INVESTIGATING TECHNOLOGY ADOPTION AND ACQUISITION IN THE HEALTHCARE SECTOR: A CASE STUDY OF A LEADING THAI PRIVATE HOSPITAL

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ABSTRACT

This research examines adopting new technology in the leading Thai hospitals using different adoption models. This research utilizes technology acceptance model 1, the technology adoption process, and innovation diffusion to review the process of adopting new technology. In addition, explore the factors that impact healthcare adoption of every type of novel technology in the hospitals and possibly new technologies utilized in the healthcare. This study was conducted at Samitivej Srinakarin via face-to-face and zoom interviews with seven employees who work at the different levels at this hospital to explore the adoption process in this hospital. The results show that the process of adopting new technologies starts with the people who work in the high position and then assign the employees who work in the lower position to search and learn about new technology and reveal that this process is universal utilization in this healthcare. A single case study of the process of adopt new technology in private hospital was conducted to address the research question: What is the innovative healthcare technology adoption process in private hospital in Thailand?

Keywords: Technology Adoption, Healthcare, Road Mapping, Innovation, Technology, Diffusion, New Technologies.

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CHAPTER 1
INTRODUCTION

1.1 Background of Research

The adoption of new technologies has become widely spread in the healthcare industry to manage, store, and transmit the digitalized data and use the latest technological developments in healthcare (Thakur, Hsu, & Fontenot, 2012). The digital and virtual healthcare trend has become popular due to the spread of coronavirus disease 2019, the increase of chronic diseases, and aging societies. Which made healthcare professionals deploy the digitally technologies to support the Covid-19 patients (Bokolo, 2021a; Okuboyejo & Eyesan, 2014).

Moreover, to remain competitive in the healthcare market by improving the hospital's effectiveness, competitiveness and proficiency in inpatient and outpatient quality care, well-being of the customer, better treatment for the patients, become innovative hospitals, and benefit that influences hospitals worldwide need to utilize a new technology relevant in the healthcare. As well as increasing the cost of the hospital (Alrahbi, Khan, & Hussain, 2019; Ruiz Morilla, Sans, Casasa, & Giménez, 2017; Laurenza, Quintano, Schiavone, & Vrontis, 2018).

With the growth of new technology needs globally utilizes in every industry. Especially in the healthcare sectors so when healthcare professional decides to adopt the new technology, the healthcare provider can utilize the technology acceptance model and adoption process proposed by Roger. There are many types of technology acceptance models. In this research, I choose the Technology Acceptance Model 1 because it is a basic model that adapts from the Theory of Reasoned Action (TRA). It is a widely utilized model for predicting and explaining user acceptance of new technology. This technology has verified to be a valuable framework to apprehend the effective of new technologies in the workplace. In addition, understand and learn about relationship between patients and healthcare technology (Fuentes-Martínez, 2020). This model includes necessary information when the organization or company wants to adopt new technology, such as perceived usefulness, ease of use, attitude toward usage, intention to use, and utilization. In addition, another thing that we search for is the technology adoption process that includes the awareness of this

technology, interest, learning, evaluation, trial, and then adoption of new technology (De Almeida, Farias, & Carvalho, 2017).

Another model is Innovation diffusion (Rogers, 1983), which depicts the innovation and adoption that occur after went through five stages that including knowledge, persuasion, decision, implement and confirmation stage. The knowledge stage is occurred when the company would like to learn and understand more about new technology. Persuasion stage is happened when the unit form favorable or unfavorable attitude toward the innovative technology. Decision making stage is where the company choose new technology. Implementation stage appear when department or unit utilizes a novel technology. Last stage is confirmation which involves with evaluate the worth of innovation and then utilize this technology in their organization. Moreover, in this stage helps them to understand how the new trend of new technologies occur and how the companies' asses the likelihood of success of their new introduction

Acquisition have not had an undoubted consequence on a company to innovative and driven by a desire to acquire to penetrate to the market and absorption of the firm's knowledge based. Additionally, before the healthcare industry or any other organization adopting or purchasing novel technologies for both embodied (machines and tools) or disembodied (software) they must consider about the existing financial (Weiyu, Othman, & Guli, 2022).

Understanding all the processes behind adopting new technology is essential because every organization and company utilizes the same process and step while embracing new technology. However, in this study, the researcher combined two models such as the technology acceptance model and the adoption process of new technology, and created a new, synthesized framework to investigate the hospital's new technologies adoption process

Many new technologies have already been implemented and utilized in healthcare worldwide that divided into many groups especially, Electronic Health Records (EHR) as a system. It is a technology that digitally stores patients' health information and records. Furthermore, the healthcare provider utilizes the technology as an application such as Telemedicine, mobile health, and digital therapeutics (Gomo health, 2021). Healthcare supports the physicians by providing clinical information,

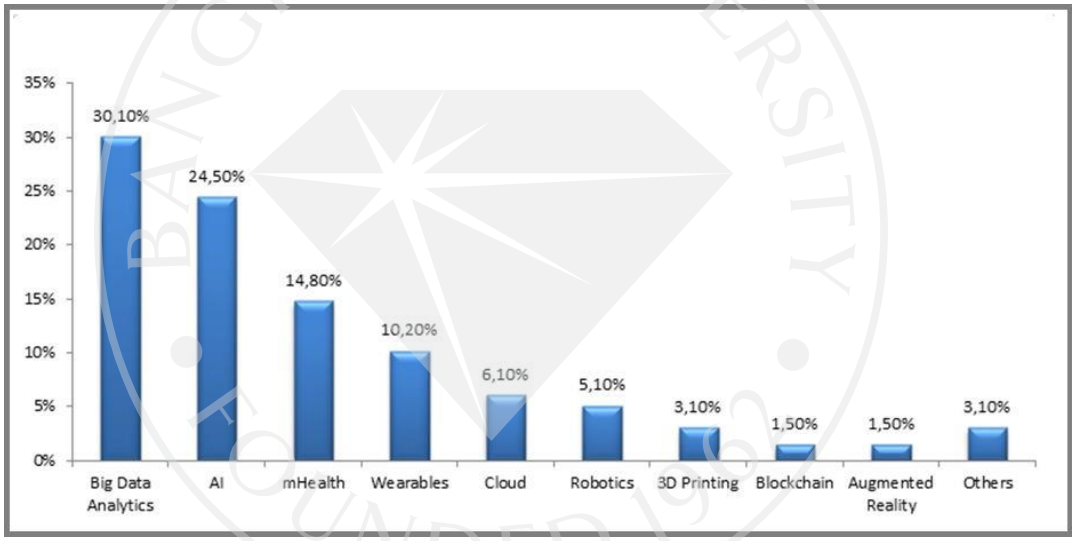
monitoring patients, and interacting with long-distance clinic healthcare between the physicians and patients who must follow up and make an appointment for the patients electronically (Wu & Luo, 2019). In addition, patients utilize telehealth to receive care without an in-person visit to the hospital and serve patients who cannot access healthcare services connected to the patient's smartphone to make a patient feel comfortable, looking at the result quickly (Ahlan & Ahmad, 2014; Standing & Standing, 2008) These two technologies became more widely accepted throughout the pandemic. Telemedicine can work well with wearable technology for remotely health monitoring in the Covid-19 cases and measuring their vital signs, such as heart rate and body temperatures (Parthasarathy, Steinbach, Knight, & Knight, 2018; Yamin & Alyoubi, 2020).

Health professionals adopt Artificial intelligence (AI) to reducing the time for diagnosing severe diseases and short-term illnesses such as skin diagnosis, endocrinology, and mental health applications (Bracq, Michinov, & Jannin, 2019). Moreover, this technology can support physicians and nurses and helps to improve efficiency with information processing and decision making. This technology became popular because it utilizes a 4P strategy to make healthcare predictive, preventive, personalized, and participatory (Russell, 2015). Many hospitals used augmented and virtual reality to train healthcare professionals to prevent the risk for the patients and the knowledge gain. AI technology can work with robotics (Briganti & Le Moine, 2020). In addition, there are many types of robots, such as robot-assisted walking and surgery robots for medical equipment (Tsymbal, 2022).

The digital twin is another critical technology that will be implemented in the healthcare sector soon, which will become one of three crucial 6G services over the next decade. This technology combines advanced technology, especially the Internet of things, Artificial intelligence, and analytics. The digital twin's development is the virtual replicas of the people, devices, objects, systems, and places. Furthermore, it has a database to record important information, especially age, weight, sex, and relatives. It is the digital description of the patients on a computer or a server in the Cloud. This technology is being discussed for utilization in humans due to its security and architecture. As well as a self-care, self-treating and self-monitoring technology is an application that patients can use to take care of themselves at home. The healthcare

industry implements this type of technology due to the contribute of the fatigue, Insomnia, and anxiety symptoms in children, family, and elderly. In addition, patients can prevent diseases, maintain their health by themselves. That is a reason why the trend of the self-care is surge (Yuwen et al., 2021). This kind of technology not only assist the pharmacist fill prescription. However, instruct the patience about the essential of healthy lifestyle (Bell, Dziekan, Pollack, & Mahachai, 2016). Furthermore, self-care technologies can reduce and save the cost of the healthcare (Zhang et al., 2020).

Figure 1.1: Key Technologies Expected to Impact the Healthcare Industry in 2019

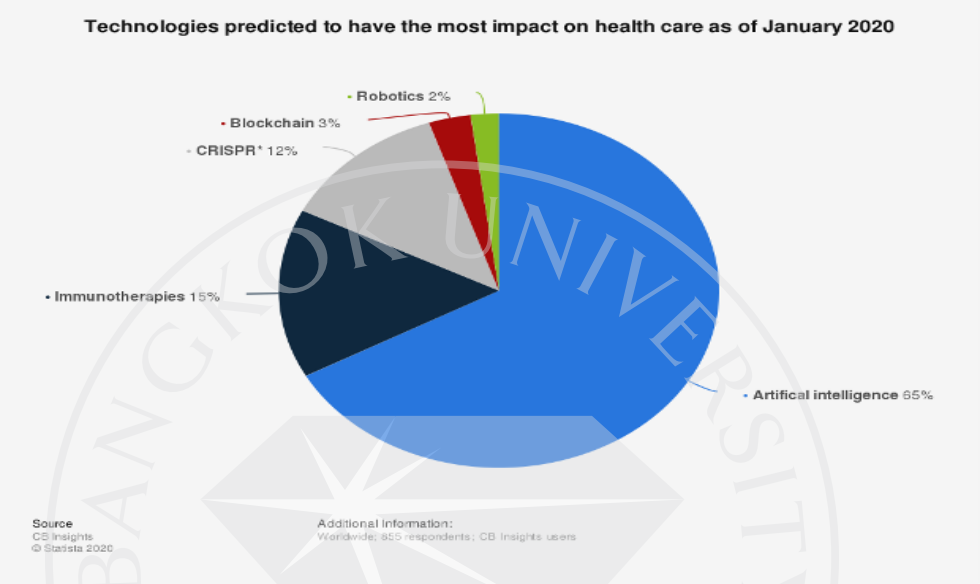


Source: Das, R. (2019). Top five digital health technologies in 2019. *Forbes*. Retrieved from https://www.forbes.com/sites/reenitadas/2019/02/04/the-top-five-digital-health-technologies-in-2019/?sh=77f6703d6c0f.

As the bar chart illustrated in Figure 1.1 presents big data analytics and Artificial intelligence are the two technologies that most impact the healthcare sector. Other technologies are MHealth, wearables, cloud, and robotics (because it is a new trend in healthcare). These new technologies are implemented to assist healthcare professionals working in a hospital. Another trend that will become more popular in

the future is the healthcare smartphone application that the patients can take care of themselves.

Figure 1.2: Technologies Predicted to have the Most Impact on Healthcare in 2020



Source: Stewart, C. (2020). *Technologies with the most impact on health care 2020*. Retrieved from https://www.statista.com/statistics/1091107/technologies-impact-on-health-care-prediction/.

1.2 Research Objective

This research aims to study how innovative healthcare technologies are adopted in private hospitals in Thailand, to learn more about what processes they use when adopting new healthcare technologies, how do they choose a new healthcare technology, and who is involved in the process of adopting of the new technology.

1.3 Research Questions

This study investigates the following main research guiding questions:

"What is the innovative healthcare technology adoption process in private hospitals in Thailand?"

In addition, the following subordinated questions were also explored:

1) How are relevant innovative healthcare technologies identified?
2) How are suitable vendors identified and selected?
3) How are the new technologies implemented in the hospitals?
4) How are they monetized in a mutually beneficial way?

1.4 Scope of Study

A single case study has been conducted to deeply understand the process of adopting new technology in the Samitivej Group. This hospital group is a big corporate. This case study explores and examines how these hospitals identified and learn about new healthcare technologies. In addition, the challenge during the adoption and acquisition has been identified, and solution to overcome the challenge has been studied. Moreover, how they selected a suitable vendor.

The researcher interviewed the workforce from different position in this organization and investigated what they do while accession and utilization new medical products.

CHAPTER 2
LITERATURE REVIEW

The literature that forms the theoretical background of this study is discussed in three sections. The first section is about new technologies utilized in the healthcare industry and possibly new technologies that could be utilized in healthcare in the future. The second review is a selection of new technology adoption and acceptance models discussed in the literature (such as the technology acceptance model 1 and the technology adoption model), the innovation diffusion model, and the influence factors that make the healthcare adoption model). The last section introduces a framework that synthesizes elements of the technology adoption process and the technology acceptance model used to guide the subsequent investigations in this study.

2.1 New Technologies that Utilize in the Healthcare Currently and Future

This section discusses a selection of new technologies used in the healthcare industry now and soon.

2.1.1 Electronic Health Record

It is a technology that represents, collects, views, edits, and stores the data related to healthcare, such as patient information and prescription, in digital form to give the patients, physicians, or healthcare providers access to read all the information from any information location. This technology supports the clinic workflow and enhances healthcare quality (Cowie et al., 2017; Evan, 2016). As well as this technology can maximize cost-efficiency and eliminate the time spent tracking down and maintaining paper-based records that can share digital information with other physicians. Additionally, this technology can reduce the duplicate order of diagnosis testing by maintaining a searchable record of all past patient tests, according to the Industry Trends, Analysis & Forecast Report by Zion Market Research. EHR is the heart of the healthcare system. (Christodoulakis, Asgarian, & Easterbrook, 2017) Moreover, in the 2021the market size and share of this technology were worth around USD 29.417.2 million and expected to hit USD 42,203.5.by 2028. (Parthasarathy et al., 2018)

2.1.2 Rule-based Expert Systems

This technology widely used to diagnose diseases such as breast cancer, asthma, and spinal cord disorders. Therefore, the healthcare provider uses this technology to develop and customize patient care planning (Yeh, Hsu, & Chang, 2021; Damirchi-Darasi, Zarandi, Turksen, & Izadi, 2015).

2.1.3 The Internet of Things (IoT)

This technology is made from remote surveillance in the healthcare industry to release the potential for patient safety and health and encourage doctors to provide treatment. Moreover, it boosted patients' participation and contentment with the facilities and efficient doctor's contact. This technology helps to decrease hospital stays and affects cost reduction. This technology can offer an application that allows patients, families, physicians, and hospital insurance companies to get the benefits. It looks like a patient's wearables that can connect, for instance, Apple Watch or wireless devices that can measure blood sugar, pressure, cardiac control, or weight, Etc. This technology can change patients' lives and make them comfortable wearing them daily. Therefore, when patients faint or have some health problem. In that case, the system will warn their families and send health or medical records to the healthcare providers to pay attention during the crisis hours. Today this technology is necessary because physicians can track patients' health records more efficiently, effectively, and accurately. (Alraja, 2021; Mukati et al., 2021)

2.1.4 Smart Implants

This technology is an implantable device that provides therapeutic benefits and has diagnostic capabilities. It is a technology that can capacitate personalized medicine, improve the quality of care for patients, and decrease the costs when enhancing the outcomes.

Moreover, provide information characterizing the environment inside the body that any other way cannot obtain and change from the data to tailor treatments. In addition, it triggers transitions in care, detects adverse events earlier, and provides continuous monitoring of intracorporal parameters. The data obtained from this technology is used to guide the real-time treatments. (Ledet, Liddle, Kradinova, & Harper, 2018)

2.1.5 Radio Frequency Identification (RFID)

It is a technology that the healthcare provider utilizes for automated tracking of people's identity, location, movement, and data collection. It must successfully apply in any industry such as logistics, manufacturing, Etc. However, this technology is not new. Healthcare has used this technology since 1973, and the first person to use RFID technology in the healthcare industry was named "Mario W. Cardullo." These systems use radio waves to capture and transfer data (Haddara & Staaby, 2018).

2.1.6 Tuberculosis Management

This technology is Directly Observed Treatment (DOT), which becomes difficult due to time and travel requiring electronic DOT for the treatment; the doctor immediately responds to the patient's question and reduces the time assessments of symptoms. This technology is another type of telemedicine. The national survey of Tuberculosis programs found that 42% already used eDOT, and 36 percent of the healthcare plan to implement this technology (Young et al., 2019).

2.1.7 Artificial Intelligence (AI)

The healthcare sector in the 21 centuries has been widely utilizing AI technology. It is the principle of evidence-based medicine that informs clinical decision-making through insights from past data information. (Garbuio & Lin, 2018) Moreover, reduce the time to classify, analyze a medical image, and predict the patients with polycystic kidneys, Cardiology, Endocrinology, Neurology, and Gastroenterology. Healthcare also utilizes this technology to improve conventional processing techniques, providing organizations with new capabilities and critical roles in healthcare toward prevention, personalization, and precision. (Stanfill & Marc, 2019; Tekkesin, 2019) In addition, digitalizing healthcare data and improving computer progress and storage. This technology can combine with other digital tools, such as surgical navigation systems for computer-assisted surgery, virtuality-reality continuum tools for surgery, pain management, and psychiatric disorders (Sarbadhikari & Pradhan, 2020; Tsymbal, 2022).

AI can categorize into two types, especially precision medicine, the tailoring of medical treatment that targets specific needs based on the characteristics of patients. For example, a person's genetic makeup and autonomous intelligence are the advanced stages of AI technology. This form of AI acts independently and chooses

the action on the business objectives. Currently, human-independent decision-making technology is in widespread use in facial recognition (Briganti & Le Moineine, 2020). AI has drawbacks, such as a lack of empathy and compassion. That means the AI cannot replace the doctor's jobs but utilize this technology to support the doctors (Buch, Ahmed, & Maruthappu, 2018).

2.1.7.1 Natural Language Processing

This technology is a part of Artificial Intelligence that concern about communication between the human and computer through the mediocre human language. It is a tool to transform paper-based records into more usable data in healthcare, such as medical journals and clinic notes (Khanna, 2018). They use this technology because "Natural language," or human language, contains many jargon words. Currently, healthcare workers use this technology to read patients' records, write a prescription, treatment plans, and medical problems. In addition, to evaluate the worthiness of a customer or analyze the customer's sentiment (Alugubelli, 2016).

2.1.8 Robot

Robotics technology is a multi-functional and specialized device that uses variable programmed motions to perform various tasks. Furthermore, there are many categories of the robots, such as Assisted Surgery, robot-assisted walking, and physical Robot (Russell, 2015). The Robot that assists surgeons is mainly used worldwide in heart surgery. The "Da Vinci System" is a famous surgery robot with 3D high-definition Vision system features and a tiny wristed (Alugubelli, 2016). Many industries were utilizing physical robotics. This type of Robot can perform simple tasks such as diagnosing, clearing, lifting, delivering, long-term planning, navigation, and decision-making. Both AI and Robot must work together because AI is software, and Robot is hardware (Davenport & Kalakota, 2019).

Patients with movement disability disorders or spinal cord injury utilize robot-assisted walking or Treadmill training for rehabilitation (Morone et al., 2017). Many commercial robot walker trainers apply to the patient's body. For example, "Exoskeletons" that patient can move hip, knee, and ankle joints. Moreover, during the gait phases, this machine controls the patient's feet and forces them to move only the feet (Sale et al., 2013).

2.1.9 Telehealth and Telemedicine Application

These two technologies have a similar function that can interact between patients and doctors. They can use this technology when two or more people live in different areas. This technology is used internet-based or telephone-based for communication. The healthcare system utilizes this technology because of unclear and unrecognizable needs and logistical issues, especially payment, interstate licensure, liability issues and patient use to manage prescriptions (Blue et al., 2019). According to the Telehealth Resource Center, a leading consortium of telehealth networks, Telehealth includes a collection and methods for enhancing health care and health education delivery and support using telecommunications technologies (Novara et al., 2020). Additionally, reducing the imminent risk of infectious disease transmission, reducing travel costs and time for patients and physicians, and using this technology have achieved similar health outcomes compared to in-person patient visit technology. Another subspecialty for using this technology is increasing access for the patients living in rural areas (Smith, Atala, Terlecki, Kelly, & Matthews, 2020).

The definition of Telehealth is the use of Electronic Information and telecommunication technologies to advocate long-distance clinic healthcare between patients and patients. This technology combines hardware and software to develop a smartphone's virtual medical interface for physicians and patients (Snoswell et al., 2020; Yamin & Alyoubi, 2020). Due to the Covid-19, many hospitals decided to use Telemedicine technology to diagnose chronic including diabetes, mental health, Etc. The patients who have these diseases need regular advice from doctors. That is why they utilize telemedicine to serve the patients who need to contact a physician regularly during a crisis (Kadir, 2019).

2.1.9.1 Telepsychiatry

The specialty field of psychiatry in telemedicine application. That is utilized to treat mental illness patients through telecommunications technology with videoconferencing (García-Lizana & Muñoz-Mayorga, 2010).

2.1.10 Digital Therapeutics (DTx)

Utilize technology to support, guide and monitor patients and a subdivision of digital health connected between patients and physicians by smartphone or computer. Physicians utilize this technology to diagnose and treat

patients with chronic illnesses such as diabetes type I and type II, cancer, anxiety, musculoskeletal pain, ADHD, asthma, migraines, insomnia, and substance abuse. In addition, encourage patients to change their behavior to improve the outcomes (Choi, Kim, Nah, & Kang, 2019; Gomo Health, 2021).

2.1.11 Personal Health Wearable and Wireless Technologies

The wearable technology utilizes to prevent diseases and maintain health. In addition, the healthcare provider utilizes this technology to monitor human daily physical activities, behaviors, and physiological. The most measured data include vital signs such as heart rate, blood pressure, calories, body temperature, blood oxygen saturation, posture, and physical activities through an electrocardiogram (ECG). This technology can work with applications that capture and interpret data. Moreover, it can integrate enterprise and cloud data repositories and the networks of wearable devices (Aliverti, 2017; Wu & Luo, 2019).

2.1.12 3D Printing

This technology is one of the disciplines of biomedical engineering that close the gap between engineering and healthcare. It combines the problem-solving and calculation-oriented side of engineering with the medical view of the human body. (Branch, 2015; Hendricks, 2016) Healthcare practitioners could use this technology to print artificial organs. Furthermore, much healthcare globally would like to use this technology because it is very cost-effective, using a three-dimensional and additive process with layers of material on top of each other to build the object (Agrawal & Banubakode, 2020). This technology can create the same dimension for the patient's body to move quickly and comfortably. However, this technology is still in the experimental stage for the human body (American Express, 2020).

2.1.13 Digital Twin Technology

This technology collects real-time data, especially age, weight, sex, relatives, and analytics (Corral-Acero et al., 2020; Croatti, Gabellini, Montagna, & Ricci, 2020). It combines advanced technologies, especially the Internet of Things and Artificial Intelligence. Moreover, has the sensor provided to build a digital copy and counterpart that can simulate the present and future to prevent unwanted situations and conditions (Chakshu, Sazonov, & Nithiarasu, 2020; Zhang et al., 2020). This technology offers a customized treatment for each patient to maximize the healthcare

system's efficacy and effectiveness. This technology also helps decrease the time to diagnose, detect and monitor medical conditions and prevent the disease before the disease exist (Shengli, 2021).

2.1.14 Virtual Reality and Augmented Reality

This computer-based technology use vision to enhance music, graphics, and video. Based on real-world and visual items, cameras and technologies allow users to interact with the objects in real-time (Bracq et al., 2019). Moreover, a broad concept encompasses three categories: screen-based VR simulators, virtual worlds, and immersive VR environments (Renu, 2021). Healthcare uses this technology to train professionals to enhance their knowledge and skills in the healthcare industry. As well as reduce the risk of errors and problems when the patients come to the surgery (Hussain et al., 2021). In addition, this technology can reduce anxieties and phobias. As well as to represent another practical use for VR and AR technology on the patient care side. Healthcare professionals can use these immersive tools to simulate real-life situations where people feel psychologically challenged, such as fear of insects. Furthermore, Physicians use this technology for patients with mental health conditions (Zakrevska, 2022).

2.1.15 Blockchain

This technology is the underlying technology for Bitcoin. The objective of utilizing this technology is to exchange electronics without needing a trusted third party and a centralized one—the transaction involving the exchange of electronic currencies between person to person and person to the company (Mozaffari et al., 2019). Usage of this technology in the healthcare industry offers a user-centered way for health information to be securely gathered, verified, and shared the financial information. In addition, to solve the severe healthcare data privacy, accuracy, and security (Shibli, 2021; “What is healthcare technology”, n.d.). Moreover, this technology is utilized in many fields in the healthcare industry such as health insurance, EHRs, drug supply, biomedical research, procurement processes, fraud detection, neuroscience research, clinical research, telemedicine, and medical education (Agbo, Mahmoud, & Eklund, 2019).

2.1.16 Tricorders

It is a health monitoring and diagnostics device that can measure many health conditions such as ECG, EMG, Blood Oxygenation, Respiration (via Bioimpedance), and motion--almost equivalent to the feature set of a hospital bedside patient monitor (Barry, Rahman, & Wang, 2021). The design of this device is portable and wireless. Furthermore, it is smartphone-based technology. This application can be downloaded via smartphones worldwide for medical sensing at the point of care, counting coughs, tracking anemia, detecting sleep apnea, and much more. In addition, this technology can bring accurate diagnostics to the patients (Naima & Canny, 2009; Somrak et al., 2014).

2.1.17 Mobile Health Technology

The healthcare utilizes mobile health technology to train healthcare professionals. In addition, to support the healthcare workforce to update immediately, receive and access patients' records from anywhere with a mobile phone. To ensure that the physicians update a piece of information with better prescription decisions and use it for monitoring patients (Okuboyejo & Eyesan, 2014). The adoption of mobile technology-based applications could eliminate redundant paperwork, thereby facilitating more efficient and effective delivery of patient care. (Standing & Standing, 2008)

Figure 2.1: The Usage of Health and Wellness Applications

Source: *Usage of health and wellness Apps in Asia*. (2020). Retrieved from https://gmo-research.com/news-events/articles/usage-health-and-wellness-apps-asia.

Table 2.1: The List of the New Technologies Utilized in the Healthcare Now and in the Future

Type of technologies	Treatment	Consultant	Clinical and administrative	Tracking and monitoring
1. Electronic health records			X	
2. Rule-based expert systems			X	
3. The Internet of thing (IoT)				X
4. Smart Implant	X			X
5. Radio Frequency Identification				X

(Continued)

Table 2.2 (Continued): The List of the New Technologies Utilized in the Healthcare Now and in the Future

Type of technologies	Treatment	Consultant	Clinical and administrative	Tracking and monitoring
6. Tuberculosis Management	X			
7. Artificial Intelligence	X		X	
8. Robot	X		X	
9. Telehealth		X		
10. Digital Therapeutics (DTx)		X		X
11. Personal Health Wearable and Wireless Technologies				X
12. Digital Twin				X
13. Virtual Reality and Augmented Reality		X	X	
14. Blockchain			X	
15. Tricorder				X
16. Mobile Health			X	
17. 3D Printing	X			

2.2 Technology Adoption

The new technology adopted is used and applied in any workplace, organization, and symbolizes the change in attitudes. For instance, judgment, feelings, and thoughts of new technology adoption. Information technology (IT) is an essential tool to enhance the competitiveness of the country's economy. Many organizations utilize new technology as a tool because there efficient, effective, and affordable (Oliveira & Martins, 2011; Rehman, Jingdong, Khatoon, & Hussain, 2017).

Types of technology adoption

1) TOE framework
2) Biotechnology
3) Crop sensors
4) Monitoring and controlling crop irrigation system via smartphone
5) Ultrasounds for livestock
6) Documentation of field via GPS
7) Information and communication technologies (ICT)

2.3 New Technology Adoption, Acceptance, Acquisition Models and Diffusion of Innovation

The drivers that interfere with adopting the new technology in healthcare need to understand the organizational perspective, such as nature and environment in the organization. On the other hand, individual views consider all drivers associated with the acceptance, consumer's attitude, intention, and readiness to use the new technology and the users. This process includes decisions, activities, and impacts from needs or problems (De Almeida et al., 2017; Peixoto, Ferreira, & Oliveira (2022).

Table 2.3: The Process of Adopting New Technology

Stages	Descriptions
1.Awareness	Aware of new technology that meets their business model and needs
2. Interest and learning	Obtain knowledge about this technology, understand this technology they are interested in and know how it integrates with their current work process.
3. Evaluation	Acquired specific innovative related products and evaluation.

(Continued)

Table 2.4 (Continued): The Process of Adopting New Technology

Stages	Descriptions
4. Trial and application	Experiment with this technology on how to use it. In this process, individuals need to see the benefit and value of this technology.
5. Adoption	Actual utilized technology.

Source: Hanegan, K. (2020). *Ten essential steps for user adoption of technology*. Retrieved from https://www.qlik.com/blog/ten-essential-steps-for-user-adoption-of-technology.

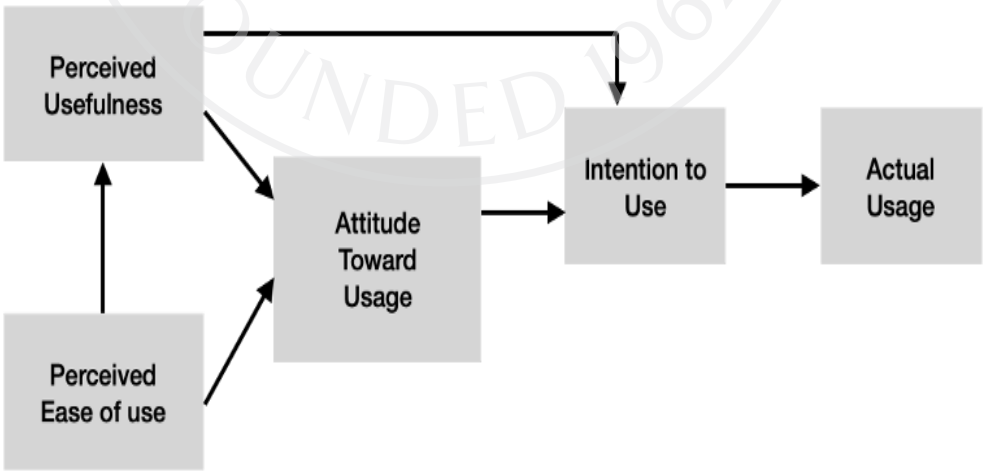
Peixoto et al. (2022) and Koch, Lam, & Meyer (1996) argued that technology adoption processes are divided into three stages in prior research. Firstly, the company must submit a writing request to allocate capital funds to purchase new technology. This stage is a "Knowledge awareness stage." Before buying new technology, they must evaluate the cost, participate in the venture, and compare similar technology with different incidents. We called this stage "The Evaluation Stage." It is an organization's decision-making. After that, the new machine arrived in the organization and began the "Adoption Implementation stage." The influence that made healthcare accept and introduce new technology is the covid-19 pandemic and other diseases. Its objective characteristics and subjective one’s influence innovation adoption.

Adopting technology in healthcare is complicated because the healthcare owner must consider the available clinical data, cost, pre-existing prescriptions, activities in the pharmaceutical companies, decisions in other medical centers, patient demand, and physician enthusiasm. In addition, many people are involved in this process, such as the head of the medical ward and physician. However, the committee is responsible for making a final decision to utilize this technology incorporating with the director of the physician, the non-clinical management representatives, and the head of the relevant medical division (Sorenson, Drummond, & Bhuiyan Khan, 2013).

2.3.1 The Technology Acceptance Model (TAM)

The TAM is a fundamental model that adjusts from the Theory of Reasoned Action (TRA) that is designed to explain human nature and contains two factors that affect behavioral intentions, such as the attitudes towards behavior and personal average (Holden & Karsh, 2010). Technology acceptance has a degree of making a decision that includes Perceived Ease of Use (PEOU), Perceived Usefulness (PU), and Perceived compatibility (PC). Perceived ease of use refers to the degree to which the prospective user expects the target system to be free of effort. Assuming that other variables are constant, the easier a technology is used, the higher its possibility of being adopted by users. In addition, Perceived Usefulness is limited to someone who thinks technology can improve and enhance job performance. Behavioral intention to use is defined as individual constructed ideas, having a mindset ready to carry out and not carry out specific behavior, and users develop a positive attitude when they find this helpful technology. TAM is not only applied for the assessment of existing technology. However, users without experience using new technology can predict the adoption (Bhatacherjee, & Hikmet, 2008; He, 2014).

Figure 2.2: A First Modified Version of the Technology Acceptance Model (TAM1)



Source: Venkatesh, V., & Davis, D. F. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186-204.

2.3.2 Technology Acquisition

It is a model that integrate the technology acquisition process with market needs, technology sources and strategic plans for the purpose of evaluate the feasible of the technology acquisition. This model is the connection between technology sourcing, product development and strategic management processes.

The processes of technology acquisition consist of five stages that include establish market-place requirements, describe the technology solution, organize the technology solution, estimate the derivation of technology acquisition, and decide. (Durrani, Forbes, Broadfoot, & Carrie, 1998) in this model include the external technology acquisition that is providing an advantage of new technologies to the organization to conquer and concentrate the obstructions of the company internal capacities. Moreover, this model also assists to fill the market gaps (Kang, Jo, & Kang, 2015).

2.3.2 Diffusion of Innovation Theory

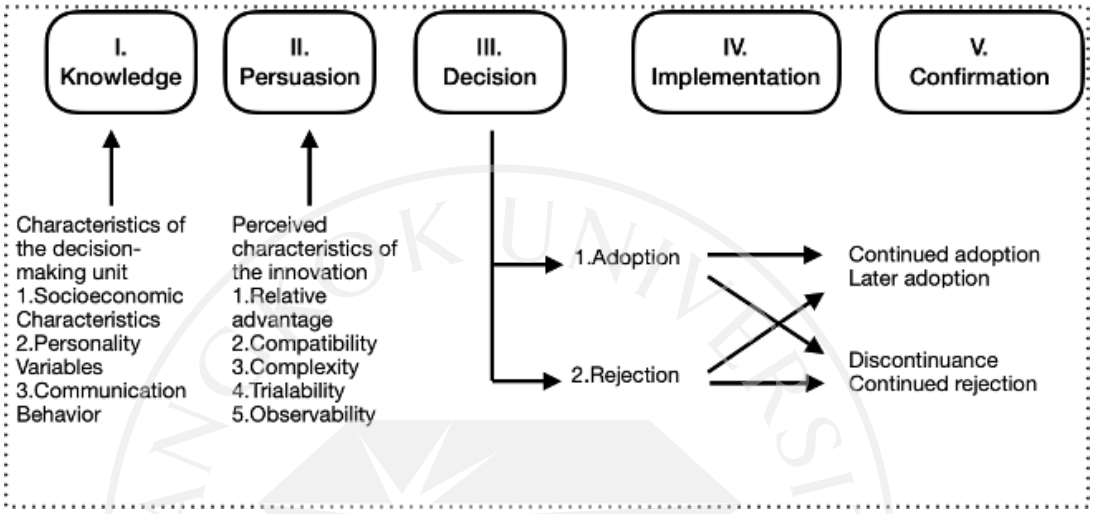
Technology diffusion explains the process when the member of the social system communicates about innovation through the channel gradually, known as diffusion. The diffusion of innovation theory demonstrates that innovation and adoption occur after five stages: knowledge, persuasion, decision making, implementation, and confirmation (Liu & Miguel-Cruz, 2022; Zhang, Yu, Yan, & Spil, 2015).

The innovation-decision process is searching for the information made by continuous activity. The subject is motivated to reduce the advantages and disadvantages of an innovative machine or product. The first stage is knowledge of novel technology. The next stage is a persuasion of the feasibility of adopters by enhancing the knowledge about technology and searching for more information about this novel technology. The third stage is deciding to adopt or decline this new technology (Rogers, 1983).

Furthermore, the fourth stage is implementation occurs when a department or organization utilizes new technology. Lastly, the stage is confirmation, in which the adopter criticizes and decides to the maintenance of the adoption or refusal of this new technology after utilizing this technology that they select. In addition, it is made through weighting the pros and cons of this new technology where people will adopt

it if they trust it will improve their organization's facility and service (Miranda, Farias, Schwartz, & De Almeida, 2016).

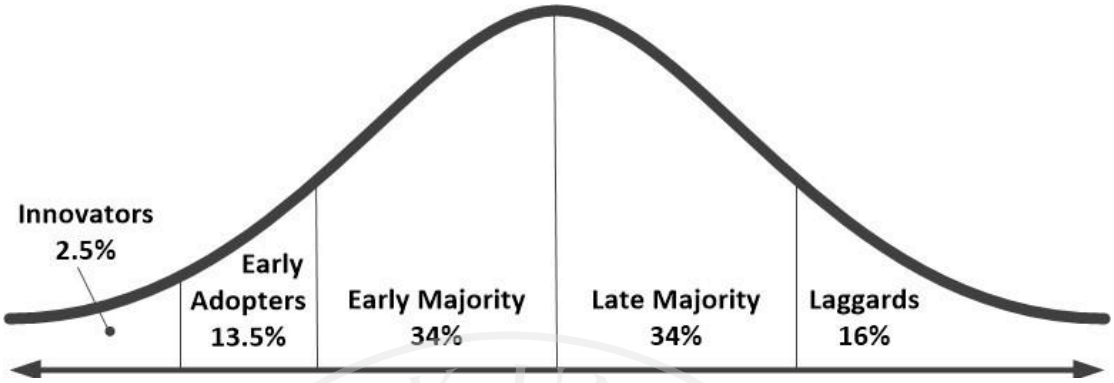
Figure 2.3: Decision Process Innovation



Source: Miranda, M. Q., Farias, J. S., Schwartz, C. D. A., & De Almeida, J. P. L. (2016). Technology adoption in diffusion of innovations perspective: introduction of an ERP system in a non-profit organization. *RAI Revista de Administração e Inovação, 13*(1), 48 57.

After that, the researcher of diffusion of innovation theory expounded on the adopter categories as a categorization of social system members based on innovativeness divided into five categories: innovators, early adopters, early majority, minor majority, and laggards. Moreover, Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other system members (Rogers, 1983; Sahin, 2006).

Figure 2.4: Types of Adopters in the Diffusion Innovation Theory



Source: Reiling, J. (2022). *Strategy, PM, and the diffusion innovation theory model*. Retrieved from https://bethestrategicpm.com/the-diffusion-innovation-theory-model-applied-to-strategy-and-project-management/.

2.3.4 The Factors that Make Healthcare Adopt New Technology

The organizational factors mean the corporate size that include the number of beds (capacity), total assets (resource), and employees. Additionally, the corporate competitors and the regulatory environment. Small organizations are more likely to adopt new technology early because the small organization wants to be a competitive advantage over large organizations. However, large organizations prefer to decelerate the adoption of technical processes. In addition, hospital age is an essential factor as well. The older hospitals have a well-defined resource-based and new technology expected to adopt in their healthcare to ensure they exist in the market. As well as the senior executive would like to enhance their reputation and group factors that mean when an organization decides to purchase something, they need to ask the Buying Center Approach. The Buying Center Approach is a member who responsible for purchasing. On the other hand, a user is more concerned about purchasing (Cao, Baker, Wetherbe, & Gu, 2012; Ghodeswar & Vaidyanathan, 2007).

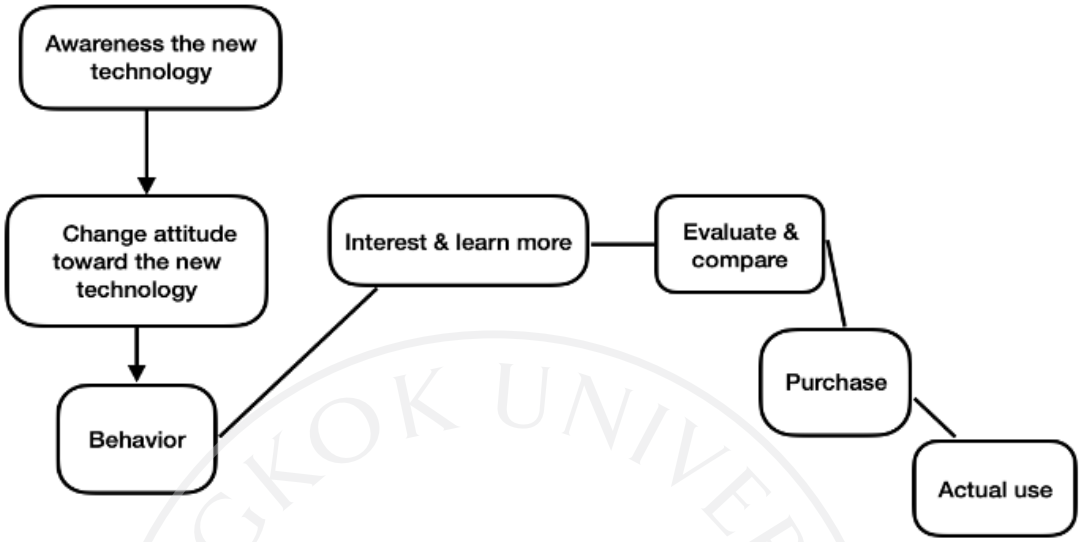
The external factor includes the pressure from other hospitals, suppliers, and high demand for using this technology from patients by requests or recommendations and the market Environment. The internal factors include organizational and top management characteristics, especially the CEO's desire to adopt new technologies

(Garavand et al., 2016). Other factors that drive hospitals to adopt new technology are perceived ease of use and the benefits of using new technology. Moreover, enhance the healthcare service quality to gain an advantage and ultimately improve operation performance, provide the efficiency and effectiveness to the healthcare provider and staff, and reduce an organization's cost (Bokolo, 2021b; Thakur et al., 2012). Similarly, when the World Health Organization (WHO) declared coronavirus disease 2019 (Covid-19). That accelerates the healthcare worldwide to adopt new technologies. (Mucheru, 2013) The service strategy and business are vital to developing and adopting new technology. Moreover, it is an external factor that influences customers' service expectations. Strategies drive operational decisions through investments, infrastructure, and employee development, resulting in enhanced capabilities in the organization (Goldstein & Ward, 2004).

2.4 Research Guiding Framework

Conclusion and development of a synthesized research-guiding framework. The author of this study synthesizes relevant elements to form a framework to guide the subsequent research into the topic. Developing this framework has had a challenging such as it is difficult to find a proper technology acceptance model that match the researcher topic because many of these models can be utilized. However, there are too complex to this study and there are a plenty of technologies adoption models, so it is difficulty to predict which models are appropriate for to the researcher study. Additionally, there are many articles, research and books that related to the new healthcare technology, but the researcher cannot utilize them because need to pay additional fees to access some articles and many of them are not related to this topic

Figure 2.5: Process of Adapting Technology in Healthcare



The researcher combines two models that include the process of technology adoption in healthcare (De Almeida et al, 2017) and the Technology Acceptance Model (TAM1) from Venkatesh and Davis (2000).

CHAPTER 3
METHODOLOGY

3.1 Research Method

This chapter introduces the methodology for this qualitative research. This research is used as a single case study qualitative research that refers to an intensive study about a person, unit, or organization, explains a specific company's event, and explores a thing that would like to understand deeply. It is one of the other categories of qualitative research, such as depth interviews, conversation, and observation. There are many advantages of this research method that I can be investigated in-depth with detail, concentrate on determining the relationship between the individual or organization, and it is a flexible method because freely to discover and efficiently address a problem. However, this research method has drawbacks, such as taking a long time to collect and analyze the data. The outcome of this question is probably based on the time that gains the data from participants. (Sekaran & Bougie, 2016; Zikmund, Babin, Carr, & Griffin, 2013)

3.2 Case Description

3.2.1 Bangkok Dusit Medical Service Company Limited (BDMS)

BDMS is the most outstanding hospital network in the Asia-Pacific. It is in the top five global private hospital groups in terms of Market Capitalization. That was registered as a hospital in October 1969 and had 14 hospitals out of 53 across the BDMS group. It was the one hospital that has been accredited by the Joint Commission International (JCI).

It is the first private established heart hospital called Bangkok Heart Hospital, a cancer hospital (Wattanosoth Hospital), and the first private hospital group in Thailand that opened a Samitivej Children's Hospital dedicated solely to pediatric care patients. The BDMS group includes many hospitals, especially The Samitivej Hospital Group, the BNH Hospital Group, the Phyathai Hospital Group, and the Paolo Hospital Group.

The vision of BDMS is to offer world-class medical care and treatment for Thai and foreign patients, complemented by the latest medical technology, and provide global quality healthcare in Thailand.

Figure 3.1: BDMS Group Hospital

Source: Bangkok Dusit Medical Services. (n.d.). *Your trusted healthcare network.* Retrieved from https://www.bdms.co.th/our-network.

3.2.2 Samitivej Group

Samitivej Hospitals are part of Bangkok Dusit Medical Services (BDMS) and a leading group of private hospitals serving Thailand and the ASEAN region. Samitivej's first hospital was founded in June 1979. Samitivej's main office is Samitivej Sukhumvit Hospital,located in Sukhumvit Soi 49, Bangkok. That has seven hospitals, including Sukhumvit Hospital, Srinakarin Hospital, Children's Hospital, Sriracha Hospital, Thonburi Hospital, Chonburi Hospital, and Chinatown Hospital. In 1999, Samitivej became the first hospital in Thailand to be awarded the prestigious recognition as a mother and baby Friendly Hospital by WHO and UNICEF. Further recognitions include Thailand's Prime Minister Award for the Most Recognized Service in 2004 and hospital accreditation by the Joint Commission International (JCI).

Samitivej was also the first hospital outside Japan to be accredited with the Japan Council for Quality Health Care (JCQHC) award. It was named the best

hospital in Asia for medical tourists by the Medical Travel Quality Alliance (MTQUA).

Figure 3.2: Samitivej Sukhumvit Hospital

Source: Samitivej Sukhumvit Hospital. (2022). *About us*. Retrieved from https://www.samitivejhospitals.com/about-us/.

3.2.3 Samitivej Srinakarin Hospital

This hospital has an expert team of 500 medical professionals and has 400 beds. The hospital is located in eastern Bangkok, near Suvarnabhumi International Airport. Patients can be transferred from the hospital to the airport in the shortest time. This hospital has won the COVID-19 Management Initiative of the Year Award for our efficiency and safety in dealing with the pandemic at the Healthcare Asia Awards 2022. It is a leader in the field of Virtual hospitals in Thailand that received a product innovation Award 2021.

Figure 3.3: Samitivej Srinakarin Hospital

Source*: Samitivej Srinakarin Hospital, Bangkok*. (n.d.). Retrieved from https://mapio.net/pic/p-12587535/.

3.2.4 Samitivej Children's Hospital

The Samitivej Children's Hospital is located in both Sukhumvit and Srinakarin hospitals that offers a complete range of pediatric medical services by a team of more than 150 specialist medical professionals. Wholly specialized in providing children with comprehensive tertiary treatment and surgical procedures. Samitivej Children's Hospital is equipped with the latest technologies especially suited to pediatric care, such as the Neonatal Intensive Care Unit (NICU), the Pediatric Intensive Care Unit (PICU) and a pediatric surgical department equipped to provide surgical procedures for the brain, urinary tract, and heart. They specialize in treating the most complicated childhood health conditions and offer an air transfer service.

This hospital is the first and only in Southeast Asia to receive the bronze standard for Geriatric Emergency Department Accreditation (GEDA) from the American College of Emergency Physicians.

Figure 3.4: Samitivej Children's Hospital

Source: Samitivej Children's Hospital. (2022). *About Samitivej Children's Hostipal*. Retrieved from https://www.samitivejhospitals.com/about-us-children/nurses.

3.3 Data Collection and Analysis

The data collection procedure was conducted face to face and through zoom interviews at Samitivej Srinakarin hospital as secondary research with the Deputy CEO, CFO, CIO, Hospital director, Head of the innovation team, Head of the Rehabilitation center, and nurses. The interview takes approximately 30 to 50 minutes per person. Two people would like to interview in English and Five interviewees would like to be interviewed in Thai because they do not feel comfortable to speaking English. After that, the researcher translated these five interviews from Thai to English which took 2 to 4 weeks. Then analyzed the data via Google Docs and ATLAS.ti to code and highlighted vital findings that fit with the framework I selected, such as awareness, interest and learning more, evaluation and evaluation comparison and actual use. These steps take two weeks to finish. The interview covered questions about the point of view about new technology that they use in this hospital. What is adopting a new technology process in their hospital, how do they select the latest technology, how do they implement new technology, and how does the user feel when using new technology?

Table 3.1: List of Interviewees

Participant No.	Level	Department/Unit	Experience (Years)
1	Deputy CEO	BDMS	4 years
2	CFO	BDMS	7 years
3	CIO	Samitivej group	8 years
4	Hospital Director	Samitivej Srinakarin	7 years
5	Head of Innovation	Samitivej group	4 years
6	Head of Rehabilitation	Rehabilitation	13 years
7	Nurse	Children	15 years

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CHAPTER 4
FINDING

4.1 Innovative Healthcare Technology Adoption Process in Private Hospitals

In this hospital, many people work here in different positions.

First are the CEO, Deputy CEO, and CFO. These three people typically look at the big picture of the Samitivej group and are responsible for deciding which new technology can be utilized in this hospital during the purchasing process. These three people are also involved in the subsidiary company called a DHV team. This team includes the three people mentioned above and the Head of the innovation team. This subsidiary company, the DHV, is responsible for searching and learning about new applications and building new applications to support the patients in every hospital in this company. In addition, they sell the application they create to other companies or hospitals to get more money and profits.

The CIO is a person who supports the IT department in every hospital under the Samitivej group because Samitivej has many hospitals in this company and should have an IT center team responsible for take care a whole system, such as electronic health records for this company. In addition, support other departments in the hospital when they utilize new medical technology.

Every hospital in this company has its hospital director responsible for combining all the latest medical technologies and information from the Head of the department. The head of the department is the one who responsibility for search for a new medical technology that they would like to utilize in their departments. In addition, they have a deputy director, director of a nurse, and assistant director in the hospital where they are working. Afterward, they need to present the three people who look at the big picture.

The Head of the doctor takes care of their department, and in this department, doctors work in their department. In adopting new medical equipment, this person is responsible for searching and learning about this technology and assigning doctors and nurses in their department to search. After the search, they must pass all the information to their hospital director.

Usually, this process starts with the CEO, Deputy CEO and CFO who see the trends of digital transformation technology. Then the CEO assigned every employee, doctor, and nurse to find and search for a new technology via the Healthcare technology website, online conference, health tech articles, and medical publications during the pandemic. However, before the pandemic, they visited a healthcare technology fair or events in other countries, such as the USA, Israel, and European countries hosting health tech events.

In contrast, one person said that they separate those responsible for finding or searching for new technology. Innovation teams in that team include secretive, transformation, and steering committees. These three teams separate a job to do, such as the secretive and steering committees' teams. They are responsible for searching for new technology and then transferring the information about it through the transformation team to combine this information and then send it to the head of innovation. After that, present this information to the CEO, deputy CEO, and CFO. They decide to utilize this technology or not. However, other more senior people have a different opinion because they take more of a big picture view. They separate their work into many groups, such as Digital health Venger and the hospital team. And the hospital director said they formed a team/group interested in this technology /staff to develop this idea and form a unit that operates on digital technology and then spine off and create/build a subsidiary company that works about digital technology if this project is successful.

1) The Digital Health Venture team has responsibility for searching for novel and innovative technologies, especially Telemedicine and telemonitoring, that are utilized in every hospital in Samitivej Group. This team is a subsidiary of Samitivej company. Samitivej hospital decided to form this company because the adoption process in the hospital is slow due to the rules and regulations. So, the DHV company works as a speed boat to run faster. In this team, we have a sub-team called in-house startup.

- This team has the CEO, Deputy CEO, CFO, and head of innovation involved to decide which application we can utilize and implement in this healthcare.

- This team and SCB10X also must create a new application and sell it to other companies and hospitals to make a profit and money.

2) The hospital or operation team to responsible for searching and finding new medical equipment such as Robot-assisted walking for the Rehabilitation center and AI for GI and Colonoscopy to diagnose rapidly. Moreover, the head of the department should be involved because they can choose which technology can be implemented and which model can be utilized. Furthermore, the CIO or head of the IT team supports the operation team utilized in these hospitals. When they decide to adopt new medical equipment technology normally starts with the head of the doctor from this department who would like to utilize this medical equipment. Then after they search and learn this thing, they must present all the information that the Digital Health Venger team and hospital team search about this new technology to the hospital director, CEO, and CFO. These three people will decide whether to purchase it or not.

This technology should reduce the burden and cost, integrate, or match they workflow, current system, or data, and solve their problem, the company's reputation. In addition, the company needs to be well-established and have a demand (patients). However, the Chief Financial Officer's point of view said that the price and finance are essential when choosing new technology. In addition, this technology should make our job easier for our employees and customers should get a benefit. In addition, it should make a value for their hospital when they utilize this new technology and be user-friendly according to the complexity of the machine.

For the medical device and applications, During the pandemic, they typically search this new technology via medical publications, and online medical conferences that host by Singapore and Thailand year by year. In addition, Google searches for the name of the company or vendors, a function of this product, and contracts with the medical equipment company that sells this product. They choose a company that can talk to them directly and gives them essential information about the product they want to purchase. In contrast, normally they participate the medical fairs and events in other countries such as the USA, Europe, Etc. This is how they search a new technology before the Covid-19 has been occurring.

4.2 Identified Healthcare Technologies

The vision of Samitivej Company is that the agile organization of value means changing rapidly and creating value for all stakeholders.

Before this company would like to adopt new technology the first thing, they must do is identify themselves. For example, what field does this hospital expert in? How many patients do they need to use this technology? What is the new customer norm? What new technologies are customers wanted in the future? Moreover, what is the future trend of new healthcare technology for new healthcare technology? Think about who is the competitor? Do hospitals or health tech companies competitors? What is their center of excellence? For example, Samitivej Srinakarin focuses on children and rehabilitation. So that is why the rehabilitation team invested in the robot-assisted walking device for the children. In Sukhumvit, we focus on gastrointestinal (GI) diseases such as Colon Cancer.

That is why they invest in the AI for Colonoscopy installed with the cameras put into the patients' rectum to see if there is any mass/polyp. They need to do this before purchasing or selecting new technology because they said there is plenty of new technology. Then what are the new technology trends? Furthermore, how many patients will use this technology if they invest in it?

To adopt new technology in these hospitals, they have a three-year concept: Buy, Build and Borrow technology. Buy mean if the hospital has enough money to purchase new technology products or machines, encounter a supplier who interested them and want them to be an investor in this company. So, they will collaborate and purchase this product from this distributor, build mean create an application by themselves. For example, Samitivej Pace is an app to tracking patients who are in the operating room and Telemedicine (Virtual hospital) and borrow mean partnership collaborate that mean exchange new technology and knowledge from another company. For instance, the virtual hospital is an app that this hospital collaborates with Siam Commercial Bank (SCB) for payment part in this application. SCB10X is a SCB subsidiary company. Moreover, SkinX is a new application that DHV team and SCB10X working together and is an application for the patients consulting their skin problem.

4.3 Identified Vendors and Selected

The head of the innovation team said they chose the vendors that are already working with this hospital right now or used to work with them before. However, the DHV company and the hospital team said that they should compare at least three vendors. Then must compare these vendors by asking essential questions such as

1) What is the function of this technology? Furthermore, how do these products work?

2) What are the advantages and disadvantages of this product?

3) How many patients are going to utilize this technology?

4) If we utilize this technology, are there going to solve our problem?

5) If we utilize this technology, will this technology make a profit for our hospital?

6) Is that technology making a value to our patients and users?

7) Can these products match our current system?

8) Does this technology have enough research and is already experimented with by humans?

9) Are these vendors having a well-established companies, well-known and stable companies, or reliable company?

10) Is this product from these company has a reasonable price?

11) Is there any company that imported this product from this vendor in Thailand?

12) Is Distributors and vendors have a well-trained staff from the headquarters?

13) Is this company startup?

14) Does this company have any first customers who purchase these products?

15) Is that machine from this supplier already getting FDA approval from The USA and Thai FDA?

The product that needs to be utilized in humans or any medical product should get the FDA to certify this product is safe to use in humans. If this product from this vendor did not gets Thai FDA. The hospital should negotiate with these vendors who interested in doing the market in Thailand to be representative. After

that, they hire an agency to do a process to get the Thai FDA. This agency is responsible for collaborating between the hospital and the vendors to send essential information and contracting the Thai FDA department to get a certificate.

When selecting the new technology, this hospital should choose the right vendor because if they choose an unwell product, the company loses the money and reputation. In addition, the hospital they must consider the market, such as which new technology is interesting? Is there any other hospital that already uses this product? Who is our competitor? And how many patients will use this equipment? However, if this technology is new and cannot compare. The Samitivej group have a Capex committee team to evaluate the Capital expenditure, the feasibility, and the value of this machine.

4.4 Purchasing

Before every team would like to purchase this technology, the hospital should have enough research about this technology. The researcher must say this technology is steady and has patients who need to use this technology. It should be advantageous to use this technology. The hospital needs to search which machines are appropriate for their department or this hospital, the names of machines, types, and models are suitable for our department. Furthermore, we must consider which function we need because different functions and models mean other treatments.

They must go to the Capex Committee (Investment committee) if they would like to purchase every type of new technology that costs more than 200,000 THB. The members of this committee include the CEO, Deputy CEO, CFO, and the HR department head. The Head of the HR department is the staff from the Center of purchasing the BDMS. This person from the Center of purchasing is responsible for comparing and evaluating vendors, bargaining for the price, and looking for the quality and function of this new technology.

This committee is responsible for taking care and supporting every hospital in Samitivej groups. However, other people, such as the hospital director, business development, CIO, and the Head of the innovation, occasionally participate in this committee when they want to purchase new technology related to their responsibilities. For example, suppose the rehabilitation center from Samitivej

Srinakarin would want to utilize Robot-assisted walking. In that case, the Head of the Rehabilitation center needs to search for all necessary information about this technology and then discuss it with that hospital director. Afterward, this hospital director defended and decided to purchase this technology or not with the Capex committee.

4.5 Implementation

They usually form a Super-user team for the new application or system that the CEO would like to utilize from a different department, including doctors, nurses, and employees. They have this team because the doctors, nurses, or everybody who works in this hospital needs to understand how to use it before utilizing it in the whole hospital. In contrast, the new medical equipment, usually the head of this department, would like to purchase this medical experiment. After that, the super-user member talks and tells every information they get to their department staff.

Both types of new technology need to do product QOC. After that, they experimented with this technology before utilizing it.

On the other hand, if they implemented AI technology for the chest X-ray and mammogram project with three heads of the department involved, including a wellness center, a Radiology department, and the surgeon. This AI project is the project that the head of Radiology said to stop this project because it is not fit for their job and work. If one department tries to stop, they should stop because this person is not satisfied with utilizing this technology.

4.6 Usage

Doctors do not complain when they utilize it for medical equipment because they choose this technology themselves. However, a few complain because doctors graduated from different universities/colleges. Every school or university uses a different brand. Some doctors like to use machines from Semen, Philip. So, it depends on which medical brand they use during their time at the university? Nevertheless, some doctors think using new technology wastes their time and fear that the technologies will replace their jobs.

In this hospital, the doctors complain about new systems or applications. Many doctors complain about Electronic Health records because Samitivej hospital has changed from paper to electronic, and the doctors need to use a computer. That is why they must have typing skills. For example, the older generation did not like to type on the computer. However, the younger generation likes to type. To solve this problem of typing lacking, sometimes, they let the older generation of doctors write on paper and scan it to the computer. This hospital does not utilize the EHR fully 100 percent, but it is a hybrid.

There are many complain such as patients complain when the hospital decided to use the Telemedicine because they want to talk directly to the doctors and see a doctor in real life. Additionally, Doctors complain because it is challenging to evaluate the patients remotely, but after Covid-19, both doctors and patients accept this technology.

Due to the challenge for the doctor to check the physical examination when using Telemedicine simultaneously, they solve this problem by purchasing a new device known as Tyto care. It is a small device with cameras and an adapter: this device includes an Autoscope, which is used for seeing the ears so the doctors can see the ears remotely, a Stethoscope is used for hearing heart and lung sounds, and a tongue depressor, used for seeing the throat. Moreover, they utilize this technology for the Covid-19 patients, and after the finished measure, the result will be sent directly to the doctor's computer. When they use both Tyto care and Telemedicine, the result makes the patients more accepting and satisfied with using the Telemedicine

According to the data from Samitivej hospital about how many children patients will utilize Telemedicine in 2019, there are a few patients who utilize this technology. However, in 2020, only 1000 transactions, and 2021,4000 transactions. The results show it increased four times, and patients and physicians are more accepting and satisfied with using this technology.

Comment: The public hospital usually needs new healthcare technology for research; they do not need to care that this technology will make a value or a profit for their hospital. Furthermore, they did not need to care that technology is costly.

The CEO's vision is that every department in this hospital should have a project about adopting new technology and disrupting yourself before anyone else

disrupts you. Another thing is that worldwide, only 10 percent of sick people are healthy, but 90% of the people are healthy. Prevention is better than healing, early detection, remote care, and self-care. Maybe we can have technology like a mirror that people can take care of by themselves in the future.

The interviewee's perspective about new technology is that we do not need to be the first organization or person who uses that new technology. However, we consider the value of this technology and how many patients are going to use this technology.

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CHAPTER 5
DISCUSSION AND CONCLUSION

This research aims to investigate the adoption process in the leading Thai hospital with the subordinate question that includes.

1) How are innovative healthcare technologies identified?
2) How are suitable vendors identified and selected?
3) How are the new technologies implemented in this hospital?
4) How are they monetizing the new technologies beneficial way?

5.1 Discussion

First, I need to introduce the vision of the Samitivej company is to be an agile organization of value that means to change rapidly and create value for the stakeholders. So, before adopting new technology they must identify what field is this hospital's expertise? What field of medicine do the physicians in this hospital have expertise in? And how many patients are going to use this technology?

This hospital has the three-year concept and strategy of adopting a new technology that called BBB and mean buy, build, and borrow. Buy means if they have money to invest in this new technology and have a good supplier interested in working with them, they will collaborate and work with this company to purchase it. Build: create an application that meets the patient's pain point. For example, create a Samitivej Pace application for tracking patients in the operation room to reduce the anxiety of the patient's relatives. Borrow or partnership collaborate. This borrowing concept means exchanging a new technology or knowledge from another company. For instance, the virtual hospital and SkinX application that they collaborate with Siam Commercial Bank subsidiary called SCB10X. That strategy is different from other public hospitals because the private hospital needs to consider the financial site when they would like to invest in new technology. In addition, have a strategy to purchase new applications and build an application to sell to another hospital to gain more profit for this hospital.

RQ 1 Process of adopting new technology at Samitivej group

Based on the findings, the idea of adopting new technology in this hospital started from the CEO and Deputy CEO, who saw the digital transformation trend, and the CEO's vision is to disrupt yourself before everyone else disrupts you. Another thing they need to consider is what medical field they are experts in? What is this hospital center excellence? Because they cannot purchase every new technology. However, they are selecting and investing in new technology based on their expertise. After they known what field, this hospital is excellent the CEO inform the Deputy CEO and CFO, these two people are looking into the big picture of this hospital to find a new healthcare technology. Afterward, they separate their work into many groups, such as Digital health Venger, including the head of the innovation team responsible for searching for a new application and the hospital team accountable for searching for new medical technology. This team has many people involved, especially the head of the doctors in every department who need to search for which new technology they need to utilize in their department and then pass all the information that the head of department get to the hospital director.

After they get all the information, the head of the innovation team and the hospital director need to go to the Capex committee, including the three people mentioned above and the head of the HR team, to get approval to purchase the new technology cost over 200,000 THB. The head of the innovation team, the hospital director and the head of the department will occasionally show up in this stage, depending on the type of new technology. For example, if this hospital wants to purchase new medical technology, they must send the hospital director to present every information to the Capex committee.

Next is the implementation stage. They form a super-user’s team, including a doctor and nurses, to implement the new technology. Finally, it is a usage stage for everybody working in this hospital who utilizes the new application, and employees in the department use this new medical equipment. In addition, CIO is someone who supports the IT team of every hospital under the Samitivej group and experiments with new technology that is implemented in healthcare.

In the finding, the DHV team has the head of the innovation team. The innovation team has three groups: secretive, transformation, and steering committee.

These three teams separate a job to do, such as the secretive and steering committees' teams have a responsibility to search for new technology. After that, these two teams transfer the information about this technology through the transformation team to combine it, then send it to the head of innovation, and then present it to the CEO, deputy CEO, and CFO.

RQ 2 How are the innovative healthcare technologies identified?

The finding they separated the new technology into two groups including medical technology such as Artificial Intelligence and robotics technology. And business or service technology such as application and system. Usually, they search for new technology on the internet in medical publications and travel abroad to other countries such as Israel, The USA to participate in the medical fair. However, due to the pandemic, they joined the online medical conference.

RQ 3 How are suitable vendors identified and selected?

Based on the finding, select the vendor who already works and collaborates with their hospital. These vendors should have well after-sales service, and when the products have a problem, the hospital can contact these vendor or company 24/7, the vendors should be well-established, well-known, and stable company and they should identify the company such as does this company have competitors? Who are their competitors? And have a well-trained staff from the headquarters because if we have a problem when we ask a Thai distributor, they can answer our questions.

After they find a new technology, they must compare a product that have a similar function from different vendors at least three. They need to compare the advantages, disadvantages, and the price of this product of these vendors and products. However, if this technology is very new and has only one vendor who sells this technology, they should find another vendor with a similar function to this equipment.

RQ 4 How are the new technologies implemented in the hospitals?

Based on the findings in this study, they implement the new technology by forming a super-user's team that includes doctors, nurses, and employees to experiment with this technology before using it in the whole hospital. In addition, the IT team should be involved in experimenting with this technology before and after purchasing it. This team is formed because they must understand how to utilize it

before utilizing it. However, after they utilize this technology and do not like it, they can cancel this project all the time. In addition, the doctors should be involved in every process when they adopt the new medical technology because they are the one who uses it, needs to understand how to use it and need to understand everything in the early stage of adoption new technology.

They choose helpful technology for their hospitals, department and have enough patients who would like to use this technology. According to the Statistics from this hospital about how many children patients will utilize telemedicine in 2019 has a few patients who utilized this technology, and in 2020 only has 1000 transactions. However, in 2021 have 4000 transactions. That means the results show it increased four times, and patients and physicians are more accepting and satisfied with using this technology means that patients and doctors more acceptance this technology. However, if the older generation of doctors or other doctors has any problem with typing on electronic health records. The nurses and management will let the older generation of doctors write on paper and scan it to the computer to solve this problem and ask doctor what skills they want us to support or teach? For example, copy and paste the keywords the doctors need to type. So, the nurses will teach them how to use this technique.

Moreover, if the doctors offered a new system that they would like to use. They will adjust or change a bit to match what they want. In addition, the findings from this study said they should have a good business model before purchasing new technology, and the price should be reasonable.

RQ 5 How are they monetized in a mutually beneficial way?

The DHV team and SCB10X create an application and sell it to other hospitals and companies that the way they make a profit. When this hospital utilizes and invest in the new technology doctors can quickly. For instance, when utilize AI which means the patients can tell other people to come to this hospital. They decided to adopt robot-assisted walking that utilize in an Arab patient that they target patients are children.

5.2 Conclusion

Adopting new technology in this hospital is different from other hospitals because they are a private and massive company that includes seven hospitals under the Samitivej group. In addition, the reason why they form a subsidiary company that called Digital Health Venger to find a new application or system because usual process is very slow and need to reduce the time to adopt new technology.
They compare a usual process as a big ship and subsidiary company as a speed boat. Before adopting new technology, they should have a good business model and have to understand what fields are they experts in?

There are three people such as the CEO, Deputy CEO, and CFO, who look at the big picture of this hospital and get approval to purchase this new technology they are interested in. They separate employees into groups to search and learn different types of technology, especially hospital teams that focus only on medical technology to reduce the time to adopt new technology, and the standard adoption process is slow. That is why the CEO decided to form a subsidiary company called the DHV team to search and learn about the new applications because they would like to follow a new trend of technologies. In this team, many members and the head of innovation are interested in new technology that did not exist before. That is why they form this company to accelerate the adoption process and make an effective for searching and learning about applications and data. The IT central department has a CIO responsible for supporting and experimenting with a new database, system, and technologies for every hospital in Samitivej Group.

When they select every new type of technology, they choose the technology that matches their job routine and needs, has value, profit, and a reasonable price. In addition, they should consider the product from these vendors should get the USA FDA and Thai FDA. During the purchase phase, they have a Capex or investment committee and have the HR department head as a part of the BDMS and responsible for deciding which technology costs over 200,000 every hospital under the Samitivej group must send someone related to the technology they would like to purchase. For example, the head of innovation if they would like to utilize a new application to defend with the members of the Capex Committee. This committee supports and

manages all hospitals in this company when they want to purchase a machine and products utilized in one hospital or every hospital under the Samitivej company.

They form the super-user team to experiment with this technology because they would like all of them to understand, learn, accept, and be satisfied with it. They want every employee to try new technology and learn about new things. Moreover, this hospital not only focuses on the healthcare industry. However, they focus on other businesses such as food, self-care applications, Etc. Suppose they need to do further business. They need to collaborate with other companies to exchange their knowledge and intellectual. For example, they collaborate with an insurance company so that patients can refund their insurance money through telemedicine and collaborate with other non-medical companies such as SCB10X, a subsidiary of Siam Commercial Bank.

The researcher suggest that they should have a Chief Technology Officer in their organization. The latter focus on research and development strategies to increase revenue and performs a cost-benefit and return-on-investment analysis. Moreover, understand and implement technologies that help the company achieve its business goals and objectives.

5.3 Limitation of this Study

This research is a single case study even though the researcher has collected evidence from multiple resources and perspective. However, there are still reliability and validity limitation such as it is challenging to find a suitable technology acceptance model that matches to this topic because there is a plenty model that can be utilized, but many of them are complicated models and There are many new healthcare technology articles, research, and books, but we cannot utilize them because we need to pay more to access some articles which are unrelated to our research topic. During the interviewed with zoom also challenging because sometimes the internet connection gets lost. Furthermore, many of the employees in this hospital cannot speak English that is the reason why the researcher must conduct an interview in Thai after that translate the transcripts to English which mean that can lose some vital information.

Therefore, it is considered that a longitudinal study on the process of adoption in this healthcare because the process in this hospital it not similar to other private or public hospital.

5.4 Recommendation for Future Research

The researcher thinks possible areas for further research or investigation include the process of adoption of new technologies in other industries such as the public or other private hospitals in other countries because we overheard that the purpose of adoption of new technology is not similar to the private hospital. After all, they do not consider the finances or other industries, especially, restaurants, grocery stores, Etc. However, if another researcher would like to investigate a private hospital in other countries, they need to carefully choose the models and consider not every hospital has similar adopt new technology process.

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APPENDIX

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Data Collection Protocol

Section A: Data Collection Procedures

Samitivej Group has been selected as the case study for this research. The key contact person will be the CEO, Deputy CEO, CFO, head of department and nurses who work at this hospital. As the researcher has close contact with the Deputy CEO, the researcher can quickly schedule the interviews with different employees from various positions.

The researcher will observe the process of adoption and acquisition in this hospital to understand how this private hospital do. In addition, discuss with the Deputy CEO before conducting the interview about what new technology they currently utilize and would like to utilize in the future.

In this research the researcher expects to conduct seven interviewees with different stakeholders within three to six weeks with an average amount of one to three interviews per week.

Section B: Interview Question

The semi-formal interviews will be conducted with different employees from incompatible positions who has been working at this hospital, and the question can potentially be addressed following this several topics.

1. General question about the process of adoption new technology. This type of question will be asked the people who worked in the management level that including the Deputy CEO, CFO, CIO, head of innovation team, head of department and some nurses.

1.1 How do you track emerging healthcare technologies that might be relevant to the hospital?

1.2 Who or what entity/business function is responsible for tracking emerging healthcare technologies?

1.3 What factors influence this hospital to adopt new technology?

- This question will ask to understand how they awareness new technology

1.4 What process are you using to learn more about interesting new healthcare technologies that might be relevant for the hospital?

1.5 Who is involved in this learning process?

1.6 How they selected a new technology?

- This question will ask about when they interesting and learning about prospective new technologies.

1.7 How do you evaluate and compare alternative technology product from different vendors or suppliers for a healthcare technology that interests you?

1.8 Who is involved in it?

1.9 What are the common decision criteria? E.g., price, financing, perceived ease of use, perceived usefulness etc.

- This question will ask to understand how they are evaluating and comparing of possible technology alternative and vendors.

1.10 Do the physicians or nurses complain about new technology when they utilize it?

1.11 How do you handle when physicians or nurses complain about new technology?

1.12 When physicians do not want to use new technology that the hospital or department selected, how do you handle with these doctors?

1.13 How do you know that doctors or nurses are satisfied with using this new technology?

1.14 If doctors or nurses aren't satisfied with using this new technology, how do they do and how do you solve this problem?

1.15 How satisfied are the parents using Telemedicine or virtual hospital application?

1.16 How many new technologies do this hospital adopt before and during Covid-19?

1.17 When do this hospital change from writing a report on the paper to typing it on the computer and do the doctors complain about this changing?

1.18 Which new technologies are mainly use in this hospital?

1.19 When does this hospital start to use Telemedicine and why they decided to use this technology?

1.20 Does this hospital utilize AI technology? And why they decided to use this technology and when they starting to use it?

- This question will ask to understand how the doctors, nurses and patients feel when they are using new technology.

2. Specific question will ask the head of the department and nurses who work in different department and use different type of new technology.

2.1 The reason for implementing a Robotic-assisted walking in your hospital?

2.2 What new technologies are utilized in the Rehabilitation center?

2.3 Is after-sale service necessary when you decide to purchase a new technology?

2.4 In the future nearby, do you have any plan to adopt more new technologies in your department?

2.5 Is the AI technology necessary for the Rehabilitation center?

2.6 Do you know the reason why the head of this department tried to stop the AI project?

2.7 Do you think Covid-19 force your hospital to adopt new technology? And do you think Covid-19 is the main factor?

2.8 Does this hospital utilize surgery robot or any type of robotics?

Section C Tentative Outline for the Case Study Report

The original collected qualitative data will codified and iteratively compare regarding to the researcher guiding framework and topic. The guiding framework be divided into seven such as awareness, change attitude, behavior, interest and learn more about new technology. Moreover, evaluate and compare, purchase and then actual use. These finding will be applied to other private hospital.

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