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A Foresight Study on Smart Healthcare in Hospitals in Klang, Selangor

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Abstract: Smart healthcare is when the patients are treated with digital medical equipments filled with Internet of Medical Things (IoMT). Recently, worsening trends like slowing rates of improvement can be linked to significant gaps in screening and treatment for NCDs (non-communicable diseases) such as hypertension and diabetes mellitus and the rising rates of key risk factors that can be expected to lead to future increases in NCDs in Malaysia. The research objectives are to identify the influencing factors and the impact and uncertainty by implementing smart healthcare in hospitals in Klang, Selangor for the next 10-15 years. Quantitative method and STEEPV analysis are used to conduct the study. Result shows that technology has the highest number of key drivers. Questionnaires and statistical analysis were used to identify the two top drivers which are quality of health services and government's responsibility.

Keywords: Smart healthcare, Patients, Diseases, Hospitals

1. Introduction

The definition of smart healthcare is that it consists of various participants such as doctors, patients, hospitals and research institutions. It is a whole system that involves various dimensions like disease prevention and monitoring, diagnosis and treatment, hospital management, health decision-making and medical researches (Tian *et al.*, 2019).

Healthcare is the preservation or improvement of health through prevention, diagnosis, treatment or cure of disease in a human being. Healthcare is done by health professionals in medical fields. They are normally called as medical officers, doctors and surgeons. In this 21st century, healthcare has been improvised and developed using IoT.

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Internet of Things (IoT) is a system which consist of interrelated computing devices that are provided with the ability to transfer data or any information over a network without requiring human-to-human or human-to-computer interaction. This system is being applied everywhere these days. There is consumer application (smart home, elder care), commercial application (medical & healthcare) and transportation (smart traffic control, electronic toll collection) (Broadband Comission, 2017).

1.1 Research Background

In the medical & healthcare industry, IoT is known as Internet of Medical Things (IoMT) or smart healthcare. Smart healthcare is when the patients are treated with digital medical equipments filled with IoMT like 3D-printing prosthetics, blood pressure monitor, heart rate monitor and smart beds. They come with the emergency notification system and also remote to control the health monitor when it is needed. Smart beds can detect movement when a patient moves on the bed. It can adjust itself to make sure sufficient pressure and support is applied on the patient without the assistance of the nurses. These facilities are provided in most of the hospitals in Malaysia. (Chaudhury, 2017)

Smart healthcare was initiated from the concept of "Smart Planet" proposed by IBM in 2009. Smart Planet is an intelligent infrastructure that uses sensors to receive information, transmits information through the Internet of Things (IoT) and processes the information using super computers and cloud computing. Smart healthcare is a health service system that uses technology such as wearable devices, IoT and internet to access information, connect people and many more in an intelligent manner. In conclusion, smart healthcare is a higher stage of information construction in the medical field (Armonk, 2009).

1.2 Problem Statements

With the development of engineering technology and industrialization especially in the medical field, there are massive changes in the lifestyle of people in the urban cities. Therefore, there is also more chances of people falling in sick. The lifestyle of people in urban areas with the increasing volume of population is influenced by different application and administration of work (Rath and Pattanayak, 2019).

These are affecting the human health system up to an extended extent and there are more health-related problems and health hazard identified in the urban areas (Rath and Pattanayak, 2019).

However, according to Dr Milton Lum (2019) these worsening trends can be linked to significant gaps in screening and treatment for NCDs (non-communicable diseases) such as hypertension, diabetes mellitus and hypercholesterolemia, and in addressing rising rates of key risk factors that can be expected to lead to future increases in NCDs in Malaysia.

One of the steps taken is, Malaysia has signed a Memorandum of Understanding (MoU) between Collaborative Research in Engineering, Science and Technology (CREST) and academia initiative with Ministry of Health (MOH) to accelerate the development of the digital healthcare landscape in Malaysia.

Overall, Malaysia is on the right track to embrace IR 4.0 with the healthcare sector as the main component (Loh, 2019).

1.3 Research Questions

(i) What are the influencing factors of implementing smart healthcare using STEEPV method in hospitals in Klang, Selangor?
(ii) What are the consequences due to implementing smart healthcare in hospitals in Klang, Selangor?

1.4 Research Objective

(i) To identify the influencing factors of implementing smart healthcare using STEEPV method in hospitals in Klang, Selangor.
(ii) To discover the consequences due to implementing smart healthcare in hospitals in Klang, Selangor.

2. Research Methodology

2.1 Research Design

The research design is to provide a framework for the study that is being researched. A decision in the research design process is the choice to be made regarding the research approach since it determines how relevant information for a study will be obtained. However, the research design process involves many interrelated decisions (Kaasu Jilcha Sileyew, 2019). According to Mohajan (2017), the qualitative and quantitative research design are used in this research such as STEEPV analysis and survey questionnaire approach.

2.2 Research Process

A foresight process can be organized and implemented in various ways. The context should be included the overall decision-making or political process of which the foresight process and its results are a part. The goal of the foresight is to find out the perspectives of the future not to predict the future. (Andersen and Rasmussen, 2014). A foresight survey enables to provide the people with the future opportunities and needs. There are three phases in foresight processes which is diagnosis, prognosis and prescription.

2.3 Population, Sample Size and Sampling Technique

The target population in this research is the patients, medical officers and the civil people who uses the services provided in hospitals from Klang valley. Figure 1 shows the total population of Klang valley according to Department of Statistic Malaysia (2020). The sample size is 384 people (Krejcie and Morgan, 1970).

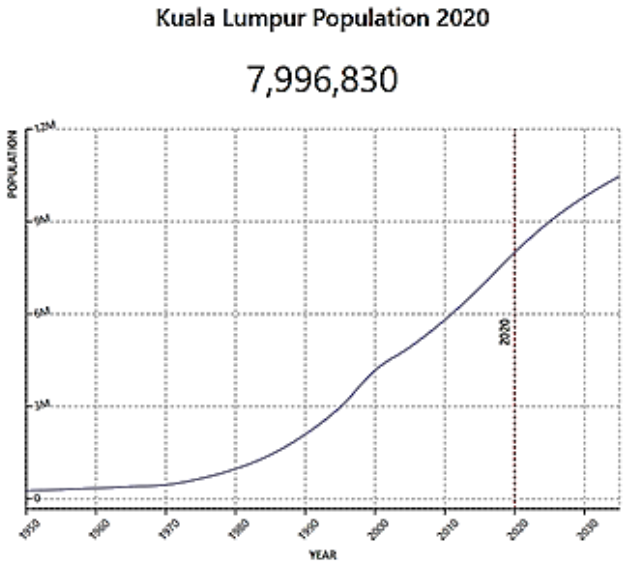

Figure 1: Number of population in Klang Valley (2020)

Convenience sampling is the sampling technique used in this research. It is a type of non-probability sampling that involves sample being taken from a certain part of the population that is close which is the people from Klang valley.

2.4 Foresight Process

The goal of the foresight is to find out the perspectives of the future not to predict the future. (Andersen and Rasmussen, 2014) The foresight tools used in this study is horizon scanning and STEEPV method.

(a) STEEPV Method

Based on Gianluca Bailey (2014), STEEPV method is a kind of brainstorming tool. STEEPV stands for Social, Technological, Economic Environmental, Political and Values. It is used for discussions about drivers and trends of the future. Besides that, STEEPV method is also a type of content analysis which is used by referring to journals, books and newspapers.

2.5 Research Instrument and Procedure

Questionnaire is used as the research instrument in this study. Section A consist of demographics information and background information of the respondents. The set of questions are such as gender, age, type of user, qualification and work experiences. Section B consists of questions that need respondents' view on the influencing factors of drivers which impact the implementation of smart healthcare in hospitals in Klang, Selangor. Then, Section C and D also consist of set of questions for the respondents to answer on the impact & uncertainty of the following factors on implementation of smart healthcare in hospitals in Klang, Selangor. Section B, Section C and Section D is determined by using five-point Likert scale. Table 1 shows an example of five-point likert scale.

Table 1: Example of five-point likert scale

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2.6 Data Analysis

Data analysis is the process of analyzing the data by using statistical and logical tool such as descriptive analysis, impact-uncertainty analysis and scenario analysis.

(a) Descriptive Analysis

Description analysis contributes a knowledge base as a foundation to further quantitative analysis (Baha, 2016). This analysis is utilized to describe variables and characteristics. Besides that, description analysis helps the researcher to simplify many data in an effective way during the research.

(b) Impact-Uncertainty Analysis

Impact-uncertainty analysis will be used to determine the higher level of uncertain and the most impactful of drivers. In this research, the key driver is obtained from descriptive analysis. Then, the key drivers are listed and analysed by using impact-uncertainty analysis to determine the influencing factors and the impact and uncertainty of implementing smart healthcare in hospitals in Klang, Selangor.

(c) Scenario Analysis

Scenario analysis is used to explore possible future. The role of scenario analysis views about the system operating under uncertainty and generate the recommendation towards the system. In this research, the top two key drivers were selected to build four alternative scenarios. It reflects the future trend and potential consequences of implementing smart healthcare in hospitals. The recommendations were proposed for sustainability of smart healthcare in hospitals regarding the positive and negative consequences.

3. Literature Review

3.1 Smart Healthcare Adoption

Smart healthcare is originated from the concept "Smart Planet" proposed by IBM (Armonk, NY, USA) in 2009. Smart Planet is an intelligent infrastructure that uses sensors to perceive information, transmits information through the Internet of Things (IoT) and processes the information using supercomputers and cloud computing. It can coordinate social systems and integrate them to realize the dynamic and refined management of the human society.

Smart healthcare is a health service system that uses high technology such as wearable devices, IoT, and mobile internet to directly access information, connect people, materials and institutions related to healthcare. Smart healthcare also promotes interaction between all parties in the healthcare field to ensure the participants get the services they need (Peng *et al.*, 2019).

3.2 Smart Healthcare Adoption in Hospitals

Smart healthcare consists of multiple participants such as doctors and patients, hospitals and research institutions. It involves multiple dimensions including disease prevention and monitoring, diagnosis and treatment, hospital management, health decision making and medical research. The applications of smart healthcare are assisting diagnosis and treatment, health management, disease prevention and risk monitoring, virtual assistants and assisting drug research (Wang *et al*., 2019).

3.3 Advantages of Smart Healthcare in Hospitals

Table 2 shows the advantages of smart healthcare.

Table 2: Advantages of smart healthcare

	Advantages
1.	Smooth hospital experiences
2.	Reduced error rates – Better patient care
3.	Efficient time usage
4.	Improved communication and better extended care
5.	Better safety and security

3.4 Disadvantages of Smart Healthcare

Table 3 shows the disadvantages of smart healthcare

Table 3: Disadvantages of smart healthcare

	Disadvantages
1.	Privacy can be potentially at risk
2.	Unauthorized access to centralization
3.	Global healthcare regulations

3.5 Identification of Issues and Drivers

STEEPV analysis is used to identify the key drivers and issues which is related to the implementation of smart healthcare in hospitals. The issues and key drivers are classified into six categories which is social, technological, economical, environment, political and values. This will give a clear view of the issues and key drivers of the research.

3.6 Merging Issues and Drivers

Table 4 is about the merged issues and key drivers that has been tabulated.

Table 4: Merged issues and key drivers

No.	Key Term
1	Interaction between patient and healthcare worker increases through having the system for monitoring the medical patients.
2	Internet of Things (IoT) increases the quality of health monitoring, consultation and prescription for patients.
3	Information and communication technologies (ICT) enhances the management of keeping health records of the patients.
4	Smart health system makes better decisions and improves healthcare.
5	RFID technology increases the efficiency and safety in the management of the transfusion process.
6.	Wearable devices are cost effective in an IoT environment.
7.	Healthcare technologies saves cost, expenditure and stress for patients.
8.	Utilization of medical devices leads to environmental emissions.
9.	Nurses (healthcare providers) face job difficulties and higher work demands.
10.	Guaranteed healthcare for the sick is government's responsibility.
11.	Privacy on patients' health data is compromised.
12.	Knowledge of utilizing the health electronic tools are essential for healthcare providers.

4. Results and Discussions

The data collection results that have been collected from the respondents which are among medical officers and patients that have been to hospital to receive treatment. The data from the questionnaire is analyzed by using Statistical Package for Social Sciences (SPSS) and impact-uncertainty analysis is constructed after the data has been analyzed. Descriptive analysis is used to analyze the data. The findings are divided into four parts which are demographic of respondents, the influencing factors of drivers which impact the Implementation of Smart Healthcare in Hospitals in Klang, Selangor, the impact of the following factors on Implementation of Smart Healthcare in Hospitals in Klang, Selangor and the uncertainty of the following factors on Implementation of Smart Healthcare in Hospitals in Klang, Selangor.

4.1 Reliability Analysis

Reliability refers to the consistency of a research study (McLeod, 2007) and reliability analysis refers to the extent to which a scale produces consistent results (Armor, 1974). Cronbach's Alpha is used to provide a measure of the internal consistency of a test or scale and it was created by Lee Cronbach in 1951 that can be expressed as a number between 0 and 1 (Tavakol and Dennick, 2011). Table 5 shows the internal consistency of reliability coefficient.

Table 5: Internal consistency using Cronbach's Alpha (Tavakol and Dennick, 2011)

Cronbach's Alpha	Internal Consistency
$\alpha \geq 9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

(a) Reliability for Pilot Test

Table 6 shows the reliability statistic for pilot test.

Table 6: Reliability statistics for pilot test

Reliability Statistics	
Cronbach's Alpha (α)	Number of Items, N
0.955	30

Based on the table above, the Cronbach's Alpha for the reliability statistic of pilot test is 0.955. The number of respondents involved for pilot test is 30. The value of Cronbach's Alpha is 0.955 which proved that the data collected was reliable to be used in this research.

(b) Reliability for Actual Study

Table 7 shows the reliability statistics for actual study.

Table 7: Reliability statistics for actual study

Reliability Statistics	
Cronbach's Alpha (α)	Number of Items, N
0.892	200

Based on the table above, the Cronbach's Alpha for the reliability statistic actual study is 0.892. The number of respondents involved in this research was 200. The value of Cronbach's Alpha is 0.892 which proved that the data collected was reliable to be used in this research.

4.2 Response Rate

Table 8 shows the response rate of the respondents.

Table 8: Response rate

Sample Size	Total Respondents	Response Rate (%)
384	200	52.08

Based on the Table 8, the sample size of this research is 384. However, the total of respondents that participated in this research was only 200. Therefore, the response rate for this research is 52.08%.

4.3 Demographic Analysis

This part consists of the demographic of respondents which are gender, age, type of user, working experience and qualifications. Table 9 shows the summarization of respondents' demographic.

Table 9: Summarization of respondents' demographic

No.	Items	Category	Frequency	Percentage (%)
1.	Gender	Male	96	48
		Female	104	52
2.	Age	17 – 20	10	5
		21 – 30	41	20.5
		31 – 40	97	48.5
		41 – 50	42	21
		51 and above	10	5
3.	Type of User	Medical	13	6.5
		Officers	41	20.5
		Government	132	66
		Officials	14	7
		Civil People		
		Students		
4.	Working	< 3 years	17	8.5
	Experience	3–5 years	85	42.5
		6-8 years	38	19
		> 8 years	60	30
5.	Qualifications	SPM	13	6.5
		Diploma	30	15
		Degree	113	56.5
		MSc	30	15
		PhD	14	7

The majority of the respondents were female with the highest percentage which is 52% followed by 48% that represents male. In total of 200 respondents, there are 104 female respondents and 96 male respondents. Moreover, the highest frequency of respondents is aged from 31-40 which is 97 (48.5%). Respondents aged from 41-50 consists of 42 with 21%. Then, respondents aged from 21-30 consists of 41 with 20.5%. The least recorded for age factor is 17-20 and 51 and above which is 10 (5%) for both individually. Other than that, the type of user is divided into medical officers, government officials, civil people and students. This is because, these people tend to receive healthcare service for any reason regardless of age. The highest frequency recorded is by civil people which is 132 (66%). Then comes with government officials with 41 at 20.5% followed by students with 14 at 7%. Lastly, medical officers recorded a frequency of 13 with 6.5%. Respondents in this research mostly have 3-5 years of working experience, 85 (42.5%). Meanwhile, respondents of more than 8 years recorded with 60 at 30%. Then, 6-8 years with the frequency of 38 (19%). The least was less than 3 years which is at 17 (8.5%). Majority respondents have degree qualification that is 113 with 56.5%. Diploma and MSc have the same frequency which is 30 (15%). PhD with the frequency of 14 at 7%. Lastly, SPM with frequency of 13 at 6.5%.

4.4 Influencing Factors

The mean of the factors that influence the implementation of smart healthcare in hospitals in Klang, Selangor is obtained from the data collection. The data was analyzed using Statistical Package for Social Sciences (SPSS).

Table 10: Mean of the factors that influences the implementation of smart healthcare in Hospitals in Klang, Selangor

No.	Factors Influences	Mean
1	Health data of the patients can be breached.	4.6150
2	The quality of health monitoring, consultation and prescription can be enhanced with the presence of Internet of Things (IoT).	4.5950
3	It is governments' responsibility to provide healthcare for the sick.	4.5850
4	Implementation of smart healthcare gives job difficulties and higher work demands for healthcare providers.	4.5750
5	Information, communication & technology (ICT) helps to keep the health records of the patients safely.	4.5550
6	Technologies in healthcare can save cost, expenditure and stress for patients.	4.5100
7	More usage of smart medical devices can harm the environment.	4.5000
8	Usage of wearable devices in hospitals are effective.	4.4700
9	Installation of RFID technology can increase the efficiency of management process.	4.4500
10	Smart healthcare system increases the interaction between patient and healthcare worker.	4.3400

Based on Table 10, it shows the mean of the factor that influences the Implementation of Smart Healthcare in Hospitals in Klang, Selangor. The highest factor that influences the implementation of smart healthcare is health data of the patients can be breached with the mean 4.6150. The lowest mean recorded was 4.3400 that is smart healthcare system increases the interaction between patient and healthcare worker.

4.5 Impact-Uncertainty

Table 11 shows the mean of the factors on the impact and uncertainty that influences the Implementation of Smart Healthcare in Hospitals in Klang, Selangor.

Table 11: The factors on the impact and uncertainty that influences the implementation of smart healthcare in Hospitals in Klang, Selangor

No.	Factors	Mean	
		Impact	Uncertainty
1	Smart healthcare system increases the interaction between patient and healthcare worker.	4.2800	2.3150
2	The quality of health monitoring, consultation and prescription can be enhanced with the presence of Internet of Things (IoT).	4.4350	2.2550
3	Information, communication & technology (ICT) helps to keep the health records of the patients safely.	4.4000	2.2700
4	Installation of RFID technology can increase the efficiency of management process.	4.3400	2.3250
5	Usage of wearable devices in hospitals are effective.	4.3350	2.2450
6	Technologies in healthcare can save cost, expenditure and stress for patients.	4.3750	2.1950
7	More usage of smart medical devices can harm the environment.	4.3950	2.1800

8	Implementation of smart healthcare gives job difficulties and higher work demands for healthcare providers.	4.4050	2.1900
9	It is governments' responsibility to provide healthcare for the sick.	4.4800	2.2100
10	Health data of the patients can be breached.	4.4300	2.1950

According to Table 11, the highest mean for the impact is it is governments' responsibility to provide healthcare for the sick with the mean 4.4800. Then, the second highest impact is the quality of health monitoring, consultation and prescription can be enhanced with the presence of Internet of Things (IoT) with the mean 4.4350. The third highest mean is 4.4300 which was health data of the patients can be breached. The lowest mean recorded by impact is 4.2800 which was smart healthcare system increases the interaction between patient and healthcare worker.

Other than that, the highest mean recorded for uncertainty is 2.3250 for installation of RFID technology can increase the efficiency of management process. The second highest mean recoded is 2.3150 for smart healthcare system increases the interaction between patient and healthcare worker. While, the third highest uncertainty is information, communication & technology (ICT) helps to keep the health records of the patients safely with the mean 2.2700. The lowest uncertainty is more usage of smart medical devices can harm the environment with mean of 2.1800. Figure 2 shows the impact and uncertainty graph.

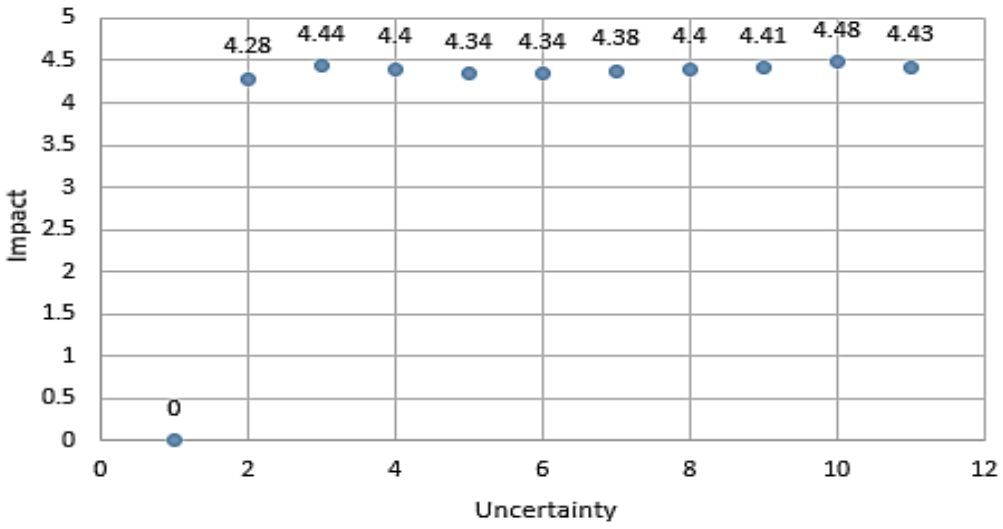

Figure 2: Impact – uncertainty analysis

Figure 2 is formulated by using scatter diagram by using the obtained mean values for the impact and uncertainty. This diagram is constructed to discover the highest factors in this research. Based on Figure 2, the two factors are the quality of health monitoring, consultation and prescription can be enhanced with the presence of Internet of Things (IoT) and it is governments' responsibility to provide healthcare for the sick with the coordinates (2.2550,4.4350) and (2.2100, 4.4800) respectively. These two factors are the top factors and will be used to generate the scenario writing analysis.

5. Discussion

5.1 First Research Objective

The first research objective is to identify the influencing factors of implementing smart healthcare using STEEPV method in hospitals in Klang, Selangor. This objective is achieved by using STEEPV analysis. Based on Table 3.4 in Chapter 3, the technology factor is the most important driver in implementing smart healthcare in hospitals with 36 drivers followed by economic (10 drivers), political (8 drivers), values (5 values), environmental and social with 4 drivers respectively.

5.2 Second Research Objective

The second research objective is to discover the consequences faced by implementing smart healthcare in hospitals in Klang, Selangor. The top factors have been identified and it will be used to develop matrix scenario. These four scenarios will give an insight and overview to four various possibilities that might occur in the next 10 years.

5.3 Development of 2×2 Matrix Scenario

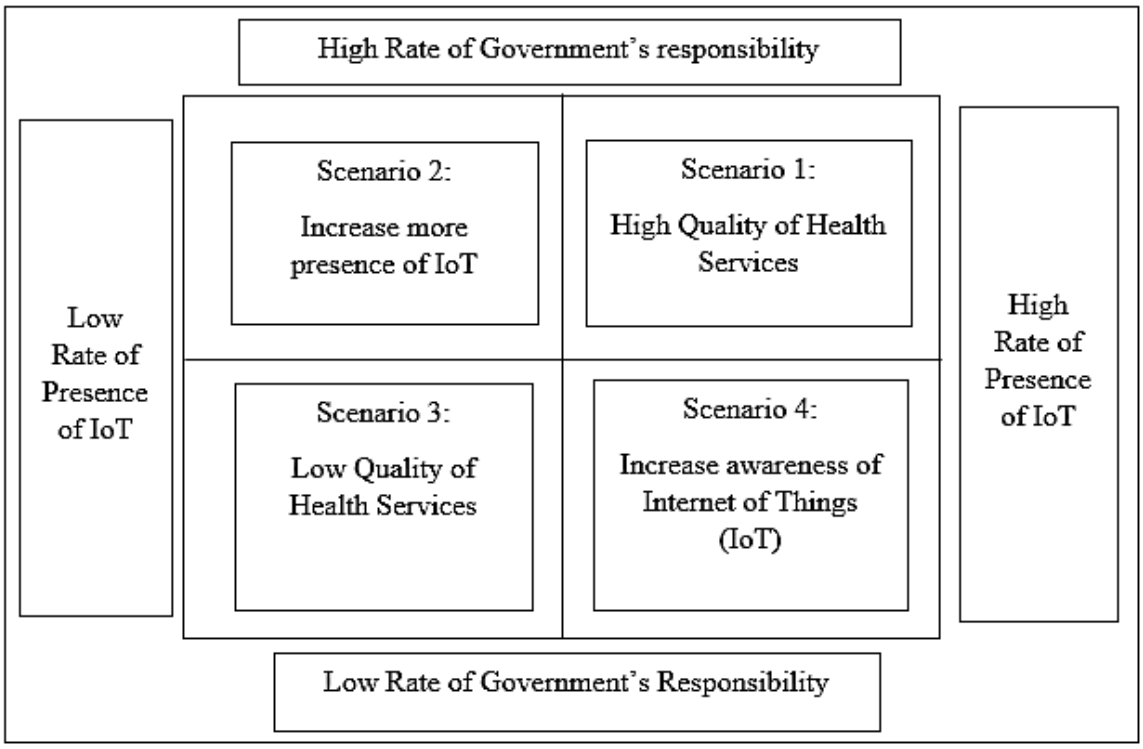

Figure 3: Matrix scenario

(a) High Quality of Health Services

Based on Figure 3 above, if the government's responsibility and the presence of IoT increases, the quality of health services will also increase.

According to WHO website, it has been estimated that high quality health systems could prevent 2.5 million deaths from cardiovascular disease, 900 000 deaths from tuberculosis, 1 million new born deaths and half of all maternal deaths each year (WHO, 2020). Moreover, it also says that the essential structures for achieving quality health care are inadequate: one in 8 health care facilities has no water service, one in 5 has no sanitation service, and one in 6 has no hand hygiene facilities at the points of care.

An estimated 1.8 billion people, or 24% of the world's population, live in fragile contexts that are challenged in delivering quality essential health services. A large proportion of preventable maternal, childhood and neonatal deaths occur in these settings (WHO, 2020).

Internet of Things (IoT) plays a crucial role in developing the quality of health services. According to Yap Sy Yuan (2019), it delivers a range of health products and services from telemedicine to self-diagnosis and monitoring which results in reduce cost and becomes a major influence of driving the insurance company for IoT adoption.

(b) Increase more Presence of IoT

Due to high rate of government's responsibility and low rate of presence of IoT, more presence of IoT needs to be increased.

According to a recent research by Digiteum in 2020, 40% of IoT devices will be used in the healthcare industry, while today, the medical IoT has a 22% share of the whole IoT market.

More than 60% of medical organizations worldwide have started to implement IoT solutions in their medical services. The number of patients and medical professionals in healthcare using IoT-connected devices for health monitoring will grow by 44.4% every year in the upcoming years. It is proven that Internet of Things in healthcare can solve the problems that arises in medicine. It is guaranteed to give better results.

Other than that, according to i-scoop article, says that devices and IoT applications gets an increasing place in between consumer & patient and healthcare providers. Patients engagement with IoT really helps in monitoring their health in smartest and quickest way.

(c) Low Quality of Health Services

This scenario has low rate of government's responsibility and low rate of presence of IoT therefore, this leads in having low quality of health services.

To avoid this scenario to happen, the responsible parties needs to take action. The authority should get a better understanding of patients' medical records and the care needs. They should prepare advanced health system focused on modern treatment approach and healthcare delivery system design, prepare clinical information system to provide decision support, plan a well-structured ongoing care program designed by a multidisciplinary team and allocate a budget to provide more healthcare facilities in hospitals (Aniket, 2020).

When all authorities come together, hospitals in Malaysia will be able to create awareness and opportunities to people in getting better quality treatments.

(d) Increase awareness of Internet of Things (IoT)

In this scenario, government's responsibility is low while, presence of IoT is high. Therefore, this issue can be overcome by increasing the awareness of Internet of Things (IoT).

According to a research done by Trend Micro, conducted by Vanson Bourne, shows that they have found 86% of their respondents believe their organization needs to improve its awareness of IoT threats. The weakest link is known to be human. Human challenges and password-related were among the risks about the plant floor and human-machine interface systems.

It should be emphasized by addressing them preferably in more holistic and collaborative way. Furthermore, the best practices and tools of security must be implemented. Trend Micro also

recommends a strong network defense approach to ensure IoT devices do not add security risk in any part of a corporate network.

5.4 Conclusion

Overall, this research is about the implementation of smart healthcare that will provide the foresight of smart healthcare trend in Selangor, Malaysia for the upcoming years. This research will also provide some contribution in addition of the knowledge of this subject to everyone all around the world. In a nutshell, all parties such as governments, healthcare providers and consumers must put their efforts in order to improve and make smart healthcare to be fully implemented in Malaysia.

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