Demand of Innovative Services on a Computed Tomography Scan

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Abstract. This paper seeks to investigate the needs of service, innovative Mobile Computed Tomography (CT) Scan service, from the leading level of Neurosurgeon in Bangkok, Thailand. The research is proposed investigating Neurosurgeon's expectations for Mobile CT Scan and current problems of CT scan operating. This is a survey research approach, performing in-depth interview which collected data from 21 Neurosurgeons, 12 hospitals in Bangkok and surrounding areas. Due to the number of samples limited, the descriptive statistics were used to analyze the data. The research address two research questions: According to the first research question, the authors' findings that most of Neurosurgeon need to use Mobile CT Scan at Operation Room (OR), Intensive Care Unit (ICU), and Emergency Room (ER), respectively. Regarding the second research question, the authors' analysis reveals purposes and found the current problems that when Neurosurgeon use CT Scan they faced low resolution and slice, moving unstable patients, wriggle patients, and Claustrophobia patients. Therefore, what are the findings of the survey are very useful in the design of new services for Mobile CT Scan to work in the next step.

1 Introduction

Presently, medical science has made great progress on surgery to correct a defect in the skull, face and jaws as well as in Surgery, Orthopaedic and Dental. They use rapid prototyping technology which consist of Computed Tomography (CT) and Medical imaging to make 3D medical model for diagnosis and treatment plan prior to surgery along with design and build implant materials by using basic medical imaging. Compared to the old tricks, Neurosurgeon use only basic medical imaging for surgery plan and implant forged by hand in the operation room after wound opened, its shown that 3D rapid prototyping technology increase the quality and safety of the surgery treatment substantially. Moreover, it also reduce surgery time and risk that occurred in patients which improves quality of Thai patients' life and bring the life as usual to them.

Computed Tomography is mainly to detect abnormalities of organs in the body by X-ray beam through the organ in vertical transversal that needs examination then create medical images. CT scan is divided into 4 systems, brain, abdomen and chest, bone muscles joints and spine, and vascular system. As a result, with a special display of vertical transversal image from CT scan combined with the present (2015) Thailand has only 2 mobile CT scan and hospitals do not allow others to use it, they have less utilization. Accordingly, National Metals and Materials Technology Center (MTEC) is interesting to study and develop a smaller and movable

CT scan which using cone beam technology instead of fan beam technology that most manufacturers widely used today. Since, the cone beam is one more compact, cheaper and lower dose, although the quality of the images coming out is still not equivalent fan beam, but it is likely to develop the area and can be used as a tool to help diagnose correctly. Thus, MTEC has built up this machine, which is cheaper by almost half, to support and disseminate CT and medical imaging technology available in every hospital in the country.

This research focus on finding the need has not been met (unmet needs) by the user then the author has led to the design of new services in response to the new format or develop a difference services to be comfortable and able to meet the unmet needs. In addition, the research also specific considered in the diagnostic vascular system, since the increasing rate of patients starting from 2004 to 2008 that reported by Bureau of Policy and Strategy office of the Permanent Secretary, Ministry of Public Health, Thailand, From figure 1, compared number of vascular system patients with other diseases, it can be seen that the percentage of 4-year average growth of vascular system, with an average of more than 20%, which is greater than the other three diseases. However, in addition to the author is interested in finding the unmet needs of the user, the author also believe that period of waiting for a CT scan is a barrier to diagnosis to treatment. Because it large and immobile so whether it is diagnosed brain, spine, abdominal, muscles, vascular, bone or small joint in the body, it must have been waiting

for this big machine. Therefore, to find unmet needs and proven authors' belief of objective above, it is necessary to continue to enhance the diagnosis and treatment of patients in Thailand by providing new service of mobile CT scan.

2 Background literature and research questions

2.1 Background literature

This research is a study of demand of innovative services On a Computed Tomography scan, so the literature review were necessary to study on current problems and theory that associated with the use CT scan today.

Problems were expected to arise from the use of CT scan was currently handling the treatment time in queues. In 2009, L. Siciliani et al. were studied in time to make the lowest overall cost which collected data from 137 hospitals in English National Health Service from 1998 to 2002 and found the level of anticipation that makes the lowest overall cost of hospital must not exceed 10 days. If not, the cost will increase as the process management increased. [2] In the same story, but change the view to the government policy of the Netherlands that deal with the problem of waiting time surgery. F. T. Schut and M. Varkevisser point that the government has started to use static control policy budget coupled with the ability to maintain the treatment in 1990, as a result, the waiting time of the patients dropped too much lower than other countries in the Organization for Economic Co-operation and Development (OECD). In 2001, afterwards, the government has changed the hospital financial from static control policy budget to Activity-based funding and during the year 2000-2006, with a competition between hospitals and more severe, the period of waiting for surgery even drop further. Finally, in 2011 in the Netherlands, it can shorten the waiting time for surgery shortened to no more than 5 weeks, so today government does not have to care about controlling the period of waiting longer, but to turn to the subject of price competition in the provision of hospital services in line with the state health insurance for future development plans. [3]

When looking deeper into the matter of reducing the cost of the hospital. There was also research that studies the management of patient care from primary or first aid in England by a cross-sectional study in patients 5 million from the 8,000 actual of 10 chronic disease through patient records, data treatment, and logs that can reduce the cost of hospital or not. The results of the study found, first aid that was made in the ambulance or in the emergency medical service would be able to contribute to the cost of hospital reduced, because this could reduce the number of emergency patients and patients with clinical symptoms of acute disease were down by more than the treatment of patients with lower prices or patient selection for admission to the hospital. [4]

Review of the literature mentioned, researchers saw a gap in the research of queue management of patients that will contribute to reducing the cost of hospital down. The

literature review related to queuing theory in the healthcare system of more than 40 articles, will have overall management system that queuing was necessary to consider the three parts together. The first part of the design of the health care that the ambulance unit in the hospital and pharmaceutical division, the second part was about the management system that deals with the allocation of resources and priorities patient, the last was part three as a matter of analyzing the health care system by reducing cost, the ability to queue, and manage time efficiently queues. [5, 6]

In a matter of prioritizing patients, 1952, N.T.J. Bailey has proposed that variable to measure the performance of patients in the grading system was a period of time to get appointments and counseling, rather than finding a balance between long queues of patients with spare time consultant. By ratio time lost all patients have equal time to the counsel of advisors which refers to the period of consultation to coincide with the patient, the second to arrive. [7] Afterward, 1991, M. Brahimi and D.J. Worthington have designed a patients grading system that could reduce the number of patients in the queue at any time while reducing the waiting period of patients without increasing the physician's time. [8] In 2005, on the part of the Department of Radiation Oncology at close to the research being conducted there, S.S. Vasanawala and T.S. Desser in the Radiotherapy Department, typically it would be analyzed radiology daily schedule already but every day of work, it would have an emergency that requires the table to a new analysis by the importance and urgency of the case. Therefore, the use of queuing theory to calculate the probability of the table daily analysis and the results show that there will be free time was about 1%-5% of the daily schedule analysis in order to receive emergency to be analyzed and not make the same analysis table was corrupted or must defer to the analysis [9].
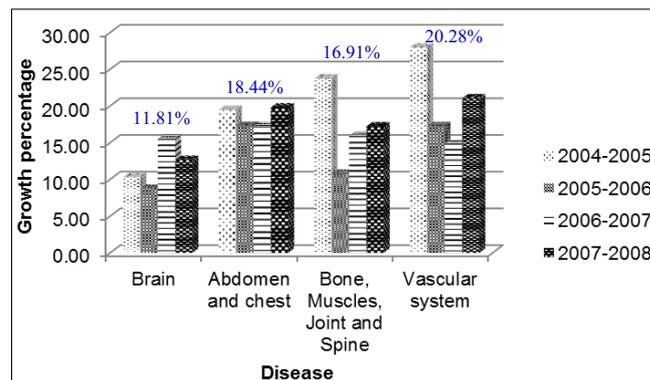

Figure 1. To compared number of vascular system patients with other diseases starting from 2004 to 2008 that reported by Bureau of Policy and Strategy office of the Permanent Secretary, Ministry of Public Health, Thailand [1].

Review of the literature on the theory of queuing in the healthcare system in terms of grading the patients, it was seen that most articles have shown a relationship in the long queues that would be able to contribute to the cost of the hospital, but did not find the article about how long the queues that will affect the effectiveness of

patient treatment with the focus on bringing people into the engine or engines were adopting the approach. Therefore, it was one of the research gaps and see what the point in further studies.

2.2 Research questions

1. What are the needs of the services from CT scan to stroke patients in the hospital network in Bangkok?
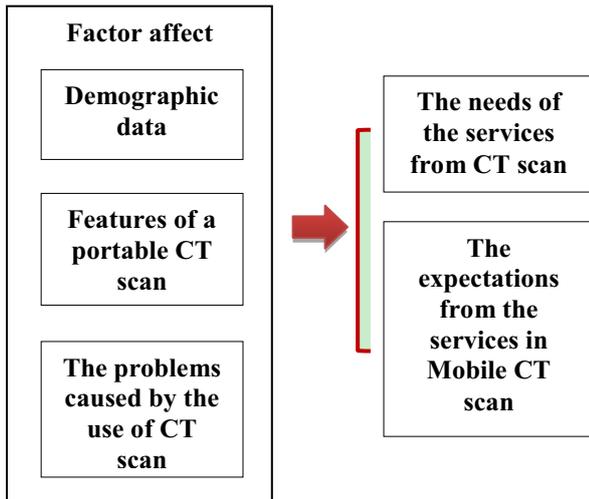2. What are the expectations in Mobile CT scan when new service implemented in the hospital network in Bangkok?

Figure 2. Conceptual framework for the study.

3 Methodology

The research "Demand of innovative services on a Computed Tomography scan" was a survey research by means of collecting data using the in-depth interview with the method as conceptual framework is presented in figure 2.

3.1 Population and sample

The population in this research was a Neurosurgeon at participating centres of excellence in computer applications for Biomedical Engineering (Phase1: The National Centre of Excellence), the project was finished in the year 2007, which all came from hospitals in the area of Bangkok. The sampling method as follows:

The selection of the sample. The Non-Probability Sampling along with Purposive Sampling were used in this study, since the researchers studied the CT scan machine with a Neurosurgical physician, Physicians Nervous system, Medical diagnostic and Radiology residency. However, researchers interested in specific Neurosurgical physician because the doctors group that was active most CT scan machine.

Due to the study use the Non-Probability Sampling along with Purposive Sampling and the researchers want to study a particular group that the population in this research was a Neurosurgeon which the Report on Public Health Resource in the year 2014 that reported by Bureau

of Policy and Strategy, Permanent Secretary Offices, Ministry of Public Health shown that Thailand has a total of 343 Neurosurgical Medical Group physicians. Because of this study, the researchers chose to study in Bangkok area which was reported that 110 doctors were in Bangkok. [10] Moreover, with access to information and the person may hinder the collection of information, the researchers have to use the connection with a research project in centres of excellence in computer applications for Biomedical Engineering with a population of 39 doctors in the project. Therefore, the study population was selected to implement on 39 doctors as mentioned above. However, the major drawback of this research was that the researchers have tried to contact and approach the doctor difficulty before they accept the interview arrangement. Finally, the researchers got an appointment for the in-depth interview with 21 people, response rate at 53.85%, and about the determine how to collect data in this study, the researchers collected primary data from in-depth interview by themselves.

3.2 The variables used in research

3.2.1 Independent variable

This including demographic characteristics (gender, age, education, job, and years of service), this was the first organization to work, under the hospital, and the current problems caused by the use of CT scanning of stroke patients.

3.2.2 Dependent variable

- The service acceptance of a small and movable CT scan of physicians in the hospitals. (Ordinal scale)
- The expectations from the services of a small and movable CT scan to a network hospital in Bangkok. (Interval scale)

3.3 The instrument used in research

The instrument used for data collection was attachment interview, which the researchers developed the attachment based on the research in the past along with the accepted theory of consumer-related services in the hospital that can be divided into five parts. [11-14]

3.3.1 Demographic data

It was referred to overview of the respondents with 3 models was questioned, Close-ended response question, Multiple choice question, and Dichotomous question.

3.3.2 Factors affecting the service acceptance of a small and movable CT scan of physicians in the hospital network in Bangkok

The factors included the acceptance of a consumer product or service four parts together, products and services, pricing, distribution, and promotion. The

researchers designed the attachment interview filled out the sequence by the respondents (Ranking question) and the respondents chose multiple answers (Checklist question).

3.3.3 The expectations from the services of a small and movable CT scan to a network hospital in Bangkok

The researcher has proposed that all 15 deals with a Likert scale.

3.3.4 Interest in the service

The researcher has designed the attachment interview that there were many answers to choose from (Multiple choice question) and the respondents to select multiple answers (Checklist question) mixed with Open-ended question.

3.3.5 The problems caused by the use of CT scan of patients with coronary artery disease from the hospital network in Bangkok

The researcher has designed the attachment interview style Open-ended question.

4 Finding and conclusion

4.1 Finding

From research "Demand of innovative services on a Computed Tomography scan" that used the attachment interview for in-depth interview to collect data directly from 21 Neurosurgeon in Bangkok area which there were issues that can be discussed below.

According to the data from five parts, the researchers chose to extract the needs of the services from CT scan and the expectations from the services in mobile CT scan which are presented in Table 1 and Table 2 in order to answer the research question as the two mentioned above.

Table 1. The result of the needs of the services from CT scan according to the in-depth interview.

Needs	Frequency	Percentage
Movable and easy to use.	17	80.95
Solve the problem of moving the patient unstable.	16	76.19
Have CT scan in OR, ICU and ER.	15	68.18
Have a lease CT scan.	11	52.38
Have CT scan in ambulance.	10	47.62
Have CT scan in country hospitals and public hospitals.	5	22.73

From Table 1, the demand trends of the needs of the services from CT scan were about movable and easy to use up to 81% and due to this core, other related

requirements were followed such as if CT scan can movable then it helps the hospitals to solve the problem of moving the patient unstable, it can be moved between Operating Room (OR), Intensive Care Unit (ICU) and Emergency Room (ER), moreover, it was also desirable to put them in the ambulance. About the lease CT scan, the respondents have shared the idea that the choice of two promotions, one-time purchase and leasing, were associated with the nature of each hospital, if the hospital has many surgical cases it also want to use CT scan in one-time purchase and installation was based at the hospital. And on the other hand, if the case surgery and patients who require CT scan was not much the hospital might to use the format for a time. Furthermore, depending on whether the unit to a large hospital in the city must attract executives or to the public or country hospitals must be priced no higher than at the hospital to pay as well.

Table 2. The result of the expectations were particularly from the services in Mobile CT scan according to the in-depth interview.

Expectations	Frequency	Percentage
In urgent situations, the doctor or nurse can make a decision to move mobile CT out of the examination room.	18	85.71
Scanned image does not exceed 5 minutes.	17	80.95
The effectiveness of diagnosis and treatment by a physician must be faster.	15	75.00
Nurse or medical technician can use the machine as it was under the control of the doctor.	14	66.67
Doctors can diagnose and symptoms faster.	16	76.19
No matter where can access to CT small portable.	9	52.94

As of the third part which have 15 optional to answer, the researchers have been extracted that information with conditions, the expectations were particularly from the services in Mobile CT scan according to the in-depth interview, are shown in Table 2. The expectations from the services of a small and movable CT scan to a network hospital in Bangkok, all through the analysis, it concluded that doctors have expectations the urgent situation a doctor or nurse can be moved CT scan outside the examination room for diagnosis, up to 86%, and the effectiveness of treatment by a physician must be faster, around 75%. With regards to the ability to read the results from CT scan has to be at least 5 minutes after the patient has photographed which was up to 81%. However, all three were expected to follow the researchers hypothesized. This was also what the researchers do not think the doctors know what to expect, but from the results of this study shown the nurse or medical technician can operate the machine itself was under the control of the doctor, which has 67% approximately. In

addition to the foregoing, it was evident that the issue of access at anywhere any time was also subject to the respondents to focus on more than 53%, since it reduced the rate of readmission of patients.

Table 3. The result of interest in the services from Mobile CT scan according to the in-depth interview.

Interest	Frequency	Percentage
Interested	18	85.71
Uncertain	3	14.29
Not interested	0	0

Table 3 shows data from the fourth part, interest in the services, it was found that although mobile CT scan was meet the doctors expected and medical attention, but since every doctor does not have the power to decide to order a medical device itself, so, if the research aims to provide the new service and innovation to physicians and patients that require the management of the hospital, the work requires planning and good marketing to offer and convince the management that benefit from the introduction of this system to improve the diagnosis and treatment. These data were the results of a study that supports physicians surveyed those were interested in this service up to 86%. Another case of Tele medicine services via mobile phones, it's not that it can help doctors decide on urgent cases faster. For that reason, some doctors do not make sure to use this machine, mobile CT scan, and the key finding of this research was not based on the assumption of the set before this study. Therefore, the result has to be studied further to get the answer correct and most suitable for future research.

Here are the problems caused by the use of CT scan of patients with coronary artery disease from the hospital network in Bangkok that got from the respondents' conversation, the analysis then showed, the research hypothesize that problems in the long queues of patients using CT scan was not a real problem after obtaining information from Neurosurgeon medical group. But the real problem, it was about to remove the patient from OR or ICU or ER to CT scan room in the hospital. It can be seen that, this conclusion was consistent with the needs in Table 1. Consequently, this is another point that researchers need to bring this issue to research information that is currently available to fix this or not, by any means and there are points that can be synthesized innovative services or innovative product or process innovation in the future.

4.2 Discussion and conclusion

As paper seeks to find unmet needs of the users, the leading level of Neurosurgeon in Bangkok, which collect data from 21 Neurosurgeons, 12 hospitals in Bangkok and surrounding areas. The methodology of data collection was in-depth interview and analysed by descriptive statistics. The research address two research questions, the first was what are the needs of the service from CT scan to stroke patients, the authors' finding that most of Neurosurgeon need to use mobile CT scan at the OR, ICU and ER, respectively. According to the second

research question, what are the expectations in mobile CT scan when new service implemented in the hospital?, the authors reveals and found the Neurosurgeons expect it can play a role in solving the current problems, low resolution and slice of current CT scan, hard to use it with moving unstable patients, wriggle patients and Claustrophobia patients, and the most important was unable to move it to elsewhere in hospital that all affect their treatment decision.

For that reason, the researchers want to solve the problem of low utilization of mobile CT scan in Thailand using mobile CT scan that MTEC has developed. In order to solve this problem, apart from increasing the number of mobile CT scan to meet the requirements of the job, in the first phase of the solution also requires management to allocate transportation schedule with the resources are limited, too. The researchers conducted this research in parallel with finding unmet need and get the results as described above then bring all data together and extracting to models and algorithms for scheduling which determine the timetable and the use of mobile CT scan in the hospital to meet the needs of medical users. This is likely to result in effective treatment and access to public services with mobile CT scan increasing as well.

References

1. Bureau of Policy and Strategy office of the Permanent Secretary. (2014, August 15). Retrieved from http://bps2.moph.go.th/
2. L. Siciliani, A. Stanciolec, R. Jacobs, J. Health Econ. **28**, 771–780 (2009)
3. F. T. Schut, M. Varkevisser, Health Policy **113(1-2)**, 127-133 (2013)
4. M. Dusheiko, H. Gravelle, S. Martin, N. Rice, P. C. Smith, J. Health Econ. **30**, 919– 932 (2011)
5. N.T.J. Bailey, Queueing for medical care, J R STAT SOC C-APPL. **3**, 137–145 (1954)
6. P. DeLaurentis, R. Kopach, R. Rardin, M. Lawley, K. Muthuraman, H. Wan, L. Ozsen, P. Intrevado, *IIE Annual Conference and Exposition*, 2006
7. N.T.J. Bailey, J R Stat Soc Series B. **14 (2)**, 185–199 (1952)
8. M. Brahimi, D.J. Worthington, J Oper Res Soc. **42**, 733–746 (1991)
9. S.S. Vasanawala, T.S. Desser, J. Radiol. **235**, 244– 249 (2005)
10. Bureau of Policy and Strategy office of the Permanent Secretary, *The Report on Public Health Resource in the year 2014* (Permanent Secretary Offices, Ministry of Public Health, 2014)
11. P. Kotler, *Marketing Management: Analysis, Planning, Implement, and Control* (9th ed., Prentice-Hall, Inc., 1997)
12. A. Chandrachai, *Business Excellence: Strategic planning and balance score card preparation guide* (13th ed.,Chulalongkorn University Press, 2012)
13. K. Vanichbuncha, *Statistic for research* (6th ed., Chulalongkorn University Press, 2012)
14. K. Vanichbuncha, *SPSS for Windows: Data analysis* (18th ed., Chulalongkorn University Press, 2011)