Bulletin of Electrical Engineering and Informatics
Vol. 14, No. 1, February 2025, pp. 752~760
ISSN: 2302-9285, DOI: 10.11591/eei.v14i1.8484

Development a decision support system for selection healthcare chatbot

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Article Info

Article history:

Received Mar 20, 2024
Revised Oct 5, 2024
Accepted Oct 17, 2024

Keywords:

Analytic hierarchy process
Criteria
Decision support system
Delphi method
Healthcare chatbot

ABSTRACT

It's an increasing number of healthcare in many countries. Healthcare chatbot can save money, time and meet patient satisfaction. The healthcare would like to select the best or optimal healthcare chatbot but in the real situations, some healthcare may select the healthcare chatbot by own opinions in the organization with several criteria. The purpose of this research is to design and develop a decision support system (DSS) to select healthcare chatbot under the criteria of: i) functionalities; ii) multilingual ability; iii) usability; and iv) security and privacy. According to this research, it can help healthcare to make a reliable decision. The DSS allows users to select the most suitable alternatives of chatbot. The DSS is analyzed by using analytic hierarchy process (AHP). The result show that the DSS was designed to help in complex decision making and show the making decision of decision maker in the reliable and accurate decision. The result found that it is an appropriate technique for using in the DSS to select the suitable healthcare chatbot in accordance with overall criteria effectively including the sensitivity analysis.

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1. INTRODUCTION

The chatbot is an automated computer program that simulates conversation with human user [1]. Chatbot becomes more popular over time and user numbers were increasing consecutively. In 2017, the number of users was 3.58 billion [2]. Healthcare chatbot market is expected to grow from USD 184.60 million in 2021 to USD 431.74 million by 2028 at CAGR of 15.20% [3]. In Thailand, medical chatbot is used for several purpose such as give information, make an appointment and medical recording. At the present, information and communication technology needs to be into account when it comes to healthcare [4]. Information system are developing very rapidly [5].

Healthcare industry is increasing of chatbot in suggestion, give information and service the patients. Healthcare systems have played an effective role in improving medical services by monitoring and diagnosis patients [6]. Visual health is an essential component of people's quality of life [7]. Chatbot in healthcare are used to manage some service in healthcare. Chatbot are revolutionizing healthcare by giving patients access to medical information, make an appointment and gathering data of patient. Healthcare chatbot can evaluate the competency and efficiency of using chatbot in organization such as testing, survey and data analysis. It also can be used to evaluate the usefulness and usability. However, it is very important for decision making to select chatbot for using in healthcare. From the literature review, there are several criteria used in selection

chatbots in other business field such as logistics, bank and service business but have no selection chatbot in healthcare by using the decision support system (DSS). Some healthcare made a decision to select healthcare chatbot by own opinion of each organization. Healthcare should realize in own policy, corporate environment and healthcare and patient requirements in order to achieve the goal to have the suitable chatbot. It can help healthcare to make reliable guidance or information. However, healthcare chatbots have a benefit to transform many aspects to healthcare. Healthcare providers utilize healthcare chatbot to respond questions, make an appointment and give information [8]. DSS is a computer application program that analyzes business data and presents it so that user can make business decision easily [9]. The DSS can integrate multiple variables and generate outcome and alternative outcome. The purpose of this research is to design and develop a DSS to select healthcare chatbot and help healthcare to make reliable decision and meet both of healthcare and patient requirements. The DSS in this research consider the criteria of functionalities, multilingual ability, usability and security and privacy. Each criteria was calculated the score. The case study of this research as healthcare in Bangkok, Thailand were used to assess the proposed DSS. After using the DSS, the result showed that the designed and developed of DSS was successful in research.

2. LITERATURE REVIEW

2.1. Chatbot

Chatbot is computer program that simulate human conversation. Chatbot is a class of bots that have existed in the chat platforms. The user can interact with them via graphical interfaces [10]. At the present, chatbot is applied to artificial intelligence (AI). Chatbot can understand question and respond based on data it has been collected. Chatbot collected data and trained on the data using AI and machine learning, natural language processing (NLP) and rules defined by the developer. It helps chatbot to provide accurate and efficient responses to all request. Chatbots have become an indispensable part of customer service strategy because of immense business advantages. Chatbot can automate tasks and enhance operational efficiency and customer experience. Chatbot has become an essential tool for business. Chatbot connected and engage with customers, send reply and reduce cost and time compared to traditional methods. Chatbot has also proven ability to collect information on business, identify qualified leads and close sales while automating customer reach out and keeping tabs. Chatbot helps enterprises to free up their worker and make them focus more on core, revenue generating task. Chatbot helps to improve the efficiency of operations. Chatbot is significant tools in doing business to enhance customer satisfaction and improve revenue. The selection of the suitable chatbot for organization become necessary for every business to ensure it meets customer requirement and reach to achieve the goal of organization. The chatbot should have speed and flexibility to serve customer service especially in service personnel. There is limitation in development of chatbot, it is ideal to implement customer service support in such a way that both chatbot and human agents should work in tandem. The chatbot should serve customers through multilingual capabilities in order to proceed with customer enquiries from any part of the world. The deep learning (DL) and NLP technologies, several chatbots offer multilingual support. The chatbot is designed to meet unique customer need, helping business to offer personalized service. The chatbot should be able to send messages, alerts and reminder the customers or patients. Modern cloud based technology helps chatbot offer quick and efficient customer support service for better customer experience and customer satisfaction. Moreover, the chatbot should is prone to cyber security and data protection. The chatbot should be able to protect against challenges and the risk of losing data during offering trustworthy customer service. The chatbot should provide security and privacy to against loss of data and other cyber attract that impact with cyber security and privacy. According to Table 1, this part is the chatbot types that consists details of algorithm and features of each type of chatbots.

Table 1. Chatbot types [1]

No	Types of chatbot	Algorithms	Features
1	Voice bot	Natural language understanding (NLL)	Applied voice to text and text to speech communication
2	Hybrid chatbot	Machine learning/NLP	Accurate composite of chatbot and live chat
3	Social messaging chatbot	Self-learning and NLP	The social media edges and interface by deploy of AI algorithm
4	Menu-based chatbot	NLP	Based on menu-driver navigation and follow a decision tree
5	Skill chatbot	Multinominal naive bayer alogorithm	Accomplish a specific set of tasks and using pre-defined skill software
6	Keyword-based chatbot	NLP	Performed customizable keyword and NLP
7	Transactional bot	Symbolic AI and NLP	Complete a transaction and streamline the user experience
8	No code or low code chatbot	AI and machine learning algorithms	Allow for speedier application delivery and further value generation

2.2. Healthcare chatbot

Medical chatbots are AI-powered conversational solutions that help patients, insurance companies, and healthcare providers easily connect with each other. These bots can also play a critical role in making relevant healthcare information accessible to the right stakeholders, at the right time. Chatbot in healthcare is used to improve and service patient in advice and assistance. Chatbot that simulate human like speech are designed to help people manage health and communication with healthcare. The workflow, monitoring, diagnosis, treatment and promotion of health are other areas where chatbot will be able to help [1]. Medical services are a lot of significant in each individual's life [11]. The global healthcare chatbot market is segmented by component, deployment model, application, end user, and region [12]. Research and development on DSS should continuous keep pace with technology changes so that the system can fit requirement of user [13]. Some example of three classes of functionality as the clinical chatbot [14].

- Provide information: the most widespread interaction in medical chatbot, the patient asks for information on a health issue. The chatbot can reply with predetermined answer. The chatbot can remind the patient in taking medicine, doing a clinical analysis, meeting the doctor.
- Provide prescriptions: the chatbot in healthcare can acquire a description of symptoms to diagnosis. Some medical chatbot are able to suggest on medical or specialist examinations.
- Management: specific way of interacting with the patient with the objective of obtaining context information. The chatbot ask the questions in the purpose of understanding a certain task was performed, reminding the next task to be performed, collect useful knowledge with the aim of foreseeing that the standard process.

From Figure 1 shows healthcare chatbot market in period year of 2023-2032. The market value is USD million and it's expected that in year 2032, the healthcare chatbot market value is equal to 1615.2 USD million.

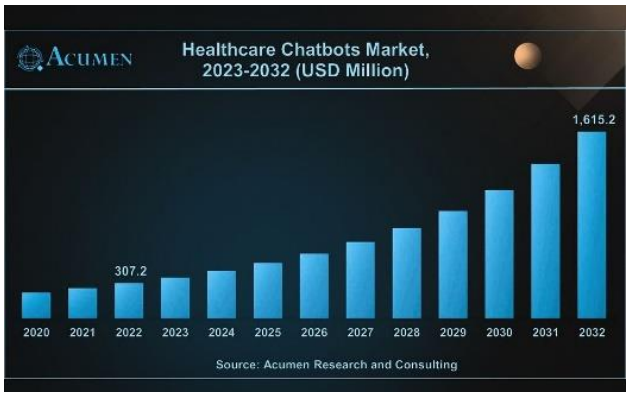

Figure 1. Healthcare chatbot market (www. precedenceresearch.com)

2.3. ChatGPT

ChatGPT is an advanced language input. It is part of the family of generative pre training transformer (GPT) models. ChatGPT is capable of capturing the nuances and intricacies of human language, allowing it to generate appropriate and contextually relevant responses across a broad spectrum [15]. It has several potentials in applications of ChatGPT in healthcare. ChatGPT is able to facilitatethe toward the management of healthcare by developing virtual assistants to make an appointment of patients, support and manage the information in healthcare. ChatGPT can help with the decision support in real time based on recommendations to suggest alternative for medical condition and provide the relevant medical guidelines. ChatGPT can improve healthcare systems in the patient medical record and effectively streamlining the process of record. Moreover, ChatGPT supports the function in real time translation. It is fast and accurate for translation in technical terms and ensuring patients understand the clinical diagnosis, alternative of treatment and medical instructions. However, there is limitation of ChatGPT in extra safety and security issues that the model may not be able to manage in sensitive medical information accurately. The accuracy of the text generated by AI model in ChatGPT depend on the define the quality and nature of the data used. Some case study, it found that the result of using AI model in ChatGPT was incorrect that effect to issues of legal in lawsuits, biases. The transparency are additional issues that need to be addressed for using AI-generated text. The area of using ChatGPT and description of each area have been illustrated in Table 2.

Table 2. The area of using ChatGPT [1]

No	Area of use	Description
1	Clinical	Used in typical clinical toxicology care
2	Medical imaging	Medical radiation science of higher education
3	Diabetes	Predict the future diabetes technology
4	Mental health care	Application for mental healthcare [16]
5	Cardiology	Perform virtual reality in cardiology
6	Medical and radiology	Report and improve communication with decision support
7	Urological science	Explain urological condition and treatment
8	Cancer care	Interpret sequencing report and offer a list of potential clinical trial options

2.4. The analytic hierarchy process

The analytic hierarchy process (AHP) was developed by Thomas Satty in 1970 It is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. The AHP is used to make decision problems both of academics and practitioner [17]. The AHP is used in the multi criteria decision making (MCDM) approach to identify problems, compiles references, evaluate alternative and find the best alternatives [18]. The AHP method was a quite effective method to solve a complex problem [19]. The AHP divides the decision problem into the following four steps which have been illustrated in Figure 2.

a. Define the problem-define and select a problem.
b. Structure the decision hierarchy-the structure is built from the top with the goal of decision.
c. Assessment of significant weight-the assessment of the significant from each level of the hierarchical structure. The pairwise comparison of AHP scale is based on scale in Table 3.
d. Check consistency-the consistency of the pairwise comparisons must be checked. The consistency index (CI) the consistency ration (CR) is used for measuring the consistency judgment for each comparison. The judgment consistency can be checked, the CR is acceptable if it does not exceed 0.10 [17]. The formula is applied to calculate the consistency rate as the following, CR=CI/CR.

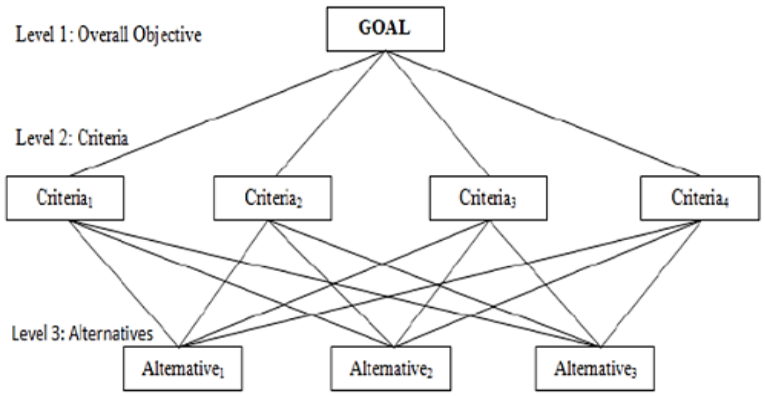

Figure 2. AHP structure (https://www.researchgate.net/figure/General-hierarchystructure-of AHP_fig2_264436283, 2022)

Table 3. Pairwise comparison AHP scale [17]

Scale	Definition
1	Equally important
3	Moderately important
5	Strongly important
7	Very strongly important
9	Extremely important
2, 4, 6, and 8	Intermediate values between the two adjacent judgements

2.5. Decision support system

The concepts of DSS were established in the early 70's by Michael S. Scott Morton under the term management decision system. DSS is interactive computer based system which help decision makers utilize data and models to solve unstructured problem [20]. DSS has been identified as useful information technology tools. DSS is a system under the control of one or more decision makers assists in the activity of decision making by providing on organized set of tools intended to impose a structure on portion of the decision making situation and improve the ultimate effectiveness of the decision outcome [20]. DSS would

be affected by the individual performance and preferency and the criteria used to make decision [20]. DSS can easy making business decision [21]. DSS is developed for solving practical problems of decision alternatives evaluation on the basis [22].

DSS is a computer application program that analyzed business data and presents it so that users can make business decision early. DSS can outcome and alternated outcome [6]. DSS is an information system that help business in decision making that judgement and sequence of actions. The information system helps the mid and high level management of an organization by analyzing volumes of unstructured data and accumulating information that can help solve the problems and help in decision making. DSS is either human powered or automated. DSS increases the speed and efficiency of decision making. It can collect and analyze real time and automates monotonous managerial process that means more of the manager's time can be spent on making decision. It helps to improve communication within organization. However, the implementation of decision making has high cost in investment. It can develop a dependence on DSS in daily decision making to improve efficiency and speed. DSS attempts to combine the use of models or analytic techniques with data access and retrieval functions. DSS also have the capacity to assist in making prediction when combine data analysis tools to develop the model [23]. DSS in healthcare have generally targeted quality, risk mitigation, productivity, and profitability outcomes of hospitals [24].

3. METHOD

Method MCDM is the method of making decision to determine the suitable alternative from a number of different alternatives. MCDM is the main method to design the DSS that divided to these steps as the following: i) identify the problem; ii) determine the condition; iii) checking the suitable alternatives; iv) choose the best alternatives.

3.1. Data collection

This research involved design and development the DSS. There are two main types of data collection in this research as the following:

a. Data for identifying criteria influencing selection healthcare chatbot

Data collection was came from literature review and expert interviews and opinions with people who work and responsibility in Information Technology in Ministry of Public Health, practitioners and top managers in healthcare organization both of public healthcare and private healthcare including the customers or patients of heathcare, chatbot developers, the companies that design the service in chatbot and academia in the university also. The data from literature review and interview are analyzed by using an International Olympic Committee (IOC) and Delphi method. The obtained criteria are analyzed by using the concept of IOC and Delphi method. The examined factor was scored and the collected data were analyzed by statistical techniques. The expert panel comprised 20 experts from practitioners in healthcare organization chatbot developer companies and academia that are chosen on the basis of profession, work experience and research activities are invited as the people who evaluate the criteria for the selection in this research. From the previous researchs and literature reviews found that have no the research to select the healthcare chatbot by using the DSS and lack of the research in criteria for selection healthcare chatbot directly. Some researchs mentioned the selection chatbot in other fields such business service, banking, retail and wholesale, and logistic and supply chain management.

b. Data for design and develop the DSS such as the possible healthcare chatbot and database of each criteria

Data for design and develop the DSS such as the possible healthcare chatbot and database of each criteria are derived from literature review, interview the chatbot developer and chatbot service provider including the academia. The analysis of these criteria was done by using in an AHP which is the tool for MCDM. From the data obtained can be processed in AHP to decide by following: i) outline and define the objective; ii) construct problem to a hierarchy; iii) build a pairwise comparison; and iv) structure priority for each element on hierarchy.

After that, it established the DSS to select healthcare chatbot by using analytical hierarchy as a tool for making decision. There are four parts of process in the DSS as the following: i) set the objective of selection chatbot; ii) define user's needs; iii) define significant weight of criteria; and iv) make decision to select chatbot from alternative.

4. RESULT AND DISCUSSION

4.1. Criteria for selection the healthcare chatbot

In Table 4 show criteria for selection chatbot in healthcare from literature review and related research. The obtained criteria are analyzed by using IOC and Delphi method with the opinions of experts

who have experience in healthcare. The data collection also derived from opinions and need both of healthcare and patients. In the view point of healthcare, it found that doctors or practitioners who work in healthcare in Thailand need to use chatbots for diagnosis, interpretation of clinical image, and provide patients information in medical history during in the operation room. In the view point and opinions from the patients they need to use chatbot for self-diagnosis, make an appointment, and payment the medical expense and keep the medical record of themselves.

Table 4. Criteria for selection chatbot in healthcare from literature review

Researcher	Criteria
Amiri and Karahanna [25]	Wide accessibility, ease of use, fast in information dissemination
Hardi *et al.* [3]	Security
Gupta and Agarwal [26]	User friendly, feedback support
Eeuwen [27]	User friendly, protect and respect privacy

The Delphi method is tested in reliability by having done a 3 round modified Delphi and did percentage agreement, Finally, this research has applied and find the new criteria that be suitable for design and develop the DSS for selection healthcare chatbot. The remain criteria are categorized into four main criteria which are:

- Functionalities: accurate answe, respond time, easy to integrate with tools
- Multilingual ability: provide the multiple languages to support users and interact with customer in multiple languages and understand questions in word and numeric
- Usability: user friendly, customize, beautiful
- Security and privacy: security features, more secure and safe to use, protect users'personal information

4.2. The analytical hierarchy process structure

The analysis of these criteria was done by an AHP which is the tool for MCDM. From the data obtained can be processed in AHP to decide by follow: i) Set and define the objective; ii) Construct to a hierarchy; iii) Build a pairwise comparison; and iv) Structure priority for each element on hierarchy and check the consistency. Finally, the DSS use the significant weight each criteria for selection the best healthcare chatbot in the next process which have been illustrated in Figure 3. It shows AHP structure of selection chatbot in healthcare.

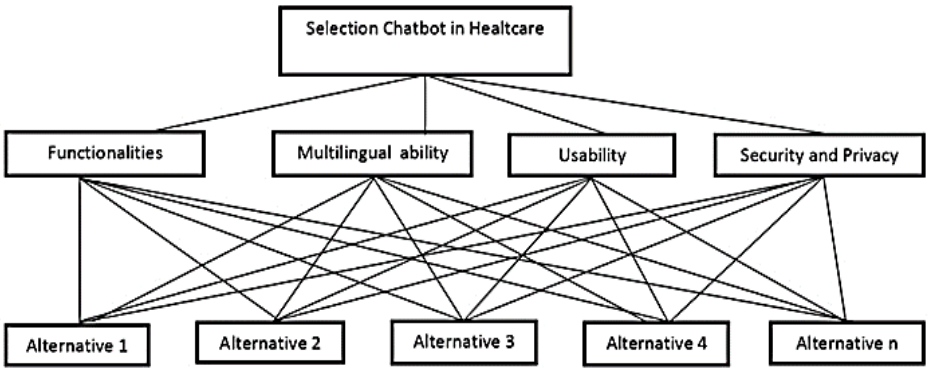

Figure 3. AHP structure of selection chatbot in healthcare

4.3. The decision support system to select healthcare chatbot

There are four parts of DSS to select healthcare chatbot as the following:

Part 1: user define the objective for making decision and limitation of each criteria.

Part 2: the database for making decision of users it contained the possible of healthcare chatbot. Data and information in the criteria of functionalities, multilingual ability, usability and security and privacy.

Part 3: find the significant weight of each criteria in AHP structure and the result from the significant weight used to select the optimal healthcare chatbot.

Part 4: the AHP in applied in selection alternatives in order to have the optimal healthcare chatbot in each case study.

4.4. The procedure and system model for decision maker

Figure 4 show using the DSS of decision maker. First process, decision maker set the objective of chatbot then go to the second process that define user's need. The third process is to design significant weight of each criteria and the last process, the DSS by using AHP in alternatives to find the optimal a healthcare chatbot.

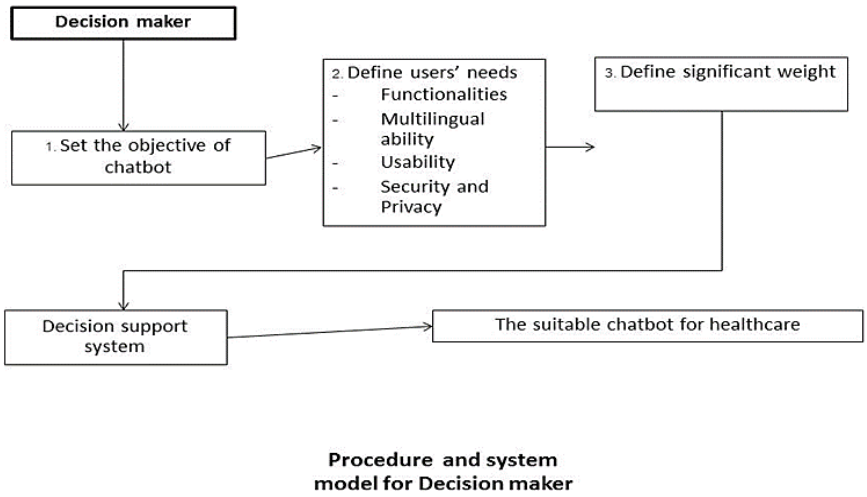

Figure 4. Procedure and system model of DSS

After decision maker set the objective, defined the criteria, defined the significant weight of each criteria. Finally, the decision maker will have got the result of the suitable or optimize chatbot for own healthcare. After compare in order to the best chatbot for healthcare in case study. It found that there is different between types of each chatbot. In ChatGPT appears to work better than the tradition one in healthcare. From the DSS in order to select the suitable chatbot in healthcare, it shows that the chatbot should be the personal chatbot of each patient and the security and privacy of personnel health information and information of healthcare should be the critical concern for the implementation of the chatbot. The chatbot should be easy to accessibility and understand communication very well. Moreover, the chatbot should be the multilingual chatbot that be able to service the patients around the world. From the DSS that input the need and requirements from the doctors and the practitioners for selecting the suitable chatbot for healthcare, it shows that the chatbot should anticipated regret of mistake in diagnosis disease by using the chatbot. It should concern the security and privacy of healthcare and the patient medical history and information. There is setting back up data and keep database in privacy and reduce the risk from cyberattack and some hazard that may occur in the database and computer system of the healthcare. It may set the authority in acces the data and information of the healthcare also. The chatbot may help to reduce the workload of doctor and practitioners in the healthcare. It is increasingconvenience to work in healthcare in each department in the healthcare such as department of radiology and cardiology. However, it should consider the risk in some negative sequence of chatbot implementation. The sensitivity analysis as a tool to implement in the DSS allows to perform the sensitivity analysis of resulting weight and ranking of the DSS and find the most the sensitivity elements with more accurate expert estimation [27]. The DSS will help and show the making decision of decision maker in the reliable and accurate decision on his user need. The DSS was designed to help individuals in moderately complex decision-making tasks [9]. The contribution of this is to design and develop the DSS to select the healthcare chatbot under define the objective, need of user, set the significant weight and then select the optimal chatbot in the DSS by application of AHP. The DSS is useful, convenience and user friendly. Moreover, it helps to give the reliable for making decision.

5. CONCLUSION

From this research, the objective of this research is to design and develop the DSS to select the healthcare chatbot under the criteria. This research was presented this DSS is able to select the suitable or optimal chatbot for healthcare. It showed that the possible healthcare chatbot model in alternative in AHP

structure and contained information in the database of the DSS. The main criteria were obtained from literature review and opinion of expert who have experience in healthcare. The result in selection optimizes chatbot came from users' needs and define significant weight of each decision maker. However, if there is something change, the result of DSS is going to be changed also. Therefore, we should concern with the sensitivity analysis also. From the literature review and related research found that lack of selection the healthcare chatbot from using the DSS that make the reliability in making decision so the researcher filled the gap by design and develop the DSS for selection healthcare chatbot.

ACKNOWLEDGEMENTS

We are grateful to Rajamangala University of Technology Phra Nakhon for supporting this study.

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