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Developing an Innovative Health Information Service System: The Potential of Chatbot Technology

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Abstract

This study is a research and development with 3 main objectives: (1) to design and to develop a health management system; (2) to evaluate the efficiency and acceptability of technology; and (3) to compare the average Body Mass Index (BMI) before and after utilizing the developed health management system guided by the principle of the wellness plan. The study was divided into 3 phases: (1) study phase that conducts semi-structured interview with a group of students and healthcare professionals, along with literature review; (2) development phase that the health management system used an adapted waterfall model, dividing the system into two parts: website and Line Chatbot; and (3) experimentation and evaluation phase which the data were collected by using questionnaires that were used and analyzed by using descriptive statistics. This study found that the developed health management system was evaluated at a high level by 3 experts. Additionally, the system acceptability was evaluated at a high level by sample group of 33 individuals. The result of research showed that the developed system was able to be used as a tool for primary health management in the areas of diet planning and exercise including to the ability to track and analyze your own health.

Keywords: Health informatics, Healthcare, Digital health, Line Chatbot, Web development

1. Introduction

Healthcare involves the maintenance and improvement of both physical and mental aspects of well-being to sufficiently meet individual needs and functions. In addition to the treatment of diseases and illnesses, healthcare also focuses on disease prevention and creating a conducive environment for the body and mind. The foundation of good health begins with health literacy, which refers to the individual's ability or potential to understand health information and make appropriate decisions about their health. Promotion of health literacy enhances individual's knowledge and understanding of health information and the benefits of self-care. For example, exercising not only enhances the body but also reduces the risk of Alzheimer's disease (Department of Disease Control, 2021a). Overall, good health is primarily attributed to both physical and mental well-being. Mental health refers to the ability to handle one's own problems appropriately without causing trouble for others. Meanwhile, physical health is related to aspects such as Body Mass Index (BMI), cholesterol levels, blood pressure, and health examination (Faculty of Dentistry, 2019). Generally, understanding physical health is fundamental knowledge that people of all ages can acquire. However, promoting the education and programs regarding habits, diets, healthy exercise, weight control, as well as attitudes, enhances individual health behaviors (Phokhwang, Sarakshetrin, Ngamwongwiwat, & Pramnoi, 2023). In medical aspect, several indicators are used in primary healthcare management, including BMI, Basal Metabolic Rate (BMR), and Total Daily Energy Expenditure (TDEE). BMI serves as a standard indicator to evaluate physical condition by assessing the balance between body weight and height (Department of Disease Control, 2021b). BMR represents the minimum number of daily calories needed to maintain homeostasis. Meanwhile, TDEE refers to the total daily energy expenditure, including both daily energy requirement and physical activity energy. TDEE can be calculated by adding the BMR value to the number

of calories expended through physical activity within a 24-hour period (Lalam, Chaimai, & Fukfon, 2022). These indicators enable individuals to plan their appropriate diet and exercise routines to achieve and control their desired weight.

The education in university level is one of the most important periods for personal physical and mental health development. Healthcare during this period is paramount, as it profoundly impacts learning effectiveness and ability to manage daily stressors and problems (Ruanphet, Khamanek, Ngomsangad, Hiranwitchayakun, & Suwannawong, 2023). In high-ranking educational institutions, students often face considerable academic pressure. Inadequate stress management potentially harm student health. Therefore, appropriate physical and mental health management is essential for students to achieve effective performance and prevent physical health-related issues. Generally, universities promote the student exercise activities in many aspects, such as providing gym and sport facilities, and offer courses related to healthcare (RMUTI Surin, 2022). On the other hand, proper diet and exercise education are crucial for students. Lack of healthcare knowledge and time management is commonly cited as major problems among students during their university education. Additionally, many students do not prioritize their health properly, which leads to various diseases such as obesity, heart diseases, and diabetes, consequently impacting their study or work performance (Kimsungnoen, Setthawong, Boonya, Yantaporn, & Dechjob, 2023). However, a previous study has shown that developing health literacy has been an effective way to help students acquire knowledge and develop positive attitudes, leading to behavioral changes (Khamngoen et al., 2023).

Therefore, this research introduces a healthcare management method based on the concept of wellness plan (Department of Health, 2022) and health informatics. This healthcare management system combines information technology and clinical knowledge to improve and solves problems in the healthcare system (Nelson, 2020) by using basic health indicators, including BMI, BMR, and TDEE. This system presents personalized diet and exercise plans to encourage individuals to access their health information anytime and anywhere. This results in increased communication with medical and fitness professionals. Additionally, this system can be used as a tool for in-depth collection and analysis of personal health information and for planning health promotion policies. This developed healthcare management system utilizes 2 technologies, consisting of a health information management website and LINE Chatbot. Users record their basic health information (e.g. age, sex, weight, height, and daily activity) on the health information management website. The LINE Chatbot enables users to inquire about diet and exercise information, restaurant recommendation and fitness locations in the study area (Surin Municipality).

2. Research Objectives

2.1 To design and develop a health management system

2.2 To evaluate the efficiency and acceptability of the developed health management system technology

2.3 To compare BMI before and after using the developed health management system

3. Materials and Methods

3.1 Scope of study

The samples for this study were selected using purposive sampling techniques (Wadeejaroen, Lertnaisat, & Teekasap, 2017). The samples were divided into 2 groups: Group 1 consisted of 3 experts (including 1 professional nurse, 1 trainer, and 1 information specialist); and Group 2 consisted of 30 students (Year 1-4 in academic year 2022) from the Department of Computer Technology, School of Agriculture and Technology, Rajamangala University of Technology, Surin campus, Thailand. Additionally, the selected individuals were those who were interested in healthcare in terms of diet and exercise and attended the university gym at least once.

Moreover, the scope of content and period, this research presented health care in terms of diet and exercise plans that are appropriate for each individual's behavior by collecting information on restaurants and exercise venues in the Surin Municipality area. The research was conducted between March 2021 - April 2022.

3.2 Design and development of health management system

This study was divided into 3 phases:(1) study and research phase; (2) platform design and development phase; and (3) monitoring and evaluation phase. The details of each phase are described below:

Phase 1: Study and research

The needs of users were gathered in this phase. Data were collected from various sources, including: (1) research and healthcare theories in the areas of wellness plan, diet, and exercise (Department of Health, 2022). (2) open-ended and closed-ended questionnaires administered to the selected sample population; and (3) unstructured interview (Wadeejaroen et al., 2017) with 2 health care professionals (a professional nurse and a trainer).

Phase 2: Platform design and development

This phase comprised of 2 steps as follows:

Step 1 which focused on design of health management system consisted of 2 parts. Part 1 focused on the development of the health management website using a client-server architecture system (Nyabuto, Mony, & Mbugua, 2023). Users were divided into 4 levels: (1) system administrator, (2) general user, (3) member, and (4) expert. Users were able to access the system via a web browser. The functionality was analyzed by the development team based on data from phase 1 to ensure the consistency with health theories of diet and exercise, and to meet the need of users as much as possible. Part 2 focused on health management using LINE Chatbot. This served as an interface between system and member users, providing real-time information to users at any time. Both systems utilized the same database in order to reduce data storage conflicts. The system architecture is shown in Figure 1. In order to use the system, users were required to register in the system by filling in basic information (name, surname, sex, weight, and height), the system then calculated BMI and displays preliminary health information and proportional assessment (underweight, normal weight, overweight, or obese). Then the users uploaded their daily activity information, and the system displayed the calories content attributed to such activities. Additionally, the system displayed recommended foods, with information on the calories that users required to meet their needs. Users watched videos of exercises which focused on specific parts of the body as shown in Figure 2.

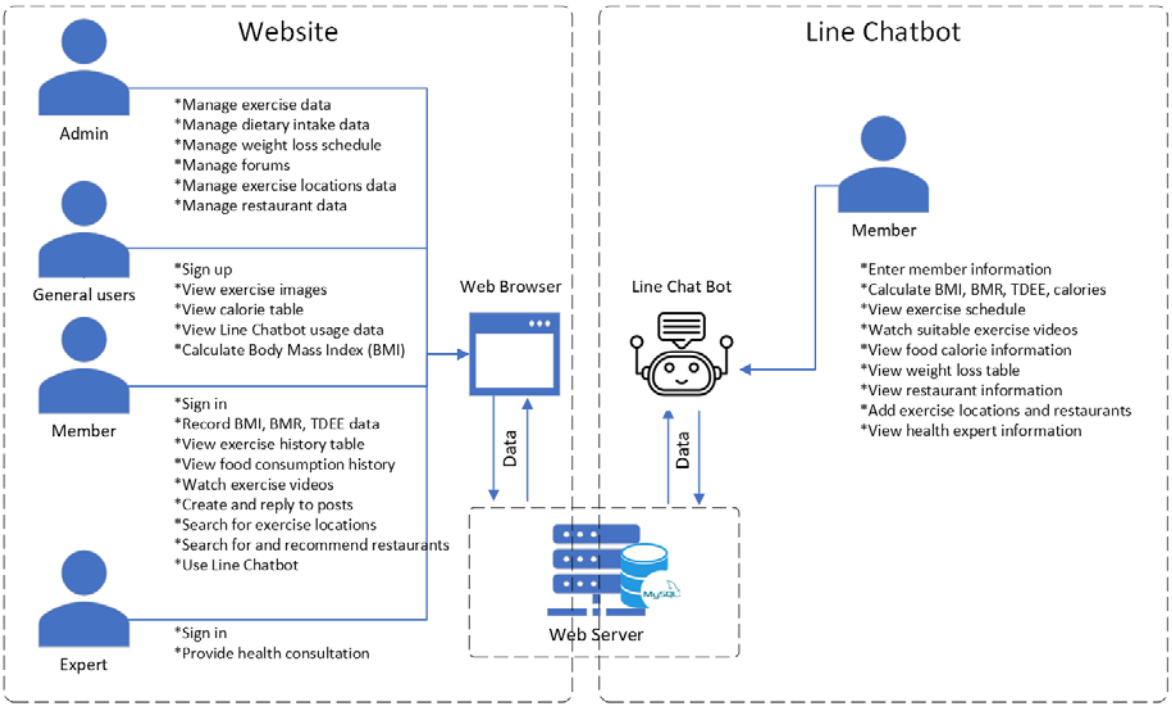


Figure 1. Architecture system of health management system.

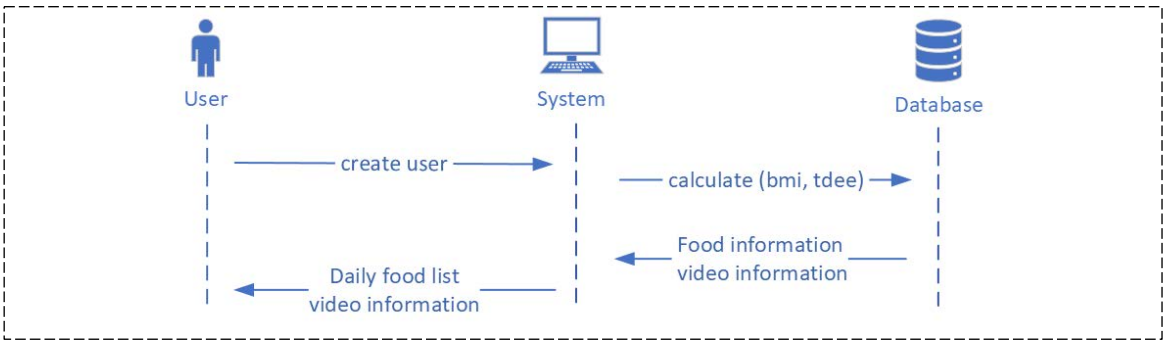


Figure 2. The flowchart of system process of health management system.

Step 2 which focused on the system development consisted of 2 parts. Part 1 involved the development of health management system website. The Front-End technology used HTML, JavaScript, JQuery, CSS, Ajax [Reference]. The Back-End technology utilized PHP and SQL. Additionally, MySQL was used as database, and it was managed by phpMyAdmin (Lamsal, 2020). The server model development involved server simulation by using the XAMPP program (Apache Friends, 2024). Subsequently, the developed system was installed on a server using the Ubuntu server as the operating system (Canonical Ltd., 2024). In addition, Part 2 focused on the development of Line Chatbot by using Dialog flow (Google, 2024). The overview of technologies which were used in the system development is illustrated in Figure 3.

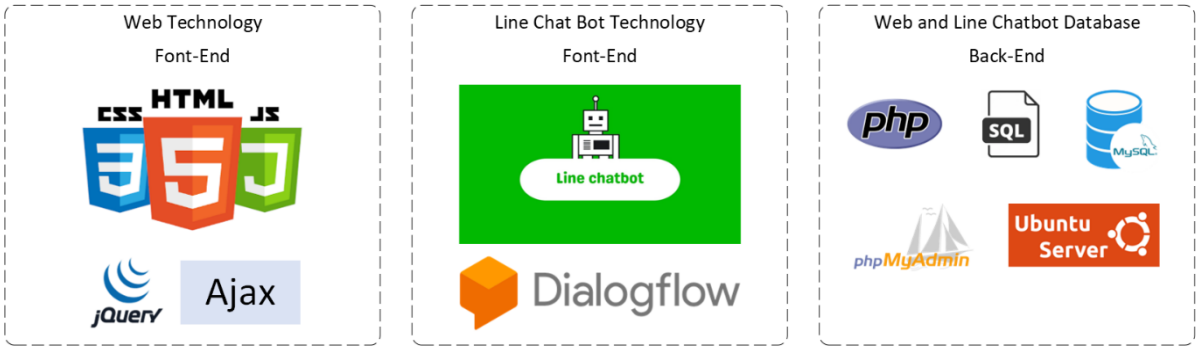


Figure 3. The overview of technologies used in the system development.

The system testing was conducted by 3 information system development professionals, including 2 developers and an independent tester (Assawamekin, 2015, p. 265). The Black-Box Testing technique, performed at a unit-level, was used to examine whether the function of system in Figure 2 met the expectation (Assawamekin, 2015, p. 282). The development team addressed any incomplete functionality. Afterwards, the software was evaluated again by performing regression testing (Assawamekin, 2015, p. 290) in order to determine if the previous change resulted in proper results. This procedure was performed until no system fault was detected. Subsequently, a user manual document was made to clarify how to use the system for different sorts of users (4 categories as shown in Figure 1) so that each category was able to comprehend and operate the developed system. This manual was generated in two formats: 1) document and 2) video explaining how to use the system.

Phase 3: Follow-up testing and evaluation

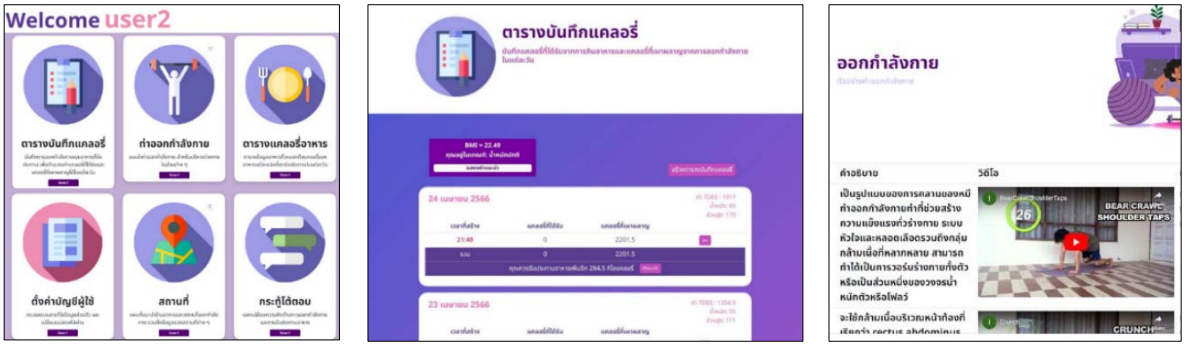
In this phase, the system was integrated into practical usage. The research team used online training to train the first sample group, whereas classroom learning method was applied to train the second group (Phiwhlueng, 2024), with the research team acting as lecturers. The 2 training sessions included a workshop where participants applied their knowledge of the system and were allowed to ask the research team questions as they arose. Furthermore, the research team then facilitated the sample group to utilize the system for one month. Users had an access to the online platform, and contact information of the development team for further information, or spoke directly with the research team. When the system usage testing period ended, the following step was

assessment. In this step, the research team collected data from the system users by asking them to assess the system after first providing clarification on the questionnaire. The performance evaluation was partitioned by 3 information specialists and assessed according to the framework for success in the development of improved systems based on the model of DeLone and McLean (DeLone & McLean, 2003). Furthermore, the acceptability of the developed system was examined by 2 groups of 33 participants. Group 1 evaluated satisfaction with administrator and expert functions, whereas group 2 evaluated satisfaction with general user, member, and LINE Chatbot features. The questionnaire was divided into 3 parts: Part 1: general information of the respondents; Part 2: Likert scale questions (Almohtadi & Aldarabah, 2021), where opinions were divided into 5 levels (Rating Scale), including 1 = very dissatisfied, 2 = dissatisfied, 3 = neither dissatisfied nor satisfied, 4 = satisfied and 5 = very satisfied and; Part 3: Suggestions. Furthermore, quantitative data (Wadeejaroen et al., 2017, p. 307) from Part 1 and 2 of the questionnaires were collected to assess and interpret the results by implementing descriptive statistics (Wadeejaroen et al., 2017, p. 307), including mean and standard deviation (SD) (Wadeejaroen et al., 2017, p. 315). The following was interpretation of the mean into satisfaction level: 4.50-5.00 the highest level, 3.50-4.49 high level, 2.50-3.49 moderate level, 1.50-2.49 low level, 1.00-1.49 the lowest level.

4. Results

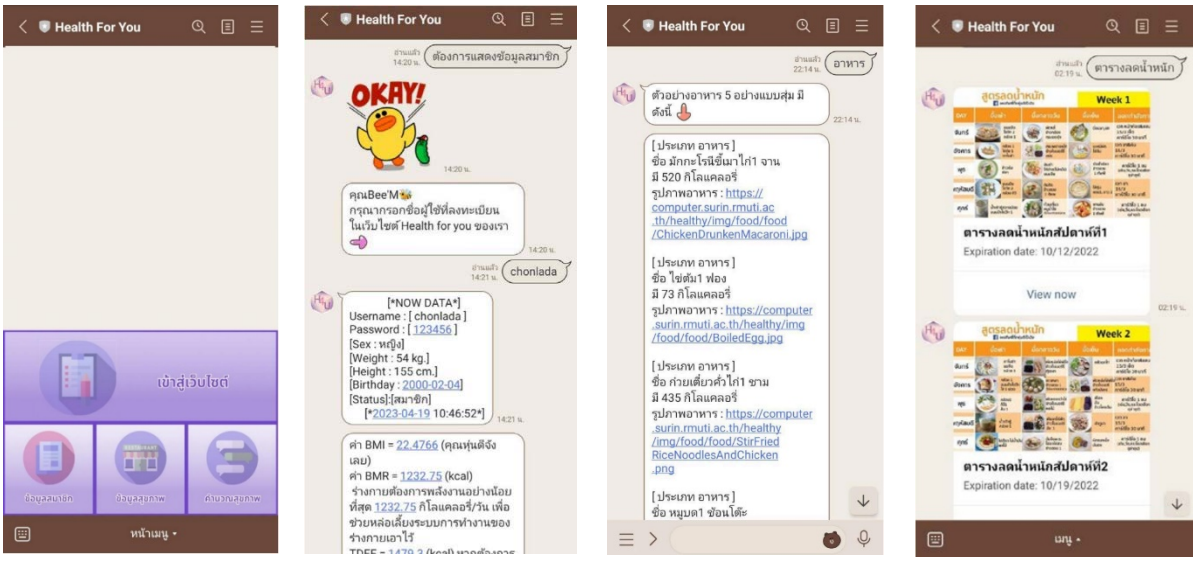
The findings of this study were split into 3 categories according to the objectives: 1) the outcome of design and development of health management system; 2) the outcome of assessment of technology acceptability and system efficiency; and 3) the outcome of sample groups' weight comparisons before and after utilizing the health management system. Details of the results were as follows:

1) The outcome of design and development of health management system was separated into 2 parts. Part 1 was the website for managing health information, where users were divided into 4 different groups: level 1 was administrator, level 2 was general user, level 3 was member, and level 4 was expert. The system provided daily activities and diet recommendations based on user weight, height, and suitable calorie content. In accordance with the user's demand, it also suggested workout routines for managing particular body areas. In order to compare weight fluctuations over the course of a month, users were required to input their weight every day in order to be recommended with restaurants with fitness centers and provide routes to those spots by the system. From the usage of a client/server architecture, the website was constructed and accessible via a web browser. The results of research are presented in Figure 4. Part 2 involved the LINE application, which linked data from the same database as the website, hosted LINE Chatbot for managing health information. The Chatbot made suggestion on a diet which adapted to the user's daily activities. The Chatbot as well determined calorie content based on the body's energy metabolism. It also provided information on exercise videos and the locations of eateries and fitness centers, depending on user preferences. Membership applications for accessing information were processed through the website. The outcomes of the LINE Chatbot's development are demonstrated in Figure 5.



a) Member homepage b) Calorie log page c) Exercise video page

Figure 4. Development results of a health information management website.



a) Chatbot homepage b) User information c) Food recommendations d) Weight loss schedule

Figure 5. Development results of LINE Chatbot.

2) The performance evaluation by 3 experts. The results revealed that the experts gave their opinion to the system efficiency in term of information quality at the highest level ($\bar{x}$ = 4.67, S.D. = 0.00). The experts as well rated the overall system performance at high level ($\bar{x}$ = 4.33, S.D. = 0.71) as shown in Table 1. Moreover, the evaluation of technology acceptance by 33 individual samples which were divided into 2 groups, resulted that the evaluation of the ease of use in group 1 (3 participants) rated an issue 3: ease of learning at the highest level ($\bar{x}$ = 5.00, S.D. = 0.00). The evaluation result of recognition of benefits found that the participants rated an issue 2: Ability to provide valuable information for decision-making at the highest level ($\bar{x}$ = 4.67, S.D. = 0.71). Meanwhile, the evaluation of the ease of use by group 2 (30 participants), indicated that group 2 rated an issue 3: ease of learning at high level ($\bar{x}$ = 4.27, S.D. = 0.71). As well as, the evaluation result of recognition of benefits found that the participants rated an issue 2: Ability to continuously track and record the weight loss results of users at high level ($\bar{x}$ = 4.33, S.D. = 0.71) as shown in Table 3.

Table 1. The results of the health management system efficiency evaluation

Topics	$\bar{X}$	S.D.	Results
1. system quality	3.67	0.00	high level
2. information quality	4.67	0.00	highest level
3. service quality	4.00	0.00	high level
4. perceived usefulness	4.33	0.71	high level
5. Overall	4.33	0.71	high level

Table 2. The result of the evaluation of technology acceptance by the sample group 1 with 3 participants.

Topics	$\bar{X}$	S.D.	Results
Field 1: Ease of use			
1. user friendly	4.33	0.00	high level
2. system flexibility	3.67	0.71	high level
3. ease of learning	5.00	0.00	highest level
Average	4.33	0.24	high level
Field 2: Recognition of benefits			
1. Ability to manage data and create clear and concise report	4.33	0.00	high level
2. Ability to provide valuable information for decision-making	4.67	0.71	highest level
3. Ability to provide effective support and services.	4.33	0.71	high level
Average	4.44	0.47	high level

Table 3. The result of the evaluation of technology acceptance by the sample group 2 with 30 participants.

Topics	$\bar{X}$	S.D.	Results
Field 1: Ease of use			
1. user friendly	4.03	1.41	high level
2. system flexibility	4.13	0.00	high level
3. ease of learning	4.27	0.71	high level
Average	4.14	0.71	high level
Field 2: Recognition of benefits			
1. Recommendation of appropriate weight loss plans based on user information (diet and exercise)	4.03	0.71	high level
2. Able to continuously track and record the weight loss results of users	4.33	0.71	high level
3. Promote and support user in receiving treatment and improving health along with providing recommendations	4.23	0.00	high level
Average	4.20	0.47	high level

3) The average body mass index comparison findings from sample group 2's health management system before and after was found that the average body mass index increased by 20 cases and decreased by 10 cases which are demonstrated in Figure 6.

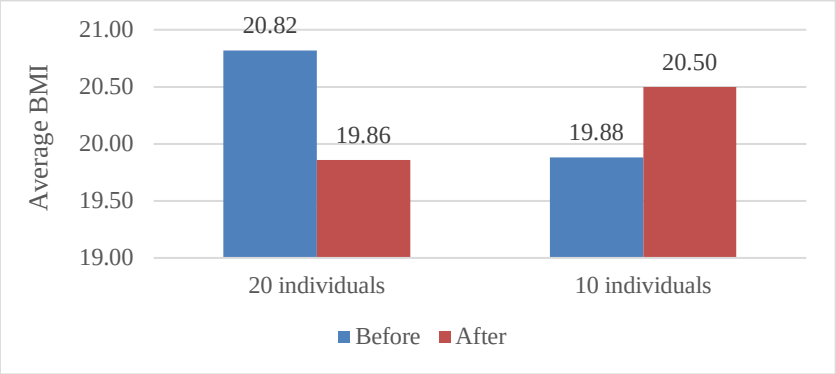


Figure 6. Compare BMI before and after system usage.

5. Discussion

5.1 Principles of software engineering play a crucial role in the development of health management systems. The LINE Chatbot and website are 2 technologies that can be utilized. As a result, users are likely to access the system quickly and simply without the necessity of installing it on their computer. The system, which connects and shares information with others, is continuously used. This is consistent with the research of Naemi et al. (2024), who has created a website to document medical data for individuals with lazy eye illness. According to the operational result, the convenience of users' assessment scores has been at a good level. The website also provides features for storing and retrieving patient information to help in managing additional challenges during treatment. Ability of the developed LINE Chatbot to respond to queries and offer health-related information to users' around-the-clock stimulates their interest and improves communication effectiveness. This is consistent with the research findings of Ulrich et al. (2024), whereby they have created a Chatbot to address and resolve patients' problems on several fronts. The Chatbot has received favorable feedback from users, according to the development findings. It could have lessened feelings of depression and anxiety. The developed Chatbot is automatically accessible and flexible. Additionally, this draws the conclusion that Chatbot may be a useful and successful instrument for altering behavior.

5.2 The result of efficiency evaluation by 3 experts showed an overall opinion at a high level ($\bar{X}$= 4.33, S.D.=0.71). The average opinions on information quality, perceived usefulness, service quality, and system quality were ranked from highest to lowest, respectively. Furthermore, the evaluation results of technology acceptance from 2 sample groups found that Group 1 (3 individuals who assessed the system administrator and expert functions) rated the advantages of technology at a high level ($\bar{X}$= 4.44, S.D.=0.47). The ease of use was also rated at a high level ($\bar{X}$= 4.33, S.D.=0.24). In addition, Group 2 (30 individuals who assessed the member, LINE Chatbot, and general user functions) rated the advantages of technology at a high level ($\bar{X}$= 4.20, S.D.=0.47). the ease of

use was rated at a high level ($\bar{X}$= 4.14, S.D.=0.71). It was evident from the assessment findings of 2 sample groups that the perceived advantages element showed a high level of result. This was a result of the system's development methodology based on the idea of a "Wellness Plan", which was a personalized healthcare plan based on each individual' s requirements and objectives. Basic user data, including age, gender, height, weight, and activities, were linked to and analyzed in a way that contributed to each individual's own diet and exercise plan. This enabled the users to receive guidance and information that was relevant and valuable for promoting health care on a personal basis. This facilitated decision-making as well, allowing data to be utilized to alter an individual' s behavior. This is in line with the research of Taptaemtut (2023). In the research, a lifestyle plan based on health literacy has been recommended for individuals of working age with metabolic syndrome, characterized by a malfunctioning metabolic system resulting in abdominal obesity. The operations result has shown that there has been a significant difference ($P<0.05$) in the sample group's health literacy scores before and after they participated in the program. This has suggested that applying medical recommendations to the people of working age could have enhanced clinical results as well as provide useful health information.

5.3 When comparing the average Body Mass Index (BMI) before and after using the health management system, it was found that among the sample group, 20 participants who used the system more than 80% of the time showed a decrease in average BMI. Conversely, 10 participants who used the system less than 80% of the time showed an increase in BMI. These results were arisen from the consistency in system usage that the users were facilitated by the ease of usage. The users inputted health information via the LINE Chatbot, which caused the data collection to be operated easily and obtained instant answers. As a result, there was motivation to consistently adopt the system's advice. This is consistent with the study conducted by Chenglai, Prampate, and Ponsung (2021), who have created a weight loss program that has enabled participants to share information with one another. As a result, the sample group has been motivated that has led to consistency, which subsequently resulted in more successful weight loss.

6. Conclusions

The result of this research indicated that LINE Chatbot and websites were capable of collecting basic user data (sex, age, height, weight, and daily activities) and then analyzing it to provide personalized exercise and diet regimens based on each person unique body requirements. The developed system had performance evaluation result and technological acceptability at high level. And the results of the comparison of the BMI of the sample group found that there were 20 cases with a reduced BMI, which showed that the developed system help increase efficiency in health management. This research was helpful in the social context of organizations which were seeking to support staff members' fundamental health since the system was simple to use, offers information that was actionable, and was easy to follow. Executives have access to summary data on the general health-related behavior of personnel of agencies, which were utilized for subsequent policy development. The research suggestions were that the data recording into the system was still recorded by the users. In some cases, there were errors or data were not recorded continuously, affecting the diet and exercise plan. Therefore, future research should add methods to record data into the system automatically, add a system to notify users continuously, which may result in better efficiency of the system.

Conflict of Interest

The authors declared that there are no conflicts of interest.

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