. An approach that looks to have a great potential for creating low-cost medication management devices for public consumption can be accomplished through designing and building user-friendly Automated Medication Reminder Devices (AMRDs) using ESP32 based microcontrollers.

This study proposes to develop AMRDs that are capable of dispensing medication to the user at predetermined times according to the user’s prescribed treatment schedule, as well as alerting the user with an alarm or notification from the internet to help support their adherence to their prescribed treatment plan while at home and/or school. The significance of this work lies in improving the medication adherence of individuals who utilize the AMRD, in particular the students, elderly, and chronically ill patients who are likely to forget or mismanage their medication dosing schedules.

For the users of the device, they will benefit from the convenience of the device, will not need to rely on manual tracking of their medication taking efforts, and will have the ability to independently manage their medication dosing schedule.

Research Questions

This study aimed to develop an Automated Medicine Reminder Device and evaluate its performance in improving medication adherence and management among users.

Specifically, the study aimed to address the following questions:

1. How workable is the Automated Medicine Reminder Device in terms of:
 - 1.1 Notification, and
 - 1.2 Dispensing efficiency
2. How acceptable is the Automated Medicine Reminder Device in terms of:
 - 2.1 Effectiveness,
 - 2.2 Usability, and
 - 2.3 Safety

Scope and Delimitation of the Study

This study focused on the development and evaluation of an Automated Medicine Reminder Device designed to provide timely medication reminders and automated medicine dispensing. The device incorporated audio alarms, internet-based notifications, and a pre-recorded voice prompt to assist users in adhering to prescribed medication schedules. The study was conducted among 25 purposively selected teachers and stakeholders of BA Calamba National High School who were undergoing maintenance medication. The device was evaluated in terms of its workability, effectiveness, usability, and safety using frequency count and mode as the statistical tools for data analysis.

Literature Review

Medication Adherence Challenges

Medication adherence refers to the extent to which patients take their medications according to the prescribed dosage, schedule, and duration. It is recognized as a critical factor in achieving positive health outcomes and reducing preventable complications. Medication non-adherence remains a global healthcare challenge, contributing to avoidable hospitalizations, increased healthcare costs, and poorer patient outcomes (Pruitt et al., 2025). Research has identified several barriers to medication adherence, including forgetfulness, limited knowledge of proper medication use, low health literacy, and complex medication regimens (Dharvees et al., 2022). In contrast, access to healthcare services, physician counseling, regular monitoring, and effective prescription refill systems have been found to promote better adherence (Dharvees et al., 2022). Studies have also highlighted that improper medication storage and poor medication management practices may compromise treatment effectiveness, emphasizing the need for healthcare providers to strengthen patient education and self-management support (Dijkstra et al., 2019). Furthermore, supportive interventions such as regular medication reviews and appropriate medication management have been shown to improve adherence, particularly among vulnerable patient populations (Horvat et al., 2024).

Automated Medicine Reminder

Automated medicine reminders are technology-based systems designed to assist individuals in taking their medications at the correct time and dosage, thereby improving medication adherence and reducing medication errors. Recent studies have highlighted the importance of user-centered design in medication reminder applications, emphasizing features such as multi-channel reminders, medication intake acknowledgment, and simplified medication setup to enhance user engagement and reduce abandonment of digital reminder systems (Chanane et al., 2023). Similarly, automated medication dispensing systems have been recognized as effective long-term interventions for older adults with chronic conditions by promoting consistent medication-taking behaviors and improving adherence compared to conventional reminder methods (Arain et al., 2021). Furthermore, research on the MePill electronic pillbox demonstrated that automated reminder devices significantly improved medication adherence and reduced hospital readmissions among patients following hospital discharge, highlighting their potential to support transitional care and improve patient health outcomes (Martini et al., 2023).

Programmable Dispense Time

Programmable dispense time refers to the automated scheduling of medication dispensing based on predetermined dosing times, ensuring that medications are released accurately and consistently without relying on a patient's memory or manual reminders. This technology addresses medication non-adherence, particularly among individuals with chronic illnesses who require multiple medications, by providing timely and automated dispensing of prescribed doses (Boquete et al., 2010). Studies have shown that programmable dispensing systems utilize real-time clock (RTC) modules and microcontrollers to manage precise medication

schedules, enabling accurate dispensing through integrated mechanical components such as servo motors (Pak & Park, 2012). Furthermore, reliable timing mechanisms, microcontroller-based scheduling, and automated dispensing devices have been identified as essential components for ensuring the accuracy and effectiveness of medication dispensing systems, particularly for older adults and patients requiring long-term medication management (Philip et al., 2020).

In-App Messaging Systems/Internet-Based Notifications

In-app messaging systems and internet-based notifications are digital communication tools that deliver real-time medication reminders and alerts through mobile applications, supporting users in adhering to prescribed medication schedules. Unlike traditional SMS reminders, these systems provide interactive, personalized, and internet-enabled notifications that enhance user engagement and facilitate continuous monitoring of medication adherence (Stawarz et al., 2018). Recent studies have shown that modern medication adherence applications increasingly utilize multi-channel notification systems, integrating push notifications with tracking and feedback features to improve usability and encourage long-term adherence (Chanane et al., 2023). Moreover, internet-based notifications offer greater flexibility by allowing reminders to be customized according to users' medication schedules, health conditions, and behavioral patterns, thereby improving perceived usefulness and ease of use while promoting technology adoption in healthcare (Ahmed et al., 2018). Despite these advantages, researchers have noted that factors such as notification timing, user fatigue, and sustained engagement remain important considerations, suggesting that digital reminder systems are most effective when combined with behavioral support and continuous monitoring (Chanane et al., 2023). Overall, in-app messaging systems and internet-based notifications have emerged as effective and scalable digital health solutions for improving medication adherence within mobile healthcare environments.

The reviewed literature established that automated medicine reminder systems, including programmable dispense time and in-app messaging or internet-based notifications, play a significant role in improving medication adherence and supporting effective medication management. Studies consistently demonstrated that automated reminders, accurate dispensing schedules, and real-time notifications help reduce missed doses, enhance user compliance, and improve health outcomes, particularly among individuals with chronic conditions. Despite the growing adoption of digital health technologies, challenges such as user engagement, notification fatigue, and long-term adherence remain. These findings highlight the importance of developing and evaluating an Automated Medicine Reminder Device that integrates accurate dispensing mechanisms with internet-based reminder systems, providing a strong foundation for the present study.

Methodology

Research Design

This study employed a developmental research design integrated with a quantitative descriptive research approach to develop and evaluate the Automated Medicine Reminder Device. Developmental research focuses on the systematic design, construction, and evaluation of products or systems intended to address practical problems and improve existing practices (Richey & Klein, 2007). The developmental phase involved the planning, design, fabrication, and programming of the Automated Medicine Reminder Device, while the quantitative descriptive approach was utilized to assess the device's performance. Specifically, the device was evaluated in terms of its workability through notification and dispensing efficiency, and its acceptability in terms of effectiveness, usability, and safety. Data were collected using a researcher-made evaluation instrument and analyzed using appropriate descriptive statistical tools to determine the device's overall performance and acceptability. This research design was appropriate because it enabled the systematic development of the device while providing an objective evaluation of its functionality and potential as a technological solution for improving medication adherence.

Research Locale

The study was conducted at BA Calamba National High School located in Pangao-an, Magpet, North Cotabato, Philippines. The study involved 25 respondents who were selected through purposive sampling. The respondents consisted of teachers and stakeholders of the school who were undergoing maintenance medication and were chosen to evaluate the performance of the Automated Medicine Reminder Device. The study focused on assessing the device's workability in terms of notification and dispensing efficiency, as well as its acceptability in terms of effectiveness, usability, and safety within the selected research setting.

Research Participants

This study involved 25 respondents composed of teachers and stakeholders of BA Calamba National High School who were undergoing maintenance medication. The respondents were selected using purposive

sampling to ensure that participants had relevant experience and characteristics necessary for evaluating the Automated Medicine Reminder Device in terms of its workability and acceptability.

Research Instrument

The study employed a researcher-made survey questionnaire to evaluate the performance of the Automated Medicine Reminder Device. The instrument assessed the device's workability in terms of notification and dispensing efficiency using a workable or not workable checklist. It also measured the device's acceptability based on three criteria: effectiveness, usability, and safety, using a five-point Likert scale. The questionnaire served as the primary instrument for gathering respondents' evaluations of the device's overall performance and acceptability.

Data Gathering Procedure

The researcher first secured permission from the principal of BA Calamba National High School to conduct the study. Upon approval, informed consent forms were distributed to the selected respondents, and only those who voluntarily agreed to participate were included in the study. The researcher explained the purpose of the research, the procedures involved, and provided clear instructions on how to accomplish the researcher-made questionnaire. The survey instrument, which was adapted from related studies and supplemented with items developed by the researcher, was then administered to gather the respondents' evaluations of the Automated Medicine Reminder Device. Following the survey, the researcher conducted the testing and demonstration of the device, which was evaluated in terms of its workability through notification and dispensing efficiency, and its acceptability in terms of effectiveness, usability, and safety. The collected data were compiled, organized, and prepared for statistical analysis to determine the overall performance and acceptability of the device.

Results and Discussions

Research Question 1: How workable is the Automated Medicine Reminder Device in terms of Notification and Dispensing Efficiency?

Table 1. Workability of the Automated Medicine Reminder

Characteristics		Workability					Remarks
		HW	MW	W	LW	NW	
1. Notification on Scheduled Time	Med 1	10					Highly Workable
	Med 2	10					Highly Workable
	Med 3	10					Highly Workable
2. Dispensing on Scheduled Time	Med 1	10					Highly Workable
	Med 2	10					Highly Workable
	Med 3	10					Highly Workable

Table 1 shows the workability of the Automated Medicine Reminder Device in terms of notification and dispensing on the scheduled time. The results revealed that all indicators obtained a perfect score of 10, which was verbally interpreted as Highly Workable. This indicates that the device consistently provided timely notifications and accurately dispensed the three medications according to their programmed schedules without operational errors, demonstrating its reliability in performing its intended functions. The findings suggest that the integration of automated notifications, programmable dispensing mechanisms, and precise scheduling enabled the device to effectively support medication adherence by reducing the likelihood of missed or delayed doses. These results are consistent with Boquete et al. (2010), who emphasized that programmable electronic pill dispensers enhance medication compliance through accurate scheduling and automated dispensing, and Pak and Park (2012), who reported that real-time clock (RTC)-based scheduling integrated with microcontroller technology ensures accurate and reliable medication dispensing at predetermined times. Furthermore, the findings support the concept that automated medication reminder systems improve adherence by minimizing human error and promoting consistent medication-taking behavior among users requiring long-term medication management. Overall, the device demonstrated a high level of workability, indicating its potential to serve as a reliable and effective tool for safe and consistent medication.

Research Question 2: How acceptable is the Automated Medicine Reminder Device in terms of Effectiveness, Usability, and Safety?

Table 2. Acceptability of Automated Medicine Reminder in Terms of Effectiveness

Statements	VE	E	ME	SE	NE	Mode	Verbal Description
1. The device effectively reminds the users to take their medicine on time.	22	3				5	Very Effective
2. The App notification system works reliably in delivering reminders.	17	8				5	Very Effective
3. The device helps users maintain proper medication schedule.	14	11				5	Very Effective
4. Reduces the chances of missed or incorrect doses.	5	17	3			4	Effective
5. The device provides accurate time display	23	2				5	Very Effective
6. The device gives clear and audible voice reminders.	17	8				5	Very Effective
7. The device prevents multiple or incorrect dispensing.	21	4				5	Very Effective
8. The device repeats alerts if medicine is not taken.	19	6				4	Effective
9. The device operates consistently without errors.	3	20	2			4	Effective
10. The overall performance of the device meets its intended purpose.	21	4				5	Very Effective

Table 2 shows the acceptability of the Automated Medicine Reminder Device in terms of effectiveness. The results revealed that the device was generally rated as Very Effective, indicating a high level of acceptability among users in assisting them to take their medications on time and complete their prescribed medication regimens. The findings suggest that the device effectively provided timely notifications, voice reminders, accurate time display, and reliable medication dispensing, making it a valuable tool for improving medication adherence. Although a few indicators were rated as Effective, these results imply that minor improvements in alert repetition and overall system reliability may further enhance the device's performance. Nevertheless, the overall findings demonstrate that the Automated Medicine Reminder Device effectively supported users in adhering to their medication schedules and minimizing missed doses. These findings are consistent with Vrijens et al. (2012), who emphasized that electronic medication reminder systems significantly improve medication adherence by promoting timely and consistent medication-taking behavior, and Chanane et al. (2023), who reported that digital medication reminder applications with automated notifications enhance user engagement and adherence to prescribed treatment regimens. Overall, the device demonstrated a high level of effectiveness, indicating its potential to serve as an efficient and dependable solution for supporting medication management among individuals requiring regular medication intake.

Table 3. Acceptability of Automated Medicine Reminder in Terms of Usability

Statements	VU	U	MU	SU	NU	Mode	Verbal Description
1. The device is easy to operate and understand.	23	2				5	Highly Usable
2. The device interface are user-friendly.	17	8				5	Highly Usable
3. The device can be used effectively by individuals of different age groups.	18	7				5	Highly Usable
4. The device provides clear instructions for setup and use.	21	4				5	Highly Usable
5. The device enhances convenience in medication management.	14	7	4			5	Highly Usable
6. The device can send app notification to the user.	15	10				5	Highly Usable
7. The device controls are easy to access.	16	9				5	Highly Usable
8. The device displays are clear and readable.	15	10				5	Highly Usable
9. The users can easily adjust schedules.	17	8				5	Highly Usable
10. The device can give voice over notification.	16	9				5	Highly Usable

Table 3 shows the acceptability of the Automated Medicine Reminder Device in terms of usability. The results revealed that all indicators were rated Highly Usable, indicating that respondents consistently perceived the device as user-friendly, easy to understand, and convenient to operate. This suggests that the

device's intuitive interface, clear display, accessible controls, internet-based notifications, flexible scheduling, and voice reminder features enabled users to manage their medications efficiently with minimal difficulty. Although the indicator on convenience in medication administration received a comparatively lower response, it remained within the Highly Usable category, implying that some users may still require familiarity and experience with the device before fully recognizing its convenience over traditional medication management methods. These findings are consistent with Nielsen (2012), who emphasized that a usable system should be easy to learn, efficient to use, and satisfying for users, and Venkatesh et al. (2003), who reported that perceived ease of use significantly influences users' acceptance and continued utilization of technology. Overall, the Automated Medicine Reminder Device demonstrated a high level of usability, indicating its potential to provide a simple, accessible, and user-centered solution for effective medication management.

Table 4. Acceptability of Automated Medicine Reminder in Terms of Safety

Statements	VS	S	MS	SS	NS	Mode	Verbal Description
1. The device is easy to operate and understand.	23	2				5	Very Safe
2. The device interface are user-friendly.	15	10				5	Very Safe
3. The device can be used effectively by individuals of different age groups.	17	8				5	Very Safe
4. The device provides clear instructions for setup and use.	12	13				4	Safe
5. The device enhances convenience in medication management.	20	5				5	Very Safe
6. The device can send SMS notification to the user.	19	6				5	Very Safe
7. The device controls are easy to access.	14	11				5	Very Safe
8. The device displays are clear and readable.	19	6				4	Very Safe
9. The users can easily adjust schedules.	11	10	4			5	Very Safe
10. The device can give voice over notification.	17	8				5	Very Safe

Table 4 shows the acceptability of the Automated Medicine Reminder Device in terms of safety. The results revealed that most indicators were rated Very Safe, indicating that respondents perceived the device as secure, reliable, and appropriate for assisting medication management across different age groups. This suggests that the device's user-friendly interface, clear instructions, readable display, reliable notification system, and voice reminder features contributed to its safe operation and minimized the risk of medication errors. Although a few indicators, particularly those related to setup instructions and display readability, received a Safe rating, the overall findings demonstrate that the device provides a high level of protection against operational errors while ensuring accurate medication dispensing and timely reminders. These findings are consistent with Carayon et al. (2006), who emphasized that well-designed healthcare technologies enhance patient safety by reducing human error and improving system reliability through effective work system design, and Nielsen (2012), who noted that systems with intuitive interfaces and clear functionality promote user confidence, minimize operational mistakes, and improve the safe use of technology. Overall, the Automated Medicine Reminder Device demonstrated a high level of safety, indicating its potential to provide secure and dependable support for individuals requiring continuous medication management.

Table 5. Overall Acceptability of Automated Medicine Reminder

Characteristics	5	4	3	2	1	Mode	Verbal Description
Effectiveness	10						Very Effective
Usability	10					5	Highly Usable
Safety	10					5	Very Safe
Overall:							Very Acceptable
N = 25							

Table 5 shows the overall acceptability of the Automated Medicine Reminder Device in terms of effectiveness, usability, and safety. The results revealed that all three evaluation criteria obtained a mode value of 5, indicating that the device was rated as Very Effective, Highly Usable, and Very Safe, with an overall verbal interpretation of Very Acceptable. This suggests that the device successfully achieved its intended purpose of

providing timely medication reminders, facilitating accurate medication dispensing, and ensuring a user-friendly and secure system for medication management. The consistently high ratings demonstrate that respondents perceived the device as reliable, easy to operate, and capable of minimizing medication-related errors while supporting adherence to prescribed treatment regimens. These findings are consistent with Venkatesh et al. (2003), who emphasized that users are more likely to accept and continuously use technologies that are perceived as useful and easy to operate, and Carayon et al. (2006), who reported that healthcare technologies designed with usability and safety principles improve user performance, reduce errors, and enhance patient safety. Overall, the Automated Medicine Reminder Device demonstrated a high level of acceptability, indicating its potential as an effective, user-centered, and dependable solution for improving medication adherence and promoting safer medication management.

Ethical Considerations

This study adhered to established ethical principles to protect the rights, privacy, and welfare of all participants throughout the research process. Permission to conduct the study was obtained from the school administration of BA Calamba National High School prior to data collection. Informed consent was secured from all participants after they were provided with a clear explanation of the study's purpose, procedures, benefits, and their right to participate voluntarily or withdraw from the study at any time without penalty. Confidentiality and anonymity were strictly maintained by assigning codes to participants and ensuring that no personally identifiable information was disclosed in the analysis or presentation of the findings. All data collected were used solely for research purposes, handled in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173), and stored securely to prevent unauthorized access. The evaluation of the Automated Medicine Reminder Device was conducted in a safe and controlled environment to minimize potential risks to participants. The study likewise upheld the ethical principles of respect for persons, beneficence, justice, objectivity, and academic integrity throughout the conduct of the research.

Conclusion

The study concluded that the Automated Medicine Reminder Device is an effective solution for improving medication adherence through its programmable dispensing and notification features. The device demonstrated a high level of workability by consistently providing timely notifications and accurately dispensing medications according to the programmed schedule. Respondents also evaluated the device as very effective, highly usable, and very safe, indicating its reliability, ease of operation, and minimal risk during use. These findings suggest that the Automated Medicine Reminder Device has strong potential to support individuals who require regular medication by promoting timely medication intake, reducing medication errors, and enhancing overall medication management.

Recommendations

Based on the findings, the study recommended that healthcare providers and caregivers consider utilizing the Automated Medicine Reminder Device to support patients requiring regular medication and improve medication adherence. Device developers were encouraged to enhance the system by integrating a solar charging feature to provide an alternative power source during electrical outages, adding a handle for easier portability, and incorporating a volume control for voice reminder alerts to better accommodate users with hearing impairments. Future implementations were also encouraged to conduct long-term testing in home, clinic, and school settings to further evaluate the device's effectiveness and reliability in real-world environments. Moreover, future researchers were advised to improve the device by integrating additional features such as voice command functionality, automated refill alerts, a medicine catcher, and non-slip footing to further enhance its usability, safety, and overall performance.

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