DIGITAL PLATFORM FOR TREATMENT AND MONITORING ELDERLY PATIENTS: A CASE STUDY AT PHOSRISUWAN HOSPITAL, SISAKET PROVINCE

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Abstract

This research presents a digital platform for the care and treatment of elderly patients. It will be a synchronization between digital platforms, and a prototype pill box device that helps to remind and store medication information and treatment of the elderly. The treatment and monitoring platform analyzes relevant data for the benefit of assisting physicians and caregivers caring for the elderly with statistical models and IoT in order to effectively treat the disease of the elderly. The prototype pill box is developed with IoT device to facilitate communication between the elderlies and the prototype. As a result, the elderlies can take the medicine on time and reduce the problem of taking the wrong medicine. The digital platform and prototype pill box device will be able to facilitate physicians, caregivers, or elderly family members to be able to follow up on the treatment of diseases and take medications of elderly patients effectively.

Keywords: Digital Platform, IoT, Medicine Reminder, Smart Pill Box

Introduction

According to the report on the situation of the elderly in Thailand in 2019 by the Thai Gerontology Research and Development Institute Foundation, Thailand has entered the aging society since 2005 until now in 2025. Thailand has a proportion of elderly people or people aged 60 years and over of more than 12 million people, accounting for 18.0% of the total population, and it is likely to increase to 20.0% of the total population in the near future, resulting in Thailand being a completely elderly country.

When people enter the elderly age, the main problem that inevitably follows is health problems. The things that help relieve symptoms and treat these diseases are seeing a specialist doctor, receiving treatment from a hospital, and taking medication. In addition, the elderly often have many of these diseases at the same time, so they must see a doctor and take medication regularly. Therefore, following up on various treatments is very important and must be responded to in a timely manner. Medicine is something that the elderly often carry with them at all times. Taking medicine may not be difficult for young people, but it is difficult for the elderly because as they get older, their physical condition deteriorates with age, including movement, eyesight, and memory loss from dementia, resulting in problems in taking medicine. Most elderly people have at least one underlying disease, which requires them to take multiple medications and is more at risk of drug abuse than other age groups. In addition, the elderly need to take their medications at different times. Elderly people with memory problems may forget to take their medications, and some medications look similar, making it difficult for elderly people with vision problems to distinguish them. This makes it more likely that they will take the wrong medication. If medication is not taken in full or incorrectly, it can cause side effects or be life-threatening. Therefore, taking medication for the elderly is an important matter that caregivers or family members should not overlook.

The authors recognize the importance of the problem of monitoring disease treatment and medication adherence for the elderlies. The research on a digital platform for the care and treatment tracking of elderly patients will integrate the work between a digital platform and a prototype pill box that helps to notify, store medicine and treatment data for the elderly. The prototype of the pill box will help us to solve the problem of medication adherence in the elderlies. This is because the pill box has an automatic notification system when it is time to take medication, and will notify via the pill box and the LINE application. The treatment history will be connected to the web application platform, allowing doctors and caregivers to know and use the obtained information to analyze and plan for future treatment.

Research Objectives

This research aims to create and study as follows:

1. Develop a database system to collect pill consumption records for elderly patients.
2. Create a smart pill box to remind and monitor pill consumption for elderly patients.

Scope of the Research

1. Population Scope: The elderly patients from our study are restricted to those who have chronic diseases at Phosrisuwan Hospital, Sisaket Province, Thailand.
2. Variable Scope:
   The independent variable is the use of smart pill box
   The dependent variable is: pill consumption of patients
   The control variables are: elderly patients, living places, chronic diseases
3. Time Scope: The test of the smart pill box together with the monitoring system took 1 month.

Furthermore, our project has general scope as detailed below:

- The tool that is developed in this project is to remind and monitor pill consumption only.
- The smart pill box is able to notify via two channels which are alarming from the box itself and Line application to a caregiver.
- The smart pill box is able to deliver only medicine that are pills or capsules.

Literature Review

A pilot study conducted by Patel, S., Jacobus-Kantor, L., Marshall, L., Ritchie, C., Kaplinski, M., Khurana, P. S., & Katz, R. J. (n.d.). assessed the efficacy of a mobile phone based medication reminder application (Pill Phone) in enhancing medication adherence and blood pressure regulation among 50 high risk urban patients with hypertension, predominantly African-American, Medicaid-insured, and diagnosed with diabetes mellitus. Medication adherence, evaluated via pharmacy refill rates, enhanced from the pre-activation period to the activation phase but substantially reduced in the post-activation phase. Self-reported adherence scores considerably rose, and average blood pressure control improved post-intervention, maintaining superior to baseline values throughout the research. Participants reported considerable satisfaction with the reminder system; however, issues such as reminder weariness, reluctance to recognize noncompliance, and minimal interest in updating prescription lists were noted. Notwithstanding its limited sample size, brief duration, and absence of a control group, the study indicates that mobile-phone-based reminders may improve medication adherence and blood pressure regulation, with prospective enhancements anticipated through personalized interventions, integration with health records, and bidirectional communication with healthcare providers.

Inadequate drug adherence may lead to adverse health consequences and financial strain. This research evaluation (Fang KY, Maeder AJ, Bjering H, 2016). grounded in 45 pertinent PubMed publications, describes three primary categories of electronic medication reminders: mobile phone reminders, in-home electronic devices, and portable reminder devices. These technologies have progressed from essential text messages to interactive voice answers and mobile applications, markedly enhancing medication adherence and user happiness. These solutions not only alert elderly patients residing independently but also mitigate the risk of overdose. These devices are intricately associated with pharmacies and healthcare professionals, establishing them as a growing trend in medication administration.

Minaam, D. S., & Abd-ELfattah, M. (2018). introduce the design and development of an innovative pillbox prototype intended to lessen medical errors resulting from the manual sorting of substantial numbers of tablets in hospitals and nursing homes. The programmable pillbox comprises nine distinct compartments, enabling carers or patients to configure precise dosages and schedules for various drugs. It delivers reminders via auditory signals, visual indicators, and an Android application, alleviating carers' responsibility to preload medications consistently and decreasing the likelihood of missed or erroneous dosages. The gadget is compatible with RoboRemo software, facilitating remote monitoring and support through local networks or the Internet.

Gandhi, R., Dhanawade, R., Ambekar, V., Chaple, P., & Chillarge, G. (2019). introduced an intelligent pillbox to mitigate problems associated with missing doses or improper medicine administration. The intelligent pillbox is connected to a smartphone application that enables carers to oversee, configure, and receive immediate notifications if the patient neglects a dose. The device is outfitted with an alarm system, touch sensors, and an

automatic lock to guarantee proper medication intake. In contrast, the feedback from the touch sensors is documented and preserved in a database.

Jayamani, S., Mohanram, D., Nandhakumaran, L., Nila, T., & Nivetha, S. (2020). An automatic dispenser system presented in employs a PIC microcontroller and GSM module to alert carers when patients consume their medications. It emphasises chronic disease management and suggests functionalities like refill automation and telemedicine integration for improved convenience.

Shanmugam, D. B., Dhilipan, J., Sivasankari, A., Munusamy, S., & Karpagam, S. (2020). An innovative IoT- and cloud-based pillbox presented in integrates features including SMS reminders, real-time sensor monitoring, and inventory management. This method notifies caregivers when the box is opened and alerts patients when medication supplies are insufficient, thereby assuring adherence and prompt refills.

In conclusion, these systems underscore the revolutionary potential of integrating sophisticated technology to provide efficient, user-centric solutions that empower patients, carers, and healthcare providers, enhancing health outcomes and quality of life.

Research Methodology

This project has research plan as follows:

1. Research Methodology

1.1 Patient Selection: The elderly patients that are selected in this project must be at least 60 years old, be sensible, be able to listen, speak, read and write Thai language. Also, the selected patients must be from Out-Patient Department (OPD), be taking at least one kind of medicine, and be willing to join the project.

1.2 Software Development:

1.2.1 Klongyaa web application for monitoring systems: The frontend was written by React, Tailwind, and Ant Design framework. The backend part was written by Express.js with TypeORM and SQL Postgres. The developers use integrate the LINE application with Hardware and web application by using LINE messaging API.

1.2.2 Klongyaa application on the smart pill box: The software of the smart pill box was written by Python and connected to Cloud Database of Klongyaa web application for monitoring systems and LINE messaging API.

1.3 Hardware Development: The smart pill box uses Rasberry Pi as the computer board, showing the interface by 7-inch touch screen LCD. The sensor to detect medicine pick-up is "distance". No battery. Due to the internet limitation of elderly's accommodations, the pill boxes need pocket WIFI to keep data into Cloud Database and to send messages to caregivers via LINE application. The box body and cover are made of acrylic plate. Four pill boxes have 8 kinds of medicine storage capacity and one pill box has 4 kinds of medicine storage capacity.

1.4 Questionaire: The questionnaire is written and is evaluated IOC which all the questions pass IOC more than 0.5.

2. Research Steps

2.1 Informal Communication among research staffs from KMUTT and Phosisuwan Hospital. The KMUTT staffs surveyed elderlies in Phosisuwan first time on 26th January 2024. The aim was to see environment and to be familiar with the local people.

2.2 The first formal meeting was started on 4th March 2025. The aims were to select a patient group to join the project, to obtain more information of medicine consumption rate per day in order to design the dimension of the pill box.

2.3 The second meeting was on 7th July when KMUTT presented the first prototype of the pill box in order to receive the comments from medical staff from Phosisuwan hospital, and revise the box due to comments.

2.4 The parallel progress between (i) questionnaire building and Index of item Objective Congruence (IOC) evaluation, (ii) hardware of the pill box building and software developing (iii) patient selection.

2.5 The first set of smart pill boxes were delivered to the selected patients. Brief caregivers and village volunteers to take care of the medicine preparation, to use Line application of the notification system.

2.6 Follow up the use of pill boxes for 1 month. Fix and reboot system when problems occur (internet instable, electric power cut etc.)

2.7 Interview satisfaction and the success of pill box use.

3. Data Collection

3.1 The data collection that is obtained from the smart pill box is obtained when the notification alarm, sending reminder to Line application of caregivers and record whether or not the pills were taken from the box. The data is stored in Postgres SQL.

3.2 The succession of notification system is by interviewing elderly patients and by observation.

3.2.1 The questions that are used to ask the elderly are: (i) the pill box does helps to take medicine on time, (ii) the pill box does helps to take medicine continuously, (iii) the pill box is convenient to use, (iv) the size of pill box is appropriate, (v) the notification from pill box is correct and (vi) overall satisfaction.

3.2.2 In our observation, we follow monitoring system online and keep in touch with village volunteers. We also observe the environment that are located our pill box.

3.3 The survey of satisfaction of smart pill box and line notification are by interviewing caregivers. Moreover, the questions that are used to ask the caregivers are categorized into two sections which are in parts of Line applications and the notification from pill boxes. The questions in the category of Line application are (i) correctness of details and information, (ii) appropriateness of text sizes (iii) convenient to use, (iv) alarming on the screen is correct and clear and (v) able to help elderly to take medicine on time. The questions in category of notification from pill box are (vi) detail components on the pill box screen is appropriate and easy to use, (vii) detail is clear and easy to understand (viii) appropriateness of text sizes, (ix) all the functions are easy to set up and use (x) easy to add more information, (xi) the alarming is correct, (xii) the data that is shown on website is correct and (xiii) overall satisfaction.

4. Data Analysis

The data from the surveys are collected and analyzed by scoring from 5 (very satisfied) to 1 (very un-satisfy). We also have the choice "unable to evaluate" in case of error and unused because of the system faulty. The data from the interview is analyzed by descriptive statistics, frequency distribution and average value.

Research Results

By the budget of our project, we are able to build up 5 of smart pill boxes, 4 boxes for 8 kinds of pill storage and 1 box for 4 kinds of medicine storage. The component of the pill box is illustrated in Figure 1.

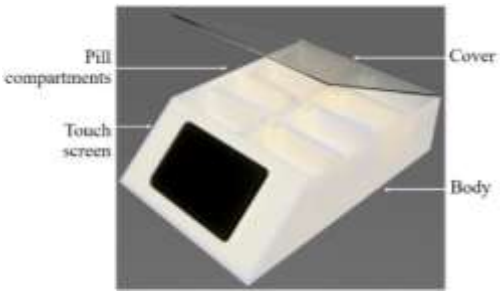


Figure 1: The components of pill box

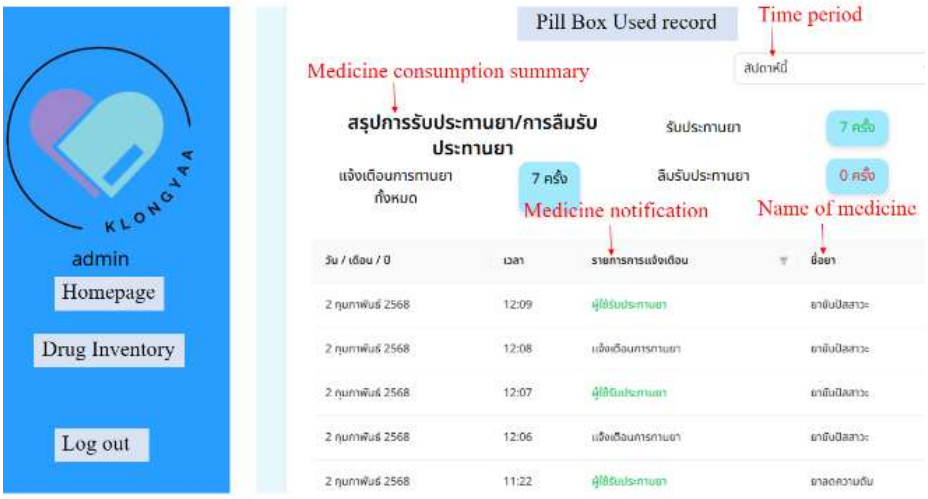
The details of the diseases in order to prepare pill for each box is as follows. We note that Box 1 and Box 4 have an error of electric power so that the patients are not able to use throughout to the whole study.

Table 1: The details of pill storage.

Smart Pill Boxes	Types of disease
Box 1	Unused
Box 2	Hypertension, Hematic
Box 3	Hypertension
Box 4	Unused
Box 5	Hypolipidaemic, Hypertension

The results of data collection are presented as follows.

1. The data of medicine consumption is collected and stored in Postgres SQL. It is presented to admin and caregivers to follow up the test. An example of the front-end is shown in Figure 2.



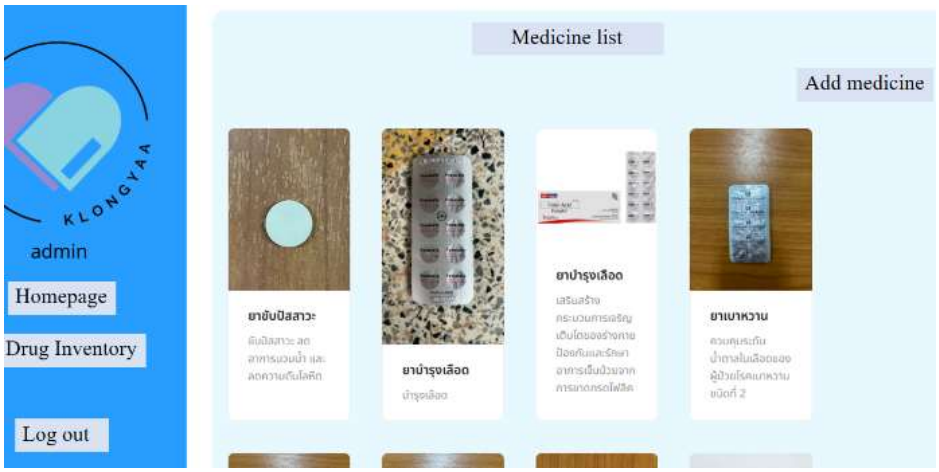


Figure 2: Front-end for admin and caregivers showing medicine intake record (up) and medicine inventory (down)

2. The succession of notification systems is presented overall by the following picture.

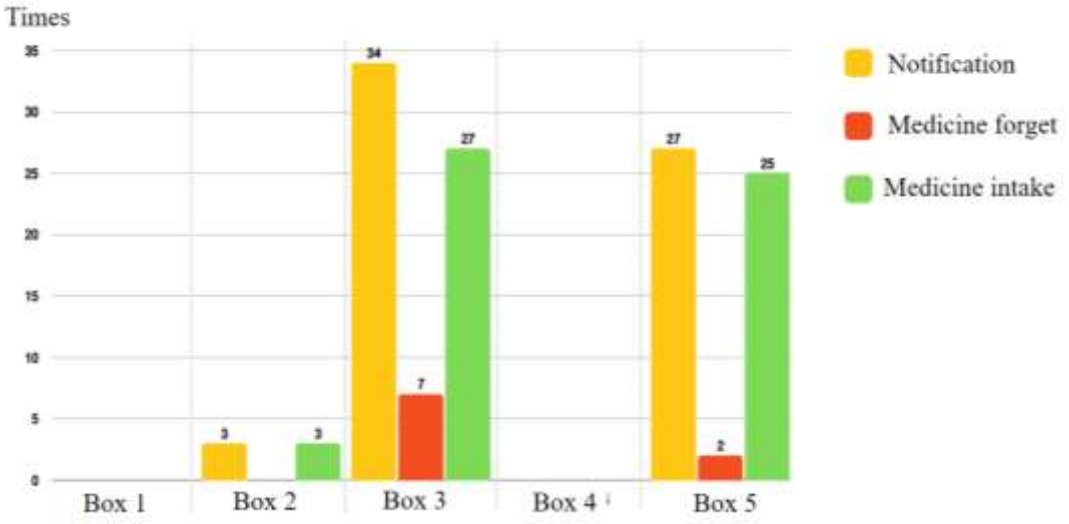


Figure 3: Overall notification and succession of taking medicine

The problem from our observation is shown in the following table.

Table 2: The details of pill storage.

Smart Pill Boxes	Status	Problems
Box 1	Unused	Power supply faulty
Box 2	Intermittent	Internet signal weakness
Box 3	Normal	-
Box 4	Unused	Power supply faulty
Box 5	Normal	Low internet stability

During our 1-month test, we have been reported problems by caregivers and village volunteers. The list of "onsite" problems together with how we solve is detailed in the following table.

Table 3: The details of pill storage.

Problems	Solving
Low internet stability	Remote to the box to reboot the program
Light bulb error	Remote to the box the reset the circuit
No alarming	Remote to the box to find error of the program
Server problem	Reset server and remote to the boxes to restart the program
Screen problem	Contact hospital admin to assist
Power cut	Remote to the box to reboot the program
Power supply faulty	-

Due to Subsection 3.2.1 which is the survey of successful of medicine notification from the elderlies, we give the results of the average of satisfaction in each question as follows.

Table 4: The survey results of satisfaction of the pill box from the elderly

Questions	Average of satisfaction scores
(i) The pill box does helps to take medicine on time	5
(ii) The pill box does helps to take medicine continuously	5
(iii) The pill box is convenient to use	5
(iv) The size of pill box is appropriate	4.67
(v) The notification from pill box is correct	4.33
(vi) Overall satisfaction	4

Due to Subsection 3.3 which is the survey of satisfaction of medicine notification from the caregivers, we give the results of the average of satisfaction in each question as follows.

Table 5: The survey results of satisfaction of the pill box from the caregivers

Questions	Average of satisfaction scores
Line application	
(i) Correctness of details and information	4.75
(ii) Appropriateness of text sizes	5
(iii) Convenient to use	5
(iv) Alarming on the screen is correct and clear	4.67
(v) Able to help elderly to take medicine on time	5
Notification from pill box	
(vi) Detail components on the pill box screen is appropriate and easy to use	5

Questions	Average of satisfaction scores
(vii) Detail is clear and easy to understand	5
(viii) Appropriateness of text sizes	5
(ix) All the functions are easy to set up and use	4.33
(x) Easy to add more information	4.33
(xi) The alarming is correct	5
(xii) The data that is shown on website is correct	4.5
(xiii) Overall satisfaction	4.33

Discussion

1. Due to the satisfaction scores from Tables 4, Questions (i) and (ii) and Table 5, Question (v), the results show that our smart pill box is able to notify the elderly patients to take medicine on time.

2. Some elderly patients feel inconvenient to leave the pill box plugging to the power while they are off to the farms. We plan to install a battery to our next pill box model.

3. The elderlies further say that it is inconvenient to take the pill box in case they have to sleep over somewhere (such as a council visit in a different province). In this view, we plan to reduce the size of our box, making it more portable to users.

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References

Fang, K. Y., Maeder, A. J., & Bjering, H. (2016). Current trends in electronic medication reminders for self-care. *The Promise of New Technologies in an Age of New Health Challenges*, 31–41.

Gandhi, R., Dhanawade, R., Ambekar, V., Chaple, P., & Chillarge, G. (2019). Smart pill box. *International Journal of Engineering Trends and Technology, 67*(5), May 2019.

Jayamani, S., Mohanram, D., Nandhakumaran, L., Nila, T., & Nivetha, S. (2020). Automatic pill dispenser and consumption monitoring system. *International Journal of Research in Engineering Science and Management, 3*(4), 647–649.

Minaam, D. S., & Abd-ELfattah, M. (2018). Smart drugs: Improving healthcare using smart pill box for medicine reminder and monitoring system. *Future Computing and Informatics Journal, 3*(2), 443–456.

Patel, S., Jacobus-Kantor, L., Marshall, L., Ritchie, C., Kaplinski, M., Khurana, P. S., & Katz, R. J. (n.d.). Mobilizing your medications: An automated medication reminder application for mobile phones and hypertension medication adherence in a high-risk urban population.

Shanmugam, D. B., Dhilipan, J., Sivasankari, A., Munusamy, S., & Karpagam, S. (2020). Smart pill box using IoT and cloud. *Bioscience Biotechnology Research Communications, 13*(4), 139–145.