E-READINESS ASSESSMENT FOR BARCODE TECHNOLOGY IMPLEMENTATION IN PHARMACEUTICAL DEPARTMENT IN THAI HOSPITALS

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ABSTRACT

Thai hospitals are facing the problems of information exchange between parties in its supply chain, which is not efficient or accurate. Using barcode technology has helped to improve efficiency and eliminate human errors in various industries including manufacturing, retail, and agriculture. However, the application of barcode technology in hospital services has just been taken into consideration. Therefore, the objective of this research is to construct a guideline for e-readiness assessment of hospital operations to adopt barcode technology into Pharmaceutical Department. A total of thirty factors are classified into six dimensions including people, technology, process, organization, government, and hospital environment. A survey of one hundred and forty hospital staff at small and large size public hospitals, and private hospitals has been conducted in order to collect data. Once the data was collected, it was analyzed using fuzzy importance-performance analysis (Fuzzy-IPA) and the Readiness-Check program was developed to guide each hospital group. This research found that each hospital group focused differently on factors of immediately improvement and the allocation of sufficient resources towards being ready for barcode technology implementation.

KEY WORDS: E-READINESS / BARCODE TECHNOLOGY / FUZZY-IPA / THAI HOSPITALS

187 pages

การประเมิน E-READINESS สำหรับการใช้เทคโนโลยีบาร์โค้ดในฝ่ายเภสัชกรรมของ โรงพยาบาลในประเทศไทย

E-READINESS ASSESSMENT FOR BARCODE TECHNOLOGY IMPLEMENTATION IN PHARMACEUTICAL DEPARTMENT IN THAI HOSPITALS

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คณะกรรมการที่ปรึกษาวิทยานิพนธ์ : จิรพรรณ เลี่ยงโรคาพาธ , Ph.D., รณชัย ศิโรเวฐนุกูล , Ph.D., มงคล เทียนวิบูลย์, Ph.D.

บทคัดย่อ

โรงพยาบาลในประเทศไทยกำลังเผชิญกับปัญหาเรื่องการแลกเปลี่ยนข้อมูลระหว่างผู้ที่มีส่วนเกี่ยวข้องต่างๆ ในห่วงโซ่อุปทานที่ไม่มีประสิทธิภาพและ ความแม่นยำ อุตสาหกรรม ต่างๆ มีการนำเทคโนโลยีบาร์โค้ดไปใช้เพื่อปรับปรุงประสิทธิภาพและลดความผิดพลาดที่เกิดขึ้นจากมนุษย์ แต่อุตสาหกรรมโรงพยาบาลในประเทศไทยยังอยู่ระหว่างการพิจารณาการใช้เทคโนโลยีบาร์โค้ดในการให้บริการ วัตถุประสงค์ของงานวิจัยนี้คือการประเมิน E-readiness ของ โรงพยาบาล และเสนอแนวทางการปรับปรุงเพื่อการใช้เทคโนโลยีบาร์โค้ดในแผนกเภสัชกรรม สำหรับปัจจัยที่เกี่ยวข้องกับการประเมิน E-readiness มีทั้งหมด 30 ปัจจัยและสามารถจัดกลุ่มได้เป็น 6 กลุ่มด้วยกันได้แก่ บุคลากร เทคโนโลยี กระบวนการ องค์กร รัฐบาล และสิ่งแวดล้อม ของโรงพยาบาล จากนั้นได้ส่งแบบสอบถามไปยังบุคลากรของโรงพยาบาล 3 กลุ่ม ได้แก่ โรงพยาบาลของรัฐขนาดเล็ก และขนาดใหญ่ และโรงพยาบาลเอกชนทั้งหมด 140 ฉบับ แล้วนำ ข้อมูลที่เก็บรวบรวมได้ไป วิเคราะห์ด้วยวิธี fuzzy importance-performance analysis (Fuzzy-IPA) และพัฒนาโปรแกรม Readiness-Check ขึ้นเพื่อใช้เป็นแนวทาง ในการปรับปรุง โรงพยาบาลแต่ละ กลุ่ม ผลที่ได้จากงาน วิจัยนี้พบว่าโรงพยาบาลแต่ละกลุ่มให้ความสำคัญกับปัจจัยที่มีผลต่อการใช้เทคโนโลยีบาร์โค้ด และการจัดสรรทรัพยากรแตกต่างกัน

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CHAPTER I
INTRODUCTION

1.1 Background and statement of problems

Hospital supply chain (HSC) is the total process from suppliers to customers involves manufacturers, suppliers, hospitals, and patients. It involves all activities and processes of planning, coordinating, operating, controlling and optimizing the whole supply chain system, with an aim to provide value-added services to patients with 6Rs – right patient, right drug, right dose, right route, right time and right document while minimizing costs (Gui-sheng**,** 2010). Furthermore, HSC includes supply chain activities such as raw material purchasing, transport, receiving medical treatment, providing medical services, and sending patients, and the three flows of the supply chain: material flow, information flow, and cash flow (Fenies *et al.*, 2006; Pedroso and Nakano, 2009; Gui-sheng**,** 2010). However, the most hospitals focus on two flows which are material and information flows only (Figure 1.1).

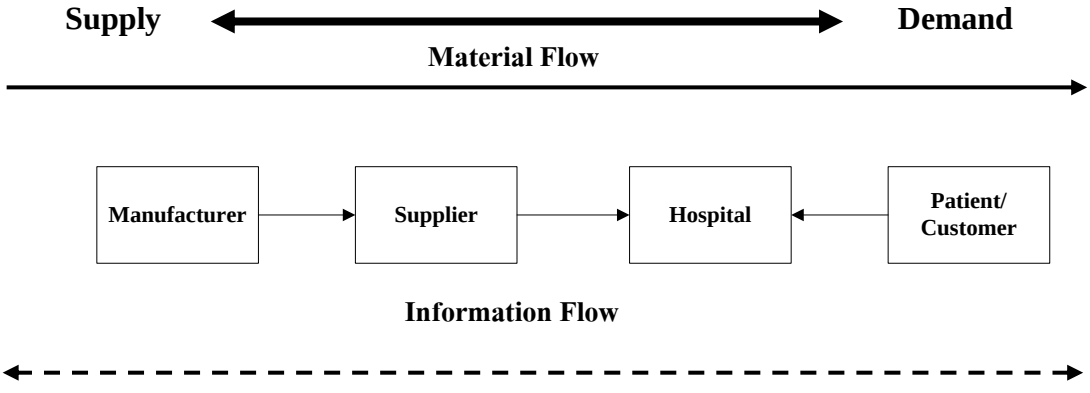


Figure 1.1 Hospital Supply Chain.

Currently, hospitals are facing the problems of information exchange between parties in its supply chain which is not efficient and accurate. Pedroso and

Nakano (2009) commented that the information flows are directly related to material flows and are crucial for the good performance of supply chains. When information do not flow quickly, smoothly and directly, it may lead to supply chain dysfunctional behavior, resulting in order quantity changes immediately, overestimated production lots and excessive inventory, as in the bullwhip effect (Sucky, 2009).

In addition, Pothitong and Charoensiriwath (2011) divided the problem into two groups include: 1) human error, an analysis shows an inefficient operation due to error during data input process. In their study, the ratio of wrong data input is 3 percent of all transactions, 5 percent of all product quantities, and 5.42 percent of all product values. This problem incurs a cost of at least US$570 per month and 2) inefficient information flow, because of discrepancies in the database system among business partners, the process of transferring order information such as Purchase Order (PO) among hospitals, the pharmaceutical company and its distributor is highly inefficient. This is because the existing labor-intensive operations involved in the whole order fulfillment process. Therefore, hospital could not link its own database to keep information of orders and send the information automatically to the distributor or supplier. In 1999, a shocking report from the Institute of Medicine stated that 44,000 to 98,000 Americans die each year because of medical errors in the hospitals (Southard, 2005).

Hospitals must have an intermediate device that can link information in supply chain. Currently, the barcode technology is most popular, barcode is a machine-readable representation of information in a visual format on a surface (Sutton, 2002; Youssef and Salem, 2007). Barcodes are simple visual representations of data, which can be transferred to a computer via a barcode scanner. Barcodes are very well established and the technology associated with their use is mature, widely disseminated, and relatively inexpensive (Merry and Webster, 2004) and improving efficiency and eliminating human error if used correctly, because barcode data entry is also much faster and more accurate than manual data entry.

However, the large problem the hospital facing with barcode technology is the fact that the ICT level of each the hospital is different. Hospitals have various organizational and geographical factors including hospital size, urban/rural location, system membership and leadership (Otieno *et al.*, 2008). In addition, the barcodes will

do nothing on their own. There will be no gain in safety unless hospitals actually use the IT device including scanners, computers, software, and databases to take advantage of these barcodes. Therefore, the application of barcode in hospital needs ICT, which is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on (Steinmueller, 2000; Jain, 2006; Day *et al.,* 2010). Furthermore, Adebayo and Adesope (2007) described ICT as scientific, technological and engineering displines and the management technologies used in the handling of information, processing and applications related to computers.

E-readiness is one of the most important tools to determine internal strength and weakness, environmental opportunities and threats. It brings awareness of new markets, innovative opportunities and services, governmental potentials to make money and possible reduce of bottlenecks. Moreover, it is a relatively new concept that has been given impetus by the rapid rate of internet penetration throughout the world, and the dramatic advance in the use of Information and Communication Technology (ICT) in business and industry (Mutula and van Brakel, 2006; Hanafizadeh *et al.,* 2009). Therefore, e-readiness is important to implement the "right" ICT solutions for the right processes, to the right degree, with the right timing (Lou and Goulding, 2010). E-readiness also refers to a country's ability to take advantages of the internet as an engine of economic growth and human development (ZiaeiPour *et al.*, 2009).

E-readiness assessment is meant to guide development efforts by providing some suitable tools for comparison and gauging progress (Mutula and van Brakel, 2006; Ghavamifar *et al.,* 2008; Lou and Goulding, 2010). It enables governments to set, measure and achieve realistic goals for an information society, information-based economy, or e-government. It is important to develop and conduct e-readiness assessment so that the results can be leveraged to catalyze action, improve global competitiveness, and use limited resources wisely (Mutula and van Brakel, 2006; Ghavamifar *et al.,* 2008). In addition, e-readiness assessment is important for healthcare to provide the public with a good quality of life (Ismail and Abdullah, 2011).

Therefore, the research question is “how ready is the hospital to implement barcode technology focusing on pharmaceutical products?”

1.2 Objective of study

To construct a guideline for e-readiness assessment of hospital operations to adopt barcode technology into Pharmaceutical Department.

1.3 Scopes of work

1.3.1 The hospitals included in this study are classified into three groups: (1) Small-size public hospitals (10-120 beds), (2) Large-size public hospitals (over 120 beds), and (3) Private hospitals, which are located in the Bangkok and Suburban areas.

1.3.2 The research focus on the use of barcode technology for pharmaceutical products in hospitals only, the target participants are pharmacists working in the hospital warehouse, pharmacists working in the pharmacy department, staff in procurement department, IT staff, staff in finance department, and nurses, and the type of barcode in this study is limited to the linear barcode.

1.4 Expected results

A guideline for the hospitals to assess themselves on their readiness to implement barcode technology into Pharmaceutical Department. In case the hospitals are not ready, the guideline will show factors they need to improve.

CHAPTER II
LITERATURE REVIEW

This research reviews readiness and barrier factors related to ICT of hospitals in Thailand, which proposed ICT evaluation for information flow efficiency called e-readiness assessment tools. We divide this chapter into four sections: (1) Hospital supply chain in Thailand and its current situation, (2) Use of barcode in hospital pharmacy: a need for change in ICT, (3) Factors of e-readiness assessment, and (4) Fuzzy-IPA method.

2.1 Hospital supply chain in Thailand and its current situation

Gui-sheng (2010) explained that a supply chain is the total process from suppliers to customers involving value increment and distributional channel control. It involves all activities and processes of planning, coordinating, operating, controlling and optimizing the whole supply chain system, with an aim to provide the customer with 6Rs – right patient, right drug, right dose, right route, right time and right document while minimizing costs. Hospital supply chain (HSC) involves suppliers, the hospital and patients, and aims to provide value-added services to patients (Figure 2.1).

Fenies *et al.* (2006), Pedroso and Nakano (2009) and Gui-sheng (2010) described that the main categories of a HSC are: supply chain participants (such as suppliers, hospitals, shippers, etc.), supply chain activities (such as raw material purchasing, transport, receiving medical treatment, providing medical services, sending patients), and the three flows of the supply chain (material flow, information flow and cash flow). The main objective of HSC is to effectively organize suppliers, the hospital and shippers to provide patients with value-added services through a series of activities of purchasing and transporting medical materials, giving medical treatment and transferring patients.

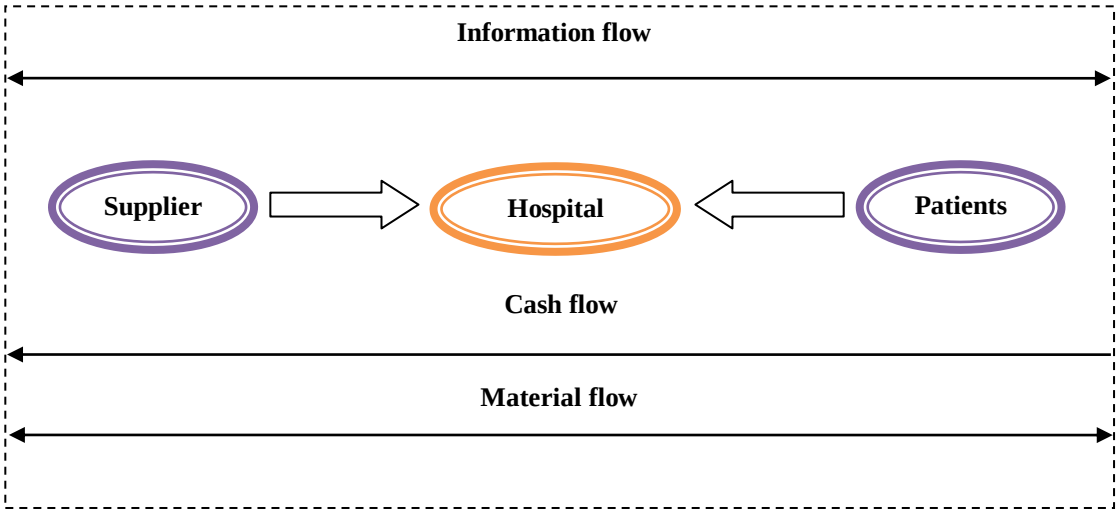


Figure 2.1 Information, Cash and Material flow in HSC

Materials in HSC can be separated in various categories such as medical device and medical supply, cloth, blood, food, and pharmaceutical products. However, this research is interested in the pharmaceutical supply chain only as shown in Figure 2.2. It is a complex scenario with millions of medicine packs moving around the world each year. The pharmaceutical supply chain has made up of six stakeholders: (1) manufacturers, (2) wholesalers, (3) hospitals, (4) drugstore, (5) clinic, and (6) patients or customers. This supply chain, much more than other, is affected by the need for the strict traceability of the drugs that are manufactured, distributed, and consumed. Moreover, because many drugs must be flowed in the whole supply chain rapidly, all the involved players must exchange business messages (purchase orders, order confirmations, etc.) in a quick and reliable way (Barchetti *et al.*, 2010).

Pharmaceutical supply chain is different from the drug supply mechanism under central planned economy. Whereas earlier pharmaceutical manufacturing firms could only sell drugs to wholesalers, now they are able to sell their products to not only the drug wholesale stations and drugstores, but also directly to hospitals. Meanwhile, bigger distributors can sell drugs to smaller ones. The wholesale prices could be different because of the different purchasing volume. There is a considerable imbalance of retail market sales within the supply chain: the hospital pharmacies account for roughly are four-fifth of all retail pharmaceutical sales (Sun *et al.*, 2008). The remain of retail drugs market are dispensed by drugstore, including retail

enterprises and rural drug supply outlets. Patients can buy drugs from either hospitals or drugstores. Because of information asymmetry on drug knowledge, physicians, who act as an agent of the patients or consumers, will decide which drugs to buy for them (Yu *et al.*, 2010).

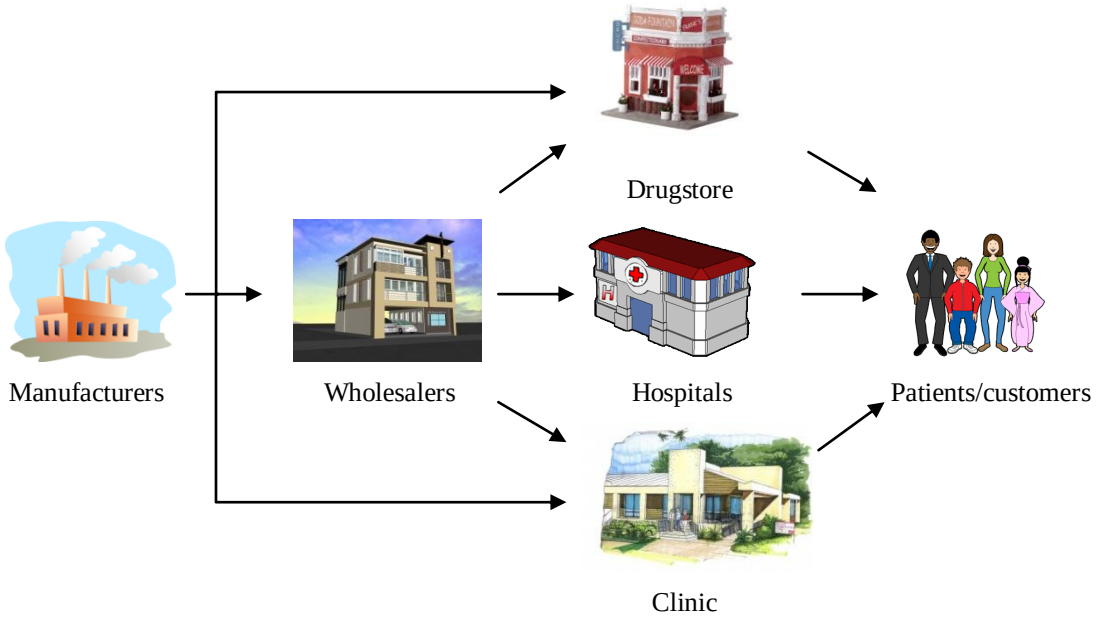


Figure 2.2 Structure of Pharmaceutical Supply Chain
(Lee and Chung, 2006; Yu *et al.*, 2010)

Pothitong and Charoensiriwath (2011) stated that the pharmaceutical supply chain in Thailand is one of the most complex operations to manage. To efficiently manage the supply chain, information technology (IT) plays the crucial role.

2.2 Use of barcode in hospital pharmacy: a need for change in ICT

2.2.1 What is barcode?

Sutton (2002) and Youssef and Salem (2007) defined a barcode as a machine- readable representation of information in a visual format on a surface which can be transfered to a computer via a barcode scanner. A barcode is an optical

machine-readable representation of data, which shows data about the object to which it attaches (Noraziah *et al.,* 2011).

2.2.2 The history of barcode

The history of barcode started in 1948 (Billis, www.about.com [20/06/2012]), when Bernard Silver was a graduate student at Drexel Institute of Technology in Philadelphia. A local food chain storeowner had made an inquiry to the Drexel Institute asking about research into a method of automatically reading product information during checkout. Bernard Silver joined together with fellow graduate student Norman Joseph Woodland to work on a solution.

On October 20, 1949, Woodland and Silver filed their patent application for the "Classifying Apparatus and Method", describing their invention as "article classification through the medium of identifying patterns".

The first barcode was using commercially in 1966, however, it was soon realizing that there would have to be some sort of industry standard set. By 1970, the Universal Grocery Products Identification Code (UGPIC) was written by a company called Logicon Inc. The first company to produce barcode equipment for retail trade use (using UGPIC) was an American company Monarch Marking in 1970, and for industrial use, the British company Plessey Telecommunications. UGPIC evolved into the UPC symbol set or Universal Product Code, which is still used in the United States. George J. Laurer considered the inventor of UPC or Uniform Product Code, which was invented in 1973.

In June of 1974, the first UPC scanner was installing at a Marsh's supermarket in Troy, Ohio. The first product to have a barcode included was a packet of Wrigley's Gum.

Currently, barcodes in different format types used in many industries worldwide.

2.2.3 Why use a barcode?

Errors in drug administration have the potential to cause unnecessary, and occasionally very serious, harm to patients (Merry and Webster, 2004). In 1999, a shocking report from the Institute of Medicine stated that 44,000 to 98,000 Americans

die each year because of medical errors in the hospitals. Medication errors are account for approximately 7,000 of those reported errors (Southard, 2005). The National Coordinating Council for Medication Error Reporting and Prevention defined a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer. Such events may be related to professional practice, healthcare products, procedures and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use" (Southard, 2005).

Therefore, in the United States, the Food and Drug Administration (FDA) has introduced a new rule, which will require certain human drug and biological product labels to have barcodes (Merry and Webster, 2004). The barcode label must list a wide variety of information typically assigned to a patient. Since each healthcare organization identifies the patient differently, the barcode placed on the wristband must contain the key data that match with the barcode scanned by the pharmacist when completing order entry of the medications as prescribed by the physician (Southard, 2005).

However, the biggest problem the healthcare industry faces with barcode technology is the fact that the drug manufacturers have not converted packaging to a unit-of-use level. This is a very costly endeavor, and since reimbursement is at the provider level, not the distributor level, there has been no initiative to standardize labels to one type of identification code (Southard, 2005).

Even so, barcodes are very well established and the technology associated with their use is mature, widely disseminated, relatively inexpensive, improving efficiency and eliminating human error if used correctly. In addition, barcode data entry is also much faster and more accurate than manual data entry (Merry and Webster, 2004). The Carillion Health System reported timesavings of 2.75 hours per 12 hours nursing shift after switching to a barcode-based system to record medication administration (Zebra Technologies, 2005). This technology has been in place for over 25 years in healthcare and longer in other industries. However, until the last several years, only 14% of U.S. hospitals had barcodes for medication administration as a

means to reduce medication errors and improve patient safety (Southard, 2005). In addition, barcodes have been incorporated for many years into unit dose systems for the administration of drugs on hospital wards and in various aspects of dispensing within pharmacies (Merry and Webster, 2004).

However, the barcodes will do nothing on their own. There will be no gain in safety unless hospitals implement systems including scanners, computers, software, and databases to take advantage of these barcodes, and unless practitioners actually use this technology (Merry and Webster, 2004).

2.2.4 Types of barcode

There are many different types of barcodes, which called symbologies. They various the amount and type (e.g. numeric only or alphanumeric) of data they can encode, the space they require to do so, and other factors (Zebra Technologies, 2005). Barcode symbologies can be divided into three types (Noraziah *et al.*, 2011):

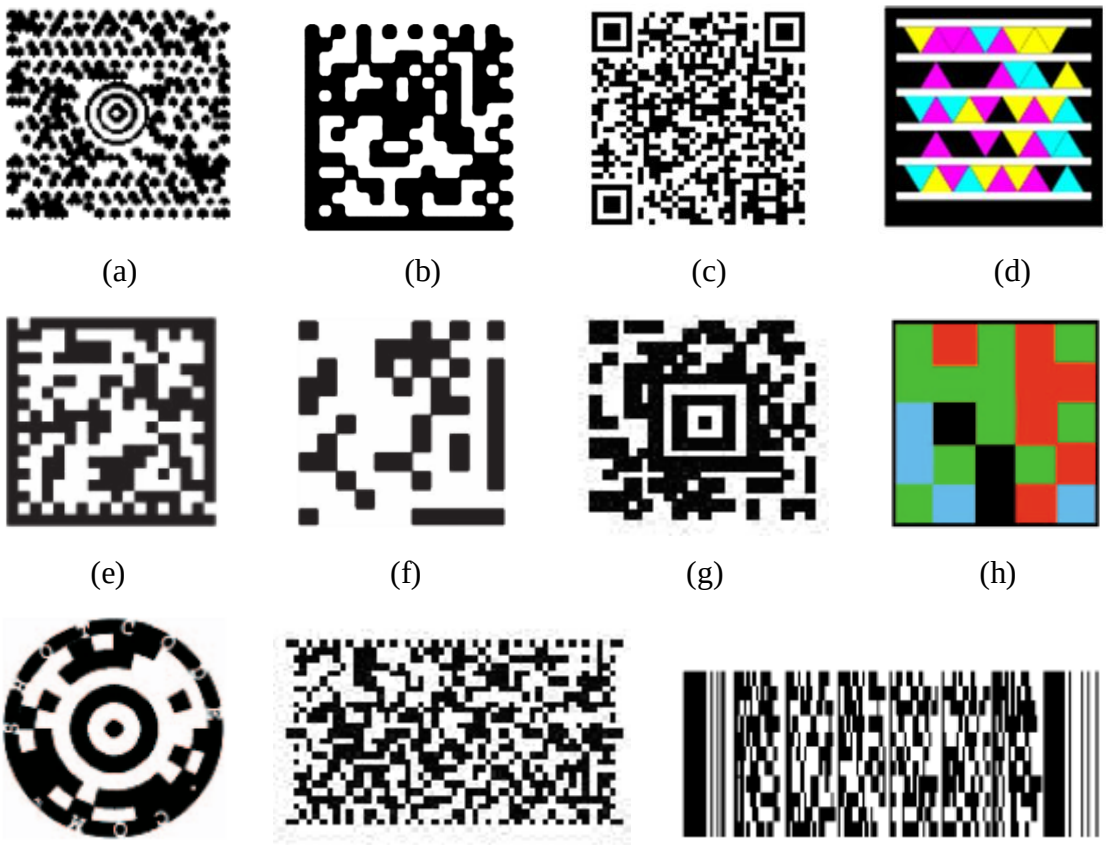
1) One-dimensional or linear barcode (1-D) such as EAN-13 (European Article Numbering), Interleaved 2 of 5 (Code 25, I2 of 5, ITF, I25), Code 128 and Code 39, shown in Figure 2.3,

2) Two-dimensional barcode (2-D) such as MaxiCode, PDF-417, Aztec code, QR code, HCCB, VSCode, Visual Code, ShotCode, ColurCode and DataMatrix, shown in Figure 2.4, and

3) Three-dimensional barcode (3-D) shown in Figure 2.5.

(a) (b) (c)

Figure 2.3 1-D barcode: (a) EAN-13 barcode, (b) Interleaved 2 of 5 (Code 25, I2of5, ITF, I25), and (c) Code 39 (Youssef and Salem, 2007)



(a) (b) (c) (d)

(e) (f) (g) (h)

(i) (j) (k)

Figure 2.4 2-D barcode: (a) MaxiCode (Youssef and Salem, 2007), (b) Data Matrix (Froschle *et al.*, 2009), (c) QR (Quick Response) code (Ozcelik and Acarturk, 2011), (d) High Capacity Color Barcode (HCCB) (Ozcelik and Acarturk, 2011), (e) VS code (Kato and Tan, 2007), (f) Visual code (Kato and Tan, 2007), (g) Aztec (Hu *et al.*, 2009), (h) Color code (Kato and Tan, 2007), (i) Shot code (Kato and Tan, 2007), (j) LONGBEI (Hu *et al.*,2009), and (k) PDF-417 (Youssef and Salem, 2007)

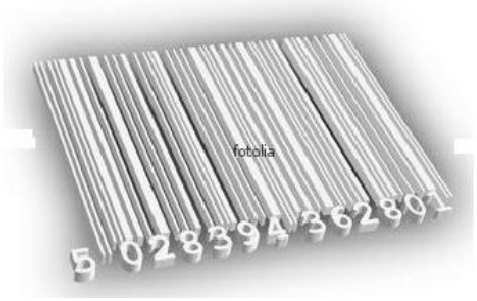


Figure 2.5 3-D barcode (Khandokar *et al.*, 2010)

The most widely used barcode is 1-D barcode, which is composed of vertical lines of varying thickness, which it easy to use, fast working, accurate, low production cost, and universal of use. However, 1-D barcode use large space, cannot withstand harsh treatment, and low capacity. A 2-D barcode, also known as a matrix code, is another type of barcode, which has much higher capacity and use small space compared to the 1-D barcode (Ozcelik and Acarturk, 2011). However, 2-D barcode cannot withstand harsh treatment, and narrow popular or using in some industries. Furthermore, Khandokar *et al.* (2010) developed the idea of using 3-D barcode came from. Because one of the problems facing the 1-D and 2-D systems is that they cannot withstand harsh treatment, such as cleaning solutions, high heat treatment or coolant sprays that most metal parts routinely undergo. Also 1-D and 2-D barcodes typically require a white background, so when applied directly to the metal there is often not enough contrast for a conventional barcode scanner to read the code. Again, information capacity increases as the dimension of barcode increases. However, 3-D barcode is not popular. It is used by heavy industries only (see Table 2.1).

Table 2.1 Comparison of barcode types (Khandokar *et al.,* 2010)

Perspective	**1-Dimension**	**2-Dimension**	**3-Dimension**
Space	Large	Small	Small
Treatment	Cannot withstand harsh treatment	Cannot withstand harsh treatment	Can withstand harsh treatment
Background	White	White	Color
Capacity	Low	High	High
Performance	Fast	Fast	Fast
Application	Universal	Some industries	Heavy industries

2.2.5 Advantages and disadvantages of using barcode technology

There are many advantages and disadvantages of using barcode technology. (Islam and Shuva, 2010). However, the authors have found some important points of advantages and disadvantages of using barcode as from a practical point of view during the survey listed below:

2.2.5.1 Advantages of using barcode technology

1) Increase the accuracy of service: use of barcode technology increases and ensures the accuracy of information services among the users.

2) Economical: it saves the money as well as the time of the information professionals and the users. Since few information professionals are required to manage the information resources and to run properly, it is economical.

3) High Speed: use of barcode technology accelerates the functions and operations and the users can get their services very quickly.

4) Professional efficiency and quality of services: barcode technology improves the efficiency of the information professionals and the quality of the information services.

5) Space saved: the space of preserving the borrower's card and the catalogue card can be saved through the use of barcode technology.

6) Data integrity: it ensures data integrity and data consistency by making a sound relationship between the resources database and the user database.

7) Create positive user attitudes: it creates and establishes positive user attitudes towards the information institution.

2.2.5.2 Disadvantages of using barcode technology

1) Lack of consciousness among the users: the user may not press the barcode identity card on the scanner kept at the main gate. One personnel has to be deputed at the gate for checking whether users are pressing their identity card on the scanner or not.

2) In case of violation of law, one employee needed: if the barcode is used on chip, which gives the signals about unauthentic users, but the users may not follow it, in that case, one employee has to be there for instant checking.

3) Problems of Internet and Electricity: it is the main problem in Bangladesh as electricity is off now and then the Internet is disconnected instantly. Therefore, the network systems and electricity problems decrease the efficiency of the system.

4) Problems of pasting barcode labels: to paste the barcode labels and to scan the barcodes from the big document is also time consuming.

5) Problems of software: if the automation software is not efficient, it may create problems to use barcode technology. So the automation software should be so efficient in order to work with barcode technology.

6) Costly: to make the infrastructure for barcode technology, it will require adequate funds. So barcode technology may be expensive at the initial stage.

2.2.6 Implementation of barcode technology in hospitals

Barcode technology is improving efficiency and eliminating human error if used correctly. This technology has been in place for over 25 years in healthcare and longer in other industries (Southard, 2005). Many researchers had studied the application of barcode in hospital as shown in Table 2.2.

Table 2.2 Review of barcode implementation in hospitals

References	Barcode Implementations
Merry and Webster (2004)	To study the barcodes and the reduction of drug administration error in anesthesia in New Zealand. The process of administering drugs in anesthesia involves the creation of a record. Barcodes are used to check drugs immediately before their administration, the ease and reliability of this aspect of record keeping could at the same time be greatly improved. This studied found that the application of barcode can be decrease of drug administration error. Then, implementing the changes associated with adopting barcodes will increase the cost of anesthesia.
Southard (2005)	To study the barcode medication administration: preparing the culture for change, a community hospital in North Carolina that has full implementation of barcode medication at the point of care found that barcode medication administration technology is an impressive breakthrough for improving patient safety.

Table 2.2 Review of barcode implementation in hospitals (cont.)

References	Barcode Implementations
Hayden *et al.* (2008)	To assess the ability of a barcode-based electronic positive patient and specimen identification (EPPID) system to reduce identification errors in a pediatric hospital's clinical laboratory, Tennessee, USA. The EPPID system included barcode identifiers and handheld personal digital assistants supporting real-time order verification. System efficacy was measured in 3 consecutive 12–month time frames, corresponding to periods before, during, and immediately after full EPPID implementation. EPPID decreased the rate of misidentification of clinical laboratory samples.
Morriss *et al* (2009)	In USA, their hypothesis was that a barcode medication administration (BCMA) system would reduce preventable adverse drug events (ADEs) by 45% in a neonatal intensive care unit. They conducted a prospective, observational, cohort study of a BCMA system intervention in a neonatal intensive care unit. Participants were admitted neonates during 50 weeks. Medication errors and potential or preventable ADEs were detected by a daily structured audit of each subject's medical record, with assignment of an event as a preventable ADE made by blinded assessors. The BCMA system reduced the risk of targeted, preventable ADEs by 47%.
Tsai *et al.* (2010)	To demonstrate that implementation of barcode medication administration system (BCMA) for oral medication could reduce half of the time for oral medication delivery. Nurses coordinated the hardware and software by accommodating the new facilities and operating BCMA system. The stability of wireless internet was the main threat. However, 93.5% nurses think that BCMA could enhance patient oral medication safety in spite of making more effort in learning new technology.

Rogers (2003) suggested that the IT adoption depends at least in part on the technology's perceived relative advantage, compatibility to existing infrastructure and practices, complexity in understanding its uses and functionality, trialability, and observability. Therefore, the implementation of barcode technology to facilitate the safer administration of drugs in hospitals will require e-readiness assessment.

2.3 Factor of e-readiness assessment

2.3.1 Our focus (IS, IT and ICT?)

The key words about information are Information System (IS), Information Technology (IT), and Information and Communication Technology (ICT). IS is one of IT divisions. The emergence of IS can be found in many areas (Nayan *et al.*, 2010). Wetherbe (1983) stated that IS as a physical process, which supports system objects in achieving organizational goal. Lucas (1992), Martin and Powell (1992), and Lederer and Salmela (1996) confirmed that input, processing and output of data processing are elements that form a system and used in decision making, communication and control in organizations. However, the IS is more input, storage, recording, processing, distribution, and transmission of data delays, errors and lack of accurate and complete information than IT.

IT refers to the equipment (hardware) and software used to control access to the collection and presentation of information in electronic form: hardware including personal computers, scanners and digital cameras etc., and software including database storage programs and multimedia programs (Lucas, 1997; Mallard, 2002). It is more input, storage, recording, processing, distribution and transmission of data is very fast, accurate and informative. Nevertheless, it is not communication device to connect to a remote computer.

ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network, hardware and software, satellite systems and so on (Steinmueller, 2000; Jain, 2006; Day *et al.*, 2010). Technical Centre for Agricultural and Rural Cooperation (CTA)

(2003) and the United States Agency for International Development (Akpabio *et al.*, 2007) underlined that the facilitate communication and thus the processing and transmission of information electronically includes technologies and method for storing, managing and processing as well as communicating information. Furthermore, Adebayo and Adesope (2007) described ICT as scientific, technological and engineering displines and the management technologies used in the handling of information, processing and applications related to computers. ICT as an extension tool could enhance the flow of information in the application of business services.

On the other hand, ICT is indispensable and have been accepted as part of the contemporary world especially in the industrialized societies. In fact, cultures and societies have adjusted to meet the challenges of the knowledge age. Therefore, the pervasiveness of ICT has brought about rapid changes in technology, social, political, demographical, cultural features of population, and global economic transformation (Bannister and Remenyi, 2003; Chikonzo, 2006; Moradi and Khalkhali, 2008; Rojko *et al.*, 2010).

The importance of ICT as powerful tools for socio-economic development is now widely acknowledged not only among large corporations but small business enterprises as well and versatility have provided substantial benefits for individuals and organizations, as well as society more generally (Mamaghani, 2006). ICT can enables individuals, teams, and organizations to gather, analyze, and distribute large amounts of information and data, and has increased "workers flexibility by creating mobile working practices and instant information transmission" (O'Driscoll *et al.*, 2009). In addition, ICT can deployed effectively as engines of economic development existing IT skills gap both in developed and developing countries must be addressed (Mutula and van Brakel, 2007) and improving communication in construction processes. One benefit of ICT is to reduce information re-entry by linking information between these processes (Bjork, 1999).

On the other hand, as cited in Day *et al.* (2010), Lowry and Moskos (2005) described ICT in the workplace as a "double edged" sword because it is not homogenous in either its uses or its impact on employees. Even though ICT can be use to make work more efficient and employees' lives better, the demands associated with its use may create additional problems for employees (Korunka and Vitouch, 1999;

Morgan *et al.*, 2000; Coovert and Thompson, 2003). ICT may have a positive impact on people by increasing access to information (Migliarese and Paolucci, 1995), allowing greater flexibility (Standen *et al.*, 1999), improving efficiency, and increasing communication (Dewett and Jones, 2001). However, ICT may also create increased demands and stress in the workplace by creating expectations of greater productivity (Wang *et al.*, 2008) and accessibility (Tarafdar *et al.*, 2007), as well as creating technical "glitches" (Coovert and Thompson, 2003).

Therefore, this research focus on ICT has been to identified as essential in improving communication in construction processes, individual, organization and recently technology. In order to reduce information re-entry by linking information between organizations (Bjork, 1999; Peansupap and Walker, 2005).

2.3.2 E-readiness definitions

E-readiness is one of the most important tools to determine internal strength and weakness, environmental opportunities and threats. It brings awareness of new markets, innovative opportunities and services, governmental potentials to make money and possible bottlenecks in countries development. Moreover, it is a relatively new concept that has been given impetus by the rapid rate of internet penetration throughout the world, and the dramatic advance in the use of ICT in business and industry (Mutula and van Brakel, 2006; Hanafizadeh *et al.*, 2009). Therefore, e-readiness is important to implement the "right" ICT solutions for the right processes, to the right degree, with the right timing (Lou and Goulding, 2010). E-readiness also refers to a country's ability to take advantages of the internet as an engine of economic growth and human development (ZiaeiPour *et al.*, 2009).

There is no single definitive definition for e-readiness, as different things to different people, in different contexts, and for different purposes (Ruikar et al., 2006; ZiaeiPour et al., 2009; Lou and Goulding, 2010). Various literatures defined e-readiness as following (Table 2.3):

Table 2.3 Definitions of e-readiness

References	E-readiness definitions
The McConnell International (2000)	To defined e-readiness in relation to a country that has extensive usage of computers in schools, businesses, government, homes; affordable reliable access in a competitive market: free trade; skilled workforces and training in schools; a culture of creativity; government business partnerships; transparency and stability in government and an evenly enforced legal system; secure networks and personal privacy; regulations allowing digital signatures and encryption; consumers' trust in e-commerce security and privacy; more trained workers; lower training costs and lower costs for e-commerce technology (ZiaeiPour *et al.*, 2009).
Center for International Development and Conflict Management (CIDCM) at the University of Maryland (2001)	To defined e-ready society as a society with an Internet Service Provider (ISP) market that has passed through three phases of development: (1) pre-commercial; (2) commercial; (3) competitive (Bridges.org, 2005; Hanafizadeh *et al.*, 2009).
Empirica Gmbh (2001)	To defined e-ready society as (1) a society where an increasing portion of social activities-work, economic transactions, communications, and other interactions between individuals, private sector organizations, and governments are conducted via ICT networks or are dependent on ICT technologies, all of which are increasingly interoperable and (2) a society where information and knowledge are increasingly important economic goods at all levels – that is, as determinants of wage levels for individuals, as factors of production for firms, and as sources of competitiveness among nations and regions or both (Hanafizadeh *et al.*, 2009).

Table 2.3 Definitions of e-readiness (cont.)

References	E-readiness definitions
Bui *et al.* (2002)	E-readiness can also be defined as the ability of an organization or economy to deploy internet-based computers and information technologies to transform traditional businesses into a new economy – an economy that is characterized by the ability to perform business transactions in real time – in any form, anywhere, anytime and at any price.
Rao (2003)	"E-readiness = ICTs + e-skilled people." To underline, the "8Cs" (connectivity, content, community, commerce, capacity, culture, cooperation and capital) give insights into the success of countries like India and the Philippines call centre operations, technology support and content management services.
Choucri, Maugis, Madnick and Siegel from Massachusetts Institute of Technology (MIT) (2003)	To defined e-readiness as the ability to pursue value creation opportunities facilitated by the use of the internet (Hanafizadeh *et al.,* 2009).
The world information technology and services alliance (WITSA, 2004)	An e-ready country required consumer trust in e-commerce security and privacy; along with better security technology; more trained workers and lower training costs; less restrictive public policy; new business practices adapted to the information age; and lower costs for e-commerce technology.
Ruikar *et al.* (2006)	E-readiness defined as "the ability of an organization, department or workgroup to successfully adopt, use and benefit from information and communication technologies (ICTs) such as e-commerce".

Table 2.3 Definitions of e-readiness (cont.)

References	E-readiness definitions
The community assessment of e-readiness by the Center for International Development, Harvard University (CID, 2007; ZiaeiPour *et al.*, 2009)	Readiness is the degree to which a community is prepared to participate in the networked world. It is gauged by assessing a community's relative advancement in the areas that are most critical for ICT adoption and the most important applications of ICT. When considered together in the context of a strategic planning dialogue, an assessment based on these elements provides a robust portrayal of a community's readiness. The value to a community of assessing its readiness lies in evaluating its unique opportunities and challenges.
The United Nations (2008)	This UN report assesses e-government readiness of member states, according to a quantitative composite readiness of e-readiness based on website assessment; telecommunication infrastructure and human resource endowment.
The Computer Systems Policy Project (CSPP)	To defined e-readiness with respect to a community that had high-speed access in a competitive market; with constant access and application of ITs in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favorable to promote connectedness and use of the network (Bridges.org, 2005; Mutula and van Brakel, 2006; Ghavamifar *et al.*, 2008; ZiaeiPour *et al.*, 2009).

The various differences in e-readiness definitions raise the question of "what is the most accurate definition for e-readiness?" The answer to this question is an ongoing debate; reflecting that there is no complete literature definition for e-readiness (Lou and Goulding, 2010). The definition of e-readiness should be specified

based on the industry. The definition of e-readiness to be used in this study will be referred to Rao (2003) that ICTs + e-skilled people.

2.3.3 Why e-readiness assessment?

There are various reasons why there is increased impetus among countries in assessing their e-readiness statuses. Countries are striving to become inclusive global knowledge societies where all persons without distinction are empowered to create, receive, share and utilize information and knowledge for their economic, social, cultural and political development (Consulting and Audit Canada, 2004). Moreover, in the current Internet age, competitiveness of countries is being increasingly associated with their level of e-readiness (Bridges.org, 2001; Economist Intelligence Unit and IBM Corporation, 2004). Countries with high level of e-readiness can use the internet to improve services and create new opportunities and have a competitive edge over those whose levels of e-readiness are low (Economist Intelligence Unit Limited, 2005).

E-readiness assessments are meant to guide development efforts by providing some suitable tools for comparison and gauging progress (Mutula and van Brakel, 2006; Ghavamifar *et al.,* 2008; Lou and Goulding, 2010). E-readiness assessments are also useful in understanding and identifying the most key and relevant IT based development opportunities. For example, to put IT to effective use, a country must be 'e-ready' in terms of infrastructure, the accessibility of IT to the population at large and the effect of the legal and regulatory framework on IT use, benchmarking progress, collaborations, determining vision, strategy, and priorities (Ghavamifar *et al.,* 2008). Furthermore, E-readiness assessment enables governments to set, measure and achieve realistic goals for an information society, information-based economy, or e-government. It is important to develop and conduct an e- readiness assessment so that the results can be leveraged to catalyze action, improve global competitiveness, and use limited resources wisely (Mutula and van Brakel, 2006; Ghavamifar *et al.,* 2008). And it is important for companies that seek to adopt e-commerce tools to undertake an analysis of their businesses to ensure a productive and beneficial implementation of these tools (Ruikar *et al.,* 2006).

E-readiness assessment is important for healthcare to provide the public with a good quality of life (Ismail and Abdullah, 2011). Because hospitals vary widely on various organizational and geographical factors including hospital size, urban/rural location, system membership and leadership; the factors that have been shown to influence the ability for the hospital to innovate (Otieno *et al.,* 2008). Md. Zan (2007) revealed the public hospitals in Malaysia are often associated with slow and inefficient services. Thus, many people are not comfortable using the services in public hospitals because the time to get the treatment is long. Bernama (2009) supported the number of negligence cases in public hospitals in 2000 to 2008 increased to 144 cases, and 61.9% of that were brought to court, while RM 7 million (U.S.$2.15 million) was contributed as substitute compensation cost for medical negligence cases. Therefore, hospitals need to improve their facilities and services to satisfy the patients and offer extraordinary opportunities to achieve the six aims of improved care including, safety, effectiveness, patient centeredness, timeliness, efficiency and equity (Otieno *et al.,* 2008).

2.3.4 Identification of e-readiness assessment factors

Through an extensive literature review, e-readiness assessment factors are identified. The articles were identified through a computer search of database of published works and conference proceedings in the e-readiness area. Adopted from articles searching method used by Janom and Zakaria (2009), the articles were searched by the title based on the criteria such as it must contains either the keyword “e-readiness” or “readiness factors” or “barrier factors”, which e-readiness assessment can be identified both positive and negative factors. Positive factors are the strength of industries or hospital which the higher is the better and can be called “readiness factors”. Negative factors are the weakness of industries or hospital which the lower is the better and can be called “barrier factors”.

2.3.4.1 Readiness Factors

Normally, the factors affecting the e-readiness includes people, process, and technology which is “ICTs + e-skilled people” (Rao, 2003). However, factors used in assessing e-readiness in various industries are different. This research studied the factors used in various industries including agriculture, SMEs, bank,

automotive, education institute, and hospital industries. A previous study from Ghavamifar *et al.* (2008) revealed that e-readiness assessment tools for developing countries are (1) infrastructure, (2) human capacity, (3) policy, (4) enterprise, and (5) content and applications. Purnomo and Lee (2010) studied e-readiness assessment for agriculture industry in Indonesia and used four types of factors, namely: (1) farmer, (2) personal, (3) infrastructure, and (4) management readiness. A more recent study by Tran *et al.* (2011) showed the importance of government, organization, and technology on a construction enterprises' e-procurement implementation readiness level in developing countries. The summary of readiness dimensions and factors used in other literatures as also shown in Table 2.4.

Table 2.4 Reviews of readiness dimensions and factors

Dimension	Factor	Reference
People	Task	Synder-Halpern, 2001; Fathian *et al.*, 2008; Janom and Zakaria, 2008
	Skills	Synder-Halpern, 2001; Fathian *et al.*, 2008
	Individual knowledge	Synder-Halpern, 2001; Janom and Zakaria, 2009
	Self-development	Aydin and Tasci, 2005; Ghavamifar *et al.*, 2008
	User acceptance	Hanmer, 1999
Process	Resources	Synder-Halpern, 2001; Mutula and van Brakel, 2006; Janom and Zakaria, 2008
	Operations	Synder-Halpern, 2001; Janom and Zakaria, 2009
Technology	Internet availability and affordability	Hanmer, 1999; Rao, 2003; Bridge.org., 2005; Fathian *et al.*, 2008; Gewald and Dibbern, 2009
	Locally relevant content	Rao, 2003; Bridge.org., 2005; Fathian *et al.*, 2008; Ghavamifar *et al.*, 2008; Janom and Zakaria, 2009

Table 2.4 Reviews of readiness dimensions and factors (cont.)

Dimension	Factor	Reference
	Innovation	Aydin and Tasci, 2005; Fathian *et al.*, 2008; Janom and Zakaria, 2008; Janom and Zakaria, 2009
	Infrastructure	Fathian *et al.*, 2008; Ghavamifar *et al.*, 2008; Purnomo and Lee, 2010
	Security and encryption	Bridge.org., 2005; Fathian *et al.*, 2008; Janom and Zakaria, 2009
	Connectivity	Rao, 2003; Fathian *et al.*, 2008; Gewald and Dibbern, 2009
	ICT services and support	Mutula and van Brakel, 2006; Fathian *et al.*, 2008
	Appropriateness of ICT	Hanmer, 1999; Bridge.org., 2005
	ICT capacity and training	Rao, 2003; Bridge.org., 2005
	Flexibility	Janom and Zakaria, 2009
	People and organizations online	Fathian *et al.*, 2008
Organization	Management	Snyder-Halpern, 2001; Aydin and Tasci, 2005; Ruikar *et al.*, 2006; Fathian *et al.*, 2008; Janom and Zakaria, 2008; Janom and Zakaria, 2009; Purnomo and Lee, 2010
	Socio-cultural	Jones, 2003; Rao, 2003; Bridge.org., 2005; Keramati *et al.*, 2011
	Values & goals	Synder-Halpern, 2001; Gewald and Dibbern, 2009; Janom and Zakaria, 2009
	Human resources	Mutula and van Brakel, 2006; Fathian *et al.*, 2008; Janom and Zakaria, 2009
	Structure	Baroud, 2006; Lai and Ong, 2010

Table 2.4 Reviews of readiness dimensions and factors (cont.)

Dimension	Factor	Reference
	Work-environment	Mutula and Brakel, 2006; Lou and Goulding, 2010
	Integration of ICT into peoples' lives	bridges.org, 2005
	Use of ICT in business	bridges.org, 2005
	Access to specialized resources	Gewald and Dibbern, 2009
	Core readiness	Baroud, 2006
	Cooperation	Rao, 2003
	Motivational	Lehman *et al.*, 2002
	Strategy	Janom and Zakaria, 2009
	Communication	Hanmer, 1999
	Information	Mutula and Brakel, 2006
	ICT management and policy	Fathian *et al.*, 2008
	Industry standards	Fathian *et al.*, 2008
Government	Legal environment and regulations	Bridge.org., 2005; Fathian *et al.*, 2008; Janom and Zakaria, 2009
	Policy	Ghavamifar *et al.*, 2008; Janom and Zakaria, 2009
	Government's role in driving e-readiness	bridges.org, 2005
	Engagement	Baroud, 2006
	Capital	Rao, 2003

Table 2.4 Reviews of readiness dimensions and factors (cont.)

Dimension	Factor	Reference
	Revenue on electronic services	Fathian *et al.*, 2008

2.3.4.2 Barrier Factors

A number of literatures have studied about the barrier factors for ICT implementation in various industries. A previous study from Mungania (2003) revealed that e-learning barriers for various industries in USA are heterogeneous, encompassing seven types of barrier, namely: (1) personal or dispositional, (2) learning style, (3) instructional, (4) situational, (5) organizational, (6) content suitability, and (7) technological barriers. Muilenburg and Berge (2005) determined eight barrier factors to online learning for education institute industry in USA including (1) administrative issues, (2) social interaction, (3) academic skills, (4) technical skills, (5) learner motivation, (6) time and support for studies, (7) cost and access to the internet, and (8) technical problems. Ali and Magalhaes (2008) divided the barriers in the adoption of e-learning for largest companies in Kuwait into four factors: (1) management support, (2) language, (3) IT problems, and (4) workload and time. The summary of barrier dimensions and factors used in other literatures is also shown in Table 2.5.

Table 2.5 Reviews of barrier dimensions and factors

Dimensions	Factors	References
People	Personality	Jones, 2003; Mungania, 2003; Baroud, 2006; Soekartawi, 2008; Kijsanayotin *et al.*, 2009; Verhoeven *et al.*, 2009; Purnomo and Lee, 2010; Sicotte and Pare, 2010
	Skills	Howard *et al.*, 2006; Yucel *et al.*, 2011
	Voluntariness	Kijsanayotin *et al.*, 2009
	Learning style	Mungania, 2003
	Age	Yucel *et al.*, 2011

Table 2.5 Reviews of barrier dimensions and factors (cont.)

Dimensions	Factors	References
	Gender	Yucel *et al.*, 2011
	Education	Yucel *et al.*, 2011
	Self efficacy	Yucel *et al.*, 2011
	Prior experience	Yucel *et al.*, 2011
Process	Implement	Malhotra and Ho, 2010
Technology	Quality	Soekartawi, 2008; Verhoeven *et al.*, 2009; Khan *et al.*, 2011
	Infrastructure	Menou and Mchombu, 2007; Khan *et al.*, 2011; Tran *et al.*, 2011
	Capacity	Baroud, 2006; Khoja *et al.*, 2007/2008; Khan *et al.*, 2011
	Performance	Soekartawi, 2008; Kijsanayotin *et al.*, 2009; Verhoeven *et al.*, 2009
	Access and equity	Jones, 2003; Howard *et al.*, 2006
	Content suitability	Mungania, 2003; Khoja *et al.*, 2007/2008
	Instructional	Mungania, 2003; Malhotra and Ho, 2010
	Technology architecture	Soekartawi, 2008
	Appropriateness of technology	Khoja *et al.*, 2007/2008
	Internet	Jones, 2003
	Usability	Sicotte & Pare, 2010
	Perceived ease of use	Yucel *et al.*, 2011
	Perceived usefulness	Yucel *et al.*, 2011
	Compatibility	Yucel *et al.*, 2011
	Impact	Yucel *et al.*, 2011

Table 2.5 Reviews of barrier dimensions and factors (cont.)

Dimensions	Factors	References
	Enjoyment	Yucel *et al.*, 2011
	Security	Khan *et al.*, 2011
Organization	Social influence	Baroud, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007/2008; Gewald and Dibbern, 2009; Kijsanayotin *et al.*, 2009
	Management	Howard *et al.*, 2006; Sicotte and Pare, 2010; Khan *et al.*, 2011; Tran *et al.*, 2011
	Strategy	Gewald and Dibbern, 2009; Malhotra and Ho, 2010; Khan *et al.*, 2011; Tran *et al.*, 2011
	Culture and tradition	Baroud, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007/2008
	Geographical	Baroud, 2006; Menou and Mchombu, 2007
	Communication	Khan *et al.*, 2011; Yucel *et al.*, 2011
	Insufficient trained staff	Jones, 2003; Baroud, 2006
	Work related	Verhoeven *et al.*, 2009
	Trust	Khoja *et al.*, 2007/2008
	Ongoing research	Jones, 2003
	Integration	Khoja *et al.*, 2007/2008
	Coordination	Yucel *et al.*, 2011
	Organizational commitment	Yucel *et al.*, 2011
	User participation	Yucel *et al.*, 2011
	Size	Yucel *et al.*, 2011
	Structure	Tran *et al.*, 2011
	Language	Khan *et al.*, 2011

Table 2.5 Reviews of barrier dimensions and factors (cont.)

Dimensions	Factors	References
Government	Finance	Jones, 2003; Baroud, 2006; Howard *et al.*, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007/2008; Soekartawi, 2008; Gewald and Dibbern, 2009; Khan *et al.*, 2011
	Policy	Baroud, 2006; Khoja *et al.*, 2007/2008; Soekartawi, 2008; Gewald and Dibbern, 2009; Verhoeven *et al.*, 2009; Purnomo and Lee, 2010; Sicotte and Pare, 2010
	Legal and regulatory frameworks	Howard *et al.*, 2006; Khoja *et al.*, 2007/2008; Tran *et al.*, 2011
	Politics	Khoja *et al.*, 2007/2008; Sicotte and Pare, 2010
	Poor commitment of policy-makers	Baroud, 2006

2.3.5 E-readiness factors of barcode technology implementation in hospitals

A number of literatures have studied about the readiness and barrier factors for ICT implementation in hospital industry. A previous study from Yucel *et al.* (2011) and Yusof *et al.* (2008b) studied factors for health information system implementation in hospitals and showed that the important factors include technological, people, and organizational factors. Sicotte and Pare (2010) investigated the implementation and deployment of two large health information exchange (HIE) projects in Quebec, Canada and showed that the risk factors include technology, people, usability, managerial, and political. Kijsanayotin *et al.* (2009) studied the factors influencing health information technology to adopt in Thailand's community health centers and found that key factors include performance expectancy, effort expectancy, social influence, and voluntariness. Among these factors, performance expectancy exerted the strongest effect. In addition, Khoja *et al.* (2007/2008) studied

barrier factors for e-health readiness assessment for developing countries and found that nine factors include appropriateness of technology, affordability, capacity, relevant content, integration, socio-cultural factors, trust, legal and regulatory frameworks, and political.

Barcode technology helps to improve efficiency and eliminating human error if used correctly. In developed countries, this technology has been in place for over 25 years in hospital and longer in other industries (Southard, 2005). The American Hospital Association (Levin, 2005) and the American Society of Health-System Pharmacists (ASHP) (Ragan *et al.*, 2005) listed the following reasons for drug management errors which lead to patient unsafety:

1) Drug information flow cannot link with the other departments in hospitals,

2) Miscommunication of drug orders, which can involve poor handwriting, trailing zeros, or confusion of metric doses or other units of dosage,

3) Lack of accuracy of drug administration and documentation,

4) Inefficiency within process,

5) Environment, such as lighting, heat, noise, and interruptions that distract the health professionals from their medical tasks.

Patients are at risk of harm from medication errors (Morriss *et al.*, 2009). The implementation of barcode technology in hospitals and healthcare institutions in the United States has been found to effectively reduce the rate of human errors associated with dispensing, transcribing and administering medications (DeYoung *et al.*, 2009; Morriss *et al.*, 2009; Paoletti *et al.*, 2007). In addition, the use of personal digital assistant (PDAs) with barcode reader in hospital is reported to improve decision-making, reduce medication errors, and to improve patient care (Lindquist *et al.*, 2008; Lu *et al.*, 2005; Baumgart, 2005).

Considering literatures in hospital industry, due to the limited works of literatures related to e-readiness, all the factors mentioned in the literature were included in this study. The hospital specific factors include trust, lighting, heat, noise, interruptions, and voluntariness.

Therefore, this dimension is quite specific for hospital industry as there is no other literature mentioned in other industries. In this research, we call factors of this dimension “Hospital environment” factors.

The above errors can be diminished by using barcode technology in the pharmacy department. To evaluate the e-readiness of the hospitals, whether or not the hospital is ready for barcode technology implementation, questionnaires will be used as a tool. The factors will be justified ranging from 1 to 5 of the Likert scale. Then a concept of fuzzy-importance performance analysis (Fuzzy-IPA) will be applied in order to make the scales more flexible and reduce bias of human perceptions.

2.4 Fuzzy-IPA method

The method or tools used in data analysis are varied ranging from modified Delphi method (Snyder-Halpern, 2001), deductive analysis (Verhoeven *et al.*, 2009), expert opinion (Janom and Zakaria, 2009), data envelopment analysis (Emrouznejad *et al.*, 2010), factor analysis (Fathian *et al.*, 2008; Lou and Goulding, 2010; Lai and Ong, 2010), regression analysis (Keramati *et al.*, 2011), fuzzy analysis (Lin and Yeh, 2010; Yucel *et al.*, 2011; Erol *et al.*, 2011), and Fuzzy-IPA (Deng and Pei, 2009; Wang and Tseng, 2011).

Fuzzy-IPA method is comprised of fuzzy logic concept and importance-performance analysis (IPA) concept.

2.4.1 Fuzzy logic

Fuzzy logic is used to solve a lot of problems related wide range of area, as providing flexible solutions. Designing a fuzzy system contains fuzzy sets and membership functions (Acilar and Arslan, 2011).

2.4.1.1 Fuzzy sets and fuzzy numbers

The fuzzy set theory first introduced by Zadeh (1965) is appropriate for dealing with uncertainty and imprecision associated with information. The basic definition and concept of fuzzy set theory can be found on Zadeh (1965),

Ma *et al.* (2007), Nasiri and Huang (2008), Deng and Pei (2009), Erol *et al.* (2011), Yalcin *et al.* (2012).

Definition 1: Fuzzy set

Let X be a universe of discourse, $\tilde{A}$ is a fuzzy subset of X such that for all $x \in X$. There is a number $\mu_{\tilde{A}}(x)$ which (Zadeh, 1965).

Definition 2: Fuzzy number

A fuzzy number $\tilde{A}$ is a normal and convex fuzzy subset of X. Here, the "convex" set implies that (Zadeh, 1965).

$$\forall x_1 \in X \ , \ x_2 \in X \quad \forall \alpha \in [0,1]$$
$$\mu_{\tilde{A}}(ax_1 + (1 - a)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2))$$

Definition 3: Triangular fuzzy number

A triangular fuzzy number $\tilde{A}$ can be defined by a triplet (l, m, u). The membership function is defined as (Kaufmann and Gupta, 1988):

$$\mu_{\tilde{A}}(X) = \begin{cases} 0 \ , & x < l \\ x - l/m - l \ , & l \leq x \leq m \\ u - x/u - m, & m \leq x \leq u \\ 0 \ , & x > u \end{cases}$$

Where l, m, and u are real number and l = m = u.

A triangular fuzzy number can be shown as (l, m, u). The parameters l, m, and u, respectively, denote the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event. The reason for using a triangular fuzzy number is that it is intuitively easy for the decision makers to use and calculate. Triangular fuzzy membership functions defined is shown in Figure 2.6.

Each triangular fuzzy number has linear representations on its left and right sides such that its membership function can be defined as displayed in Zimmermann (1991).

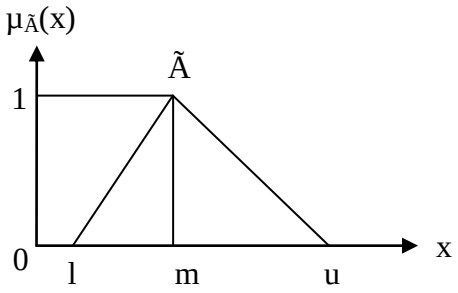


Figure 2.6 A triangular fuzzy number

Numerous studies have applied fuzzy set theory to research problems involving uncertainty. For example, Nasiri and Huang (2008) use fuzzy sets to employ to express environmental performance assessment judgments and to formulate the weighted aggregation process in waste recycling, Canada. Furthermore, Ma *et al.* (2007) propose a fuzzy-set-based approach is described linguistic information in multi-criteria decision-making. In above researches, the qualitative data or linguistic terms used to represent imprecise assessments of decision criteria or performance attributes are all expressed using fuzzy number. Consequently, researchers or practitioners should consider the application of fuzzy set theory into IPA since customer perceptions of service performance are characterized by uncertainty and fuzziness (Deng and Pei, 2009).

2.4.1.2 Membership function

This membership value is denoted by $\mu_A(x)$, where x is an element of fuzzy set A. The membership value $\mu_A(x)$ is the degree of belief with which an element can be stated to belong to the set (Kumar *et al.,* 2004). Membership function, such as triangular, trapezoidal, Gaussian, S, or π function, to name a few, to initially represent the distribution of the pattern data (Choi and Rhee, 2009).

The selection of membership function must selected to suitable and to cover of receiving data. It can overlap for smooth of the work, which can have varied value of membership. In addition, membership function can be change to suitable of the work or requirement.

2.4.1.3 Linguistic variable

A linguistic variable is defined as a variable, the values of which are expressed in words, phrases or sentences in a given language (Zadeh, 1975a,

1975b, 1976; Ayyub and Haldar, 1984). The phrase "performance of constructed facility", for example, is a linguistic variable that can take the values of excellent, good or low. The information expressed in the phrase has a value that is not clearly defined. The variabilities of the linguistic variables can be represented as fuzzy sets (Kumar *et al.,* 2000). The concept of a linguistic variable is very useful in dealing with situations, which are too complex or not well defined to be reasonably described in conventional quantitative expressions (Zimmermann, 1991).

The values of linguistic variables are called linguistic labels. In more specific terms, a linguistic variable is characterized by a quintuple (H, T(H), U, G, M) in which (Carrasco *et al.,* 2012):

- H is the name of the variable.
- T(H) is the term-set of H or the collection of linguistic values (labels).
- U is the universe of discourse.
- G is the syntactic rule, i.e., a context-free grammar which generates the terms in T(H).
- M is the semantic rule which defined the meaning of each linguistic label X, M(X), where M(X) denotes a fuzzy subset of U.

2.4.1.4 Fuzzy linguistic approach

The fuzzy linguistic approach is a very feasible method to handle the linguistic assessment information. The use of fuzzy linguistic approach has given very good results for modeling qualitative information and it has proven to be useful in many problems (Li *et al.,* 2011), e.g., in decision making (Ma *et al.,* 2007; Lin and Yeh, 2010; Yalcin *et al.,* 2012), model for the integration of e-financial services (Carresco *et al.,* 2012), quality evaluation (Wang and Tseng, 2011; Arantes and Verdier, 2010; Fan *et al.,* 2009), selection of supply chain partners (Chang *et al.,* 2006), and risk assessment model (Yucel *et al.,* 2011). This approach comprises two steps:

1) Assignment of triangular fuzzy number to indicate the perceptions of respondents

This study used a triangular fuzzy number to represent the linguistic term of respondent's perception of staff importance or performance. Moreover, the linguistic terms from among which respondents chose to indicate their perception towards service are very high (VH), high (H), medium (M), low (L), and very low (VL). In the first part in the survey of this study, respondents were asked to complete the question about the range of each linguistic term based on their own subjective decision. For example, one respondent gave triplets (0, 0, 25), (0, 25, 50), (25, 50, 75), (50, 75, 100) and (75, 100, 100) meaning VL, L, M, H, and VH, respectively (see Figure 2.8). Another respondent gave triplets (0, 0, 30), (0, 30, 50), (30, 50, 70), (50, 70, 100) and (70, 100,100) meaning VL, L, M, H, and VH, respectively. Finally, this study aggregates respondent opinions regarding specific linguistic terms by calculating the average triangular fuzzy number for all respondents. Consequently, the final average triangular fuzzy number of each linguistic term is decided and used for the subsequent assignment of a triangular fuzzy number indicating respondent perceptions (Tsaur *et al.*, 1997).

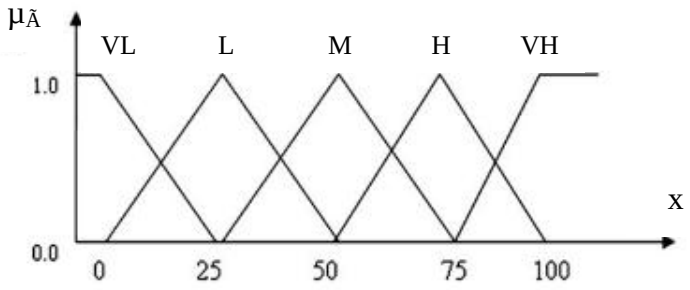


Figure 2.7 The *i*th respondent's linguistic term (Deng and Pei, 2009)

The integration formula is as follows (Deng and Pei, 2009):

$$\tilde{A}_{k\ avg} = \frac{\sum_{i=1}^{n} \tilde{A}_k^{\,i}}{n} = \frac{\left(\sum_{i=1}^{n} a_{k1}^{(i)}, \sum_{i=1}^{n} a_{k2}^{(i)}, \sum_{i=1}^{n} a_{k3}^{(i)}\right)}{n}, \; i = 1, 2, \ldots, n; \; k = 1, 2, 3, 4, 5 \quad (1)$$

where $\tilde{A}_k^i$ is the triangular fuzzy number of *k*th linguistic term under *i*th respondent; $a_{k1}^{(i)}$, $a_{k2}^{(i)}$ and $a_{k3}^{(i)}$ represent the lower value, the moderate value and the upper value of the support of $\tilde{A}_k^i$, respectively; n denotes the total number of respondent; *k* denotes the number of linguistic term and there are five linguistic terms in this study, including VL, L, M, H, and VH.

2) Fuzzy number arithmetic and defuzzification for respondent perceptions

After all respondent perceptions are assigned triangular fuzzy number, the necessary arithmetic and defuzzification can be performed. The necessary triangular fuzzy number arithmetic and defuzzification are as follows (Deng and Pei, 2009):

(1) Average *j*th attribute performance:

$$\tilde{A}_{j\ avg} = \frac{\sum_{i=1}^{n}\tilde{A}_j^i}{n} = \frac{(\sum_{i=1}^{n}a_{j1}^{(i)}, \sum_{i=1}^{n}a_{j2}^{(i)}, \sum_{i=1}^{n}a_{j3}^{(i)})}{n},\ i = 1, 2, \ldots, n;\ j = 1, 2, \ldots, m \quad (2)$$

where $\tilde{A}_j^i$ is the triangular fuzzy number of *j*th attribute performance under *i*th respondent; $a_{j1}^{(i)}$, $a_{j2}^{(i)}$ and $a_{j3}^{(i)}$ represent the lower value, the moderate value and the upper value of the support of $\tilde{A}_j^i$, respectively; n denotes the total number of respondents; m is the total number of attributes performance.

(2) Defuzzification of triangular fuzzy number:

As Chen, Chien and Tsai, and Kaufmann and Gupta (Chen, 1996; Chien and Tsai, 2000; Southard, 2005) note, the defuzzification formula for triangular fuzzy number is

$$V_{\tilde{A}} = (a_1+2a_2+a_3)/4 \quad (3)$$

where $V_{\tilde{A}}$ is the crisp number of $\tilde{A}$ triangular fuzzy number (a_1, a_2, a_3).

2.4.1.5 Fuzzy entropy weight

Entropy method is particularly useful for assigning a weight to each criterion because of the fact that (Chen and Hwang, 1992; Hwang and Yoon, 1981; Zeleny, 1982; Xu *et al*., 2004; Zou *et al*., 2006; Sopadang *et al*., 2002): (1) this method does not require an individual decision maker to rank the criteria, (2) the relative weight of each criterion can be obtained using rather simple calculations, and (3) the determination of weight by calculating entropy is to choose the best indicators (Zhi-hong *et al*., 2006).

The entropy concept suggests that if values for alternatives as to a criterion are the same, the criterion can be eliminated from further consideration. Alternately, the weight assigned to a criterion can be smaller if all the alternatives have similar values for a criterion. On the other hand, when the differences between a criterion's values across particular alternatives are greater, the criterion is viewed as more important. The entropy concept has been shown to be particularly useful to investigate contrasts between sets of data (Erol *et al*., 2011).

Traditional entropy method is an object empowerment approach, in which the weight values of individual indicators are determined by calculating the entropy and entropy weight (Qi *et al*., 2010). However, fuzzy entropy weight is entropy method based on fuzzy arithmetic (linguistic values).

The main steps of the entropy weight method include: the formation of the evaluation matrix; the standardization of the evaluation matrix; the calculation of the entropy and the entropy weight (Qi *et al*., 2010). The equations of calculation are referred from Erol *et al*. (2011) as follow:

Deciding matrix D of m alternatives and n attributes (factors)

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccc} X_1 & X_2 & & X_j & & X_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad (4)$$

Where A_i the *i*th alternative considered,

x_{ij} the numerical outcome of the *i*th alternative with respect to the *j*th factor.

Fuzzy entropy algorithm for determining the evaluation factor weights can be summarized as follows (Erol *et al.*, 2011):

Step 1: Calculate the normalized fuzzy decision matrix, $\widetilde{\boldsymbol{R}}$.

The positive factor, the normalized value is calculated as follows:

$$\widetilde{\boldsymbol{R}} = \frac{\boldsymbol{x_{ij} - min\, x_j}}{\boldsymbol{max\, x_j - min\, x_j}} \quad , \qquad i = 1, 2,\ldots, m;\ j = 1, 2,\ldots, n \tag{5}$$

Similarly, the normalized value for the negative factor is calculated as follows:

$$\widetilde{\boldsymbol{R}} = \frac{\boldsymbol{max\, x_j - x_{ij}}}{\boldsymbol{max\, x_j - min\, x_j}} \quad , \qquad i = 1, 2,\ldots, m;\ j = 1, 2,\ldots, n \tag{6}$$

Step 2: Determination of fuzzy weights

$$W_j = (w_j^l, w_j^m, w_j^u) \quad , \qquad j = 1, 2,\ldots, n \tag{7}$$

$$\boldsymbol{w_j^l} = \frac{\dfrac{\mathbf{1}}{\boldsymbol{x_{ij}^l}} - \mathbf{1}}{\dfrac{\mathbf{1}}{\boldsymbol{x_{ij}^l}} - \mathbf{1} + \sum_{\boldsymbol{k \neq j}} \dfrac{\mathbf{1}}{\boldsymbol{x_{1k}^r}} - \mathbf{1}} \quad , \qquad k = 1, 2,\ldots, n \tag{8}$$

where value of r_{ij} is defined as the following probability:

$$\boldsymbol{r_{ij}} = \frac{\boldsymbol{x_{ij}}}{\sum_{\boldsymbol{i=1}}^{\boldsymbol{m}} \boldsymbol{x_{ij}}} \tag{9}$$

$$w_j^m = \frac{\frac{1}{x_{ij}^m} - 1}{\sum_{k=1}^{n} \frac{1}{x_{1k}^m} - 1}, \qquad k = 1, 2, \ldots, n \tag{10}$$

$$w_j^u = \frac{\frac{1}{x_{ij}^u} - 1}{\frac{1}{x_{ij}^u} - 1 + \sum_{k \neq j} \frac{1}{x_{1k}^l - 1}}, \qquad k = 1, 2, \ldots, n \tag{11}$$

Step 3: Calculate the distance based weights.

The entropy $\widetilde{E}_j$ of the set of attribute j is

$$\widetilde{E}_j = -\frac{1}{ln\, m} \sum_{i=1}^{m} f_{ij}\ ln f_{ij} \quad , \qquad 0 \leq \widetilde{E}_j \leq 1 \tag{12}$$

$$f_{ij} = \frac{1 + \widetilde{R}}{\sum_{i=1}^{m} (1 + \widetilde{R})} \tag{13}$$

Now, calculate the fuzzy distance entropy weight with the following equation:

$$w_j^d = \frac{1 - \widetilde{E}_j}{\sum_{i=1}^{n} (1 - \widetilde{E}_j)} \tag{14}$$

Step 4: Determination of the final fuzzy entropy weights.

$$\widetilde{W}_j = \left((w_j^l) \times \left(\frac{w_j^d}{w_j^m} \right), (w_j^m) \times \left(\frac{w_j^d}{w_j^m} \right), (w_j^u) \times \left(\frac{w_j^d}{w_j^m} \right) \right) \tag{15}$$

2.4.2 Importance-Performance Analysis

Importance-performance analysis **(**IPA), originally introduced by Martilla and James (1977), yields insights into which product or service attributes a firm should focus on to achieve customer satisfaction (Chu and Choi, 2000; Oh, 2001; Matzler *et al.*, 2004). A commonly seen IPA is a two-dimensional grid, depicted in Figure 2.7,

constructed by plotting mean ratings of performance and importance. Importance is labeled as the y-axis, whereas performance is labeled as the x-axis. This four-quadrant matrix can be used to identify improvement opportunities as well as to guide strategic planning efforts (Wu and Shieh, 2009; Wang and Tseng, 2011; Ziegler *et al.*, 2012). The meanings of these four quadrants in IPA are as follows:

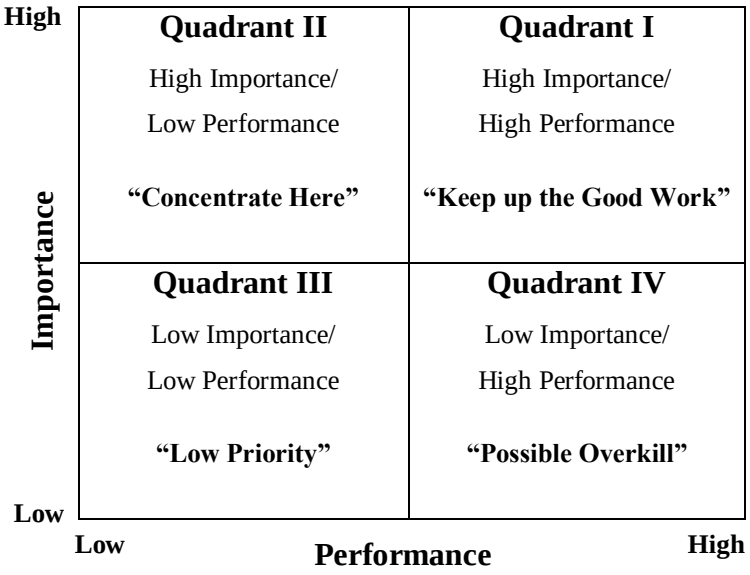


Figure 2.8 Importance – performance analysis (Martilla and James, 1977)

Quadrant I

Attributes are perceived to be very important to respondents, and at the same time, the organization seems to have high levels of performance on these activities. The message here is to "Keep up the Good Work".

Quadrant II

Attributes are perceived to be very important to respondents, but performance levels are fairly low. This sends a direct message that improvement efforts should "Concentrate Here".

Quadrant III

Attributes are low importance and low performance. Although performance levels may be low in this cell, managers should not be overly concerned since the attribute in this cell is not perceived to be very important. Limited resources should be expended on this "Low Priority" cell.

Quadrant IV

This cell contains attributes of low importance, but relatively high performance. Respondents are satisfied with the performance of the organizations, but managers should consider present efforts on the attributes of this cell as being "Possible Overkill".

IPA is considered as a simple but effective tool. It is very helpful in deciding how to best allocate scarce resources in order to maximize satisfaction (Matzler *et al.*, 2004). IPA has become a popular managerial tool that has been broadly used to identify the strengths and weaknesses of brands, products, services and retail establishments in various industries in recent years (Chu and Choi, 2000). Matzler *et al.* (2004) studied on customer satisfaction with a supplier in the automotive industry. Using a regression analysis with dummy variables, the asymmetric relationship between attribute-level performance and overall satisfaction could be confirmed. Ziegler *et al.* (2012) measured the satisfaction of customer in the whale shark tourism industry on Isla Holbox, Mexico. In order to assess the success of this industry in meeting customer expectations. While Chu and Choi (2000) used the IPA to selected hotel's factors in the Hong Kong hotel industry and to compared between business and leisure travellers. In addition, Wang and Tseng (2011) integrated fuzzy and IPA to evaluated satisfaction of international student in Taiwan called "Fuzzy-IPA".

To summarize, the critical review of the concepts and frameworks in the fields of pharmaceutical supply chain in hospital, barcode technology, and e-readiness assessment suggests the following key points that would be a helpful guide in the development of a conceptual framework on barcode technology adoption.

1. The success of barcode technology adoption or implementation depends on e-readiness of the hospitals.

2. E-readiness assessment means ICTs + e-skilled people.

3. Barcode technology adoption concern multiple factors including people, process, technology, organizational, government, and hospital environment. All factors will contribute for the ultimate success.

4. A method to assess barcode technology adoption proposed in this study is Fuzzy-IPA method. Its classify both readiness and barrier factors into four scenarios

including “Keep up the Good Work”, “Concentrate Here”, “Low Priority”, and “Possible Overkill”.

Therefore, this research is focused on pharmaceutical supply chain concerning procurement and inventory management in hospitals. Factors of e-readiness assessment, concluded from literature review, are six dimensions (people, process, technology, organization, government, and hospital environment). Each factor will be identified by expert interviews if it is related to the hospital pharmacy operations as described in Chapter III.

CHAPTER III
RESEARCH METHODOLOGY

This chapter present steps of research methodology used for e-readiness assessment for barcode technology implementation in hospitals. Research tools include the review of literature and expert interview which were used to identify factors and classify factor dimensions. Then, the questionnaires were developed for getting inputs from relevant people, followed by data collection, and data analysis using Fuzzy-IPA methods. The final step in research methodology is to construct guideline for hospitals to implement barcode technology.

3.1 Steps of research methodology

The research methodology could be divided into six processes; literature review, expert interview for factor identification and classification, questionnaires development, data collection, data analysis, and guideline construction for barcode technology implementation in Thai hospitals. Figure 3.1 presented steps of research methodology.

3.1.1 Literature review

Through an extensive literature review as mentioned in Chapter II, e-readiness assessment factors are identified. The articles were identified through a computer search of database of published works and conference proceedings in the e-readiness area. The articles were searched by the title based on the criteria such as it must contain either the keyword “e-readiness, ICT readiness, readiness factors, barrier factors, or risk factors”. There are 72 factors related to the ICT implementation in various industries as shown in Appendix A. The factors which have been mentioned twice and more are included in this research. In total, 34 factors were selected (Table

3.1). Factors were not included; user acceptance, voluntariness people and organizations online, flexibility, information, industry standards, integration of ICT into peoples' lives, use of ICT in business, access to specialized resources, core readiness, cooperation, motivational, revenue on electronic services, government's role in driving e-readiness, engagement, behavioral intention, age, gender, self efficacy, prior experience, implement, usability, technology architecture, compatibility, impact, enjoyment, trust, ongoing research, organizational commitment, user participation, size, and language as shown in Appendix A.

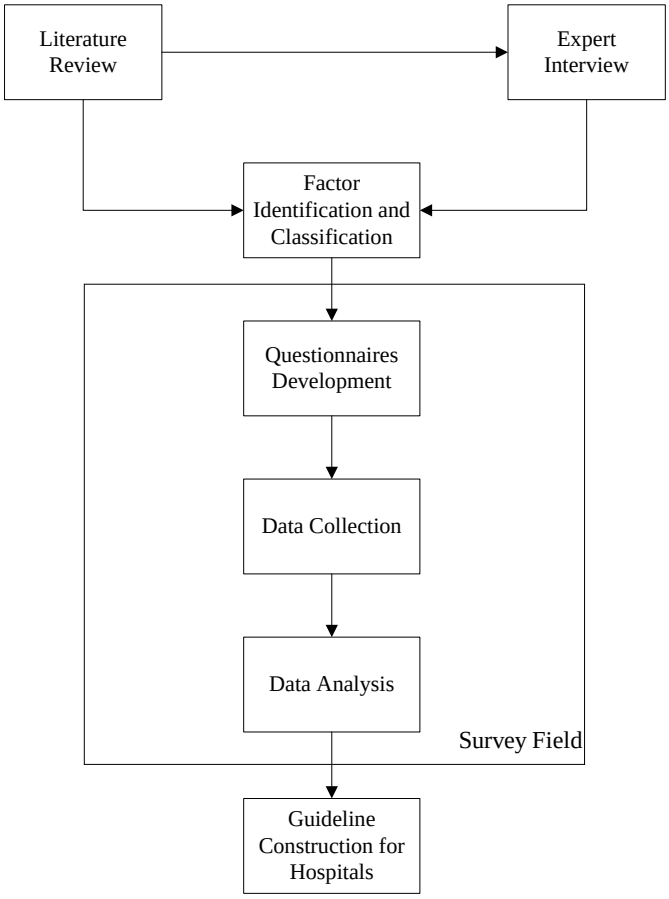


Figure 3.1 Steps of research methodology

Table 3.1 Dimensions and factors from the literature review

Dimensions	Factors
1. People	1.1 Personality
	1.2 Skills
	1.3 Task
	1.4 Individual knowledge
	1.5 Self-development
2. Process	2.1 Resources
	2.2 Operations
3. Technology	3.1 Infrastructure
	3.2 Internet availability and affordability
	3.3 Locally relevant content
	3.4 Innovation
	3.5 Security and encryption
	3.6 ICT services and support
	3.7 Quality
	3.8 Performance
	3.9 Access and equity
	3.10 Appropriateness of ICT
	3.11 ICT capacity and training
	3.12 Instructional
	3.13 Linkage of information
4. Organization	4.1 Management
	4.2 Socio-cultural
	4.3 Strategy
	4.4 Values & goals
	4.5 Human resources
	4.6 Structure
	4.7 Communication
	4.8 Geographical
	4.9 Training staff
	4.10 Work-environment

Table 3.1 Dimensions and factors from the literature review (cont.)

Dimensions	Factors
5. Government	5.1 Finance
	5.2 Policy
	5.3 Legal and regulatory frameworks
	5.4 Politics

From Table 3.1, the factors collected from readiness and barrier of e-readiness literature are called "General e-readiness assessment framework". However, in addition to the general e-readiness assessment framework, the ultimate goal that all parties in the HSC concern is the safety and well being of the patients. Therefore, this study added another group of factors to the e-readiness assessment framework which is related to "Hospital environment". The Hospital environment factors are called "Specific dimension in HSC" as shown in Figure 3.2 and the factors in the dimension are included trust, lighting, heat, noise, interruptions, and voluntariness.

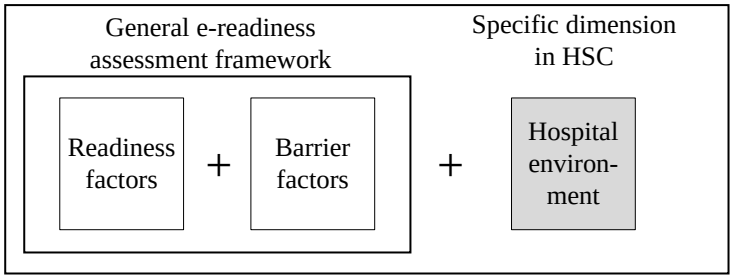


Figure 3.2 Research framework

Then, we interviewed the experts whose works are related to the flow of pharmaceutical products and information within the hospitals. They are the target uses of barcode technology implementation in hospital in the future.

3.1.2 Expert interview

Expert interview was conducted to determine how experts and practitioners defined e-readiness of hospitals and what they considered as key factors. Using three experts of hospital, two persons-information technology (IT) staff and one person-pharmacist in warehouse department.

The result of expert selection are 30 factors consisting of six dimensions: (1) people (5 factors); personality, skills, individual knowledge, task, and self-development, (2) process (2 factors); resources, and operations, (3) technology (10 factors); infrastructure, internet availability and affordability, innovation, security and encryption, ICT services and support, quality, performance, access and equity, appropriateness of ICT, and linkage of information, (4) organization (4 factors); management, strategy, structure, and communication, (5) government (4 factors); finance, policy, legal and regulatory frameworks, and politics, and (6) hospital environment (5 factors); lighting, heat, noise, interruptions, and voluntariness as shown in Table 3.2.

Table 3.2 Dimensions and factors from the expert interviews

Dimensions	**Factors**
1. People	1.1 Personality (P1)
	1.2 Skills (P2)
	1.3 Task (P3)
	1.4 Individual knowledge (P4)
	1.5 Self-development (P5)
2. Process	2.1 Resources (C1)
	2.2 Operations (C2)
3. Technology	3.1 Infrastructure (T1)
	3.2 Internet availability and affordability (T2)
	3.3 Innovation (T3)
	3.4 Security and encryption (T4)
	3.5 ICT services and support (T5)
	3.6 Quality (T6)
	3.7 Performance (T7)
	3.8 Access and equity (T8)
	3.8 Appropriateness of ICT (T9)
	3.10 Linkage of information (T10)

Table 3.2 Dimensions and factors from the expert interviews (cont.)

Dimensions	Factors
4. Organization	4.1 Management (O1)
	4.2 Strategy (O2)
	4.3 Structure (O3)
	4.4 Communication (O4)
5. Government	5.1 Finance (G1)
	5.2 Policy (G2)
	5.3 Legal and regulatory frameworks (G3)
	5.4 Politics (G4)
6. Hospital environment	6.1 Lighting (E1)
	6.2 Heat (E2)
	6.3 Noise (E3)
	6.4 Interruptions (E4)
	6.5 Voluntariness (E5)

From Table 3.2, the experts did not select the following factors including: locally relevant content, ICT capacity and training, instructional, socio-cultural, values & goals, human resources, geographical, training staff, work-environment, and trust. These factors are not considered as important factors for e-readiness assessment for barcode technology implementation in Thai hospitals.

The result of the study was used to design e-readiness assessment questionnaires. This assessment was composed of dimensions and factor definitions. Definitions were used to determine interesting areas for information and/or data and to the same understanding of respondents of questionnaires. The dimension and factor definitions were shown in Table 3.3.

Table 3.3 Definition of dimensions and factors

Dimensions and factors	Definitions
1. People	**User's in hospitals such as pharmacist, nurse, IT staff, finance staff, warehouse staff, and purchasing staff.**
1.1 Personality	User's personality.
1.2 Skills	User's skills of barcode scanner.
1.3 Task	User's quantity of work.
1.4 Individual knowledge	User's individual knowledge.
1.5 Self-development	User's capability in developing his/her work.
2. Process	**A working procedure related to the use of barcode technology.**
2.1 Resources	Resources sufficiency.
2.2 Operations	Steps in operations.
3. Technology	**All aspects related to information technology (IT) and communication technology (CT) in hospital.**
3.1 Infrastructure	Infrastructure which is related to barcode technology implementation.
3.2 Internet availability and affordability	Internet services at departments/units.
3.3 Innovation	New process/steps.
3.4 Security encryption	The protection of data against unauthorized access of hospital.
3.5 ICT services and support	ICT system for supporting hospital staff.
3.6 Quality	The quality of ICT system in the hospitals.
3.7 Performance	The performance of ICT system in the hospitals.
3.8 Access and equity	Ability to access information system of the users.
3.9 Appropriateness of ICT	The appropriateness of ICT system in the hospitals.
3.10 Linkage of information	The capability for linking information in every unit.

Table 3.3 Definition of dimensions and factors (cont.)

Dimensions and factors	Definitions
4. Organization	**Organization and activities in the organization.**
4.1 Management	Management's support for barcode technology implementation.
4.2 Strategy	Strategy of the hospital.
4.3 Structure	Appropriateness of hospital structure for barcode technology implementation.
4.4 Communication	Communication within hospitals.
5. Government	**Role of government as a driver or supporter to adoption of barcode technology.**
5.1 Finance	Financial support from government.
5.2 Policy	Consistency between the policies of the government and the operations.
5.3 Legal and regulatory frameworks	Law and regulations related to the barcode technology adoption.
5.4 Politics	The impact of political changes to hospital question.
6. Hospital environment	**Working environment in hospital.**
6.1 Lighting	The appropriateness of lighting in the working area.
6.2 Heat	The temperature in the working area.
6.3 Noise	Voice in the working area.
6.4 Interruption	The disturbance in the working area.
6.5 Voluntariness	Patients' perception of the service staff.

From Table 3.3, all definitions were used in the questionnaires in order to ensure the same understanding on each factor.

3.1.3 Questionnaires Development

Questionnaires have been developed in order to measure the e-readiness level of the hospital for barcode technology implementation. The questionnaires in this research comprised three parts. The first part included respondent's information. The second part contained 30 statements reflecting the factors of performance and

importance in hospital. The final part included hospital profile. This research used five-point Likert scale to give scores for the importance of each factor and the scores for the actual performance of the hospitals specifically to each factor. The importance factors are ranging from 1) very low important to 5) very high important (see Table 3.4). The performance factors in this study concern the readiness level which are ranging from 1) very poor to 5) excellent (see Table 3.5). The questionnaires in English and Thai are shown in Appendix C and D. The questionnaires were pre-tested and revised before sending to the respondents. The range of each factor performance is shown in Appendix B.

Table 3.4 Importance score and description

Score	Meaning	Description
5	Very high	Factors are considered as the very high important factors affecting the implementation of barcode technology in hospital.
4	High	Factors are considered as the high important factors affecting the implementation of barcode technology in hospital.
3	Medium	Factors are considered as the medium important factors affecting the implementation of barcode technology in hospital.
2	Low	Factors are considered as the low important factors affecting the implementation of barcode technology in hospital.
1	Very low	Factors are considered as the very low important factors affecting the implementation of barcode technology in hospital.

Table 3.5 Performance score and description

Score	Meaning	Description
5	Excellent	Factors are excellent worked the hospital or staff.
4	Good	Factors are good worked the hospital or staff.
3	Average	Factors are somewhat worked the hospital or staff.
2	Poor	Factors are a little worked the hospital or staff.
1	Very poor	Factors are not worked the hospital or staff.

3.1.4 Data collection

The questionnaires were sent to the target hospitals for data collection. The hospitals are divided into three groups: (1) Small-size public hospitals (10-120 beds), (2) Large-size public hospitals (over 120 beds), and (3) Private hospitals. The target participants are pharmacists working in the hospital warehouse, pharmacists working in the pharmacy department, staff in procurement department, IT staff, staff in finance department, and nurses. The target number of respondents for each group of the hospitals is 30. This is based on the Central Limit Theorem which stated that the sampling distribution of any statistic will be normal or nearly normal, if the sample size is large enough or N>30 (Bartz, 1999). Then, the data were analyzed with Fuzzy-IPA method.

3.1.5 Data Analysis

The data were analyzed using Fuzzy-IPA method. Fuzzy-IPA method used in this study comprises six steps adapted from Deng and Pei (2009) and Erol *et al.* (2011):

1) Collect data for importance and performance of each factor identified from step of data collection.

2) Use fuzzy entropy to find the importance weight of the factors which studied in Chapter II (Equation 3 - 15).

3) Use fuzzy linguistic to find the performance values of the factors which studied in Chapter II (Equation 1 - 3). The Linguistic terms are used as shown in Table 3.6.

4) Plot all factors' importance and performance on the Fuzzy-IPA matrix.

Table 3.6 The linguistic terms (Deng and Pei, 2009)

Linguistic terms	Linguistic values
Very low	(0.00; 2.38; 21.83)
Low	(5.56; 24.92; 46.75)
Medium	(27.70; 49.29; 69.76)
High	(52.62; 73.41; 92.22)
Very high	(78.02; 95.95; 100.00)

5) The reasonable action plan for each factor in each quadrant determined the priority is given to factors fell in Quadrant II "Concentrate Here".

6) The data analyzed for each group of hospitals separately. The comparison analysis conducted among these groups of the hospitals including small-size public hospitals, large-size public hospitals, and private hospitals.

3.1.6 Guideline construction for hospitals

After the data analysis using Fuzzy-IPA method, each factor was classified into each quadrant. Priority gave to the factors fell in Quadrant II "Concentrate Here" and almost all resources should be used to improve these factors to be ready for the barcode technology implementation. A clear guideline should be made for each group of hospitals to follow in order to achieve a certain e-readiness level for these factors. If there still be some resources available, the factors in Quadrant I "Keep up the Good Work" should be put into consideration and further action.

CHAPTER IV
RESULTS

This chapter described the results of the study based on the research methodology in Chapter III. The results start from descriptive statistics, the e-readiness factor' scores which were collected from questionnaires survey, the analysis using Fuzzy-IPA method, and the construction of Readiness-Check program.

4.1 Descriptive statistics

The total of one hundred and forty questionnaires were sent to fourteen hospitals in the three groups (sixty questionnaires for six small-size public hospitals, forty questionnaires for four large-size public hospitals, and forty questionnaires for four private hospitals). One hundred and fourteen questionnaires were returned, yielding a response rate of 81%. The list of hospitals included in this study is shown in the Appendix E. The response rate for each hospital group varied from 76% to 85% as shown in Table 4.1. Table 4.2 reports the overall and group-specific descriptive statistics for respondent characteristics. Overall, respondents are 31-40 years old (45%) and about 66% are female. About 32% are IT hospital employees, 29% are pharmacists, and 20% are nurses. Most of respondents working in hospital have more than 4 years (60%) of experience.

Table 4.1 The response rate

Questionnaires	**Small-size public hospitals**	**Large-size public hospitals**	**Private hospitals**
Sent	60	40	40
Returned	46	34	34
Response rate (%)	**76.67**	**85.00**	**85.00**

Table 4.2 Descriptive statistics for respondent characteristics

Respondent characteristic	Overall (%)	Small-size public hospitals (%)	Large-size public hospitals (%)	Private hospitals (%)
Gender				
Male	33.33	30.43	35.29	35.29
Female	66.67	69.57	64.71	64.71
Age (year)				
20-30	26.32	23.91	41.18	14.71
31-40	45.61	56.52	41.18	35.29
>40	28.07	19.57	17.65	50.00
Role of respondents				
Pharmacist	28.95	36.96	32.35	14.71
Nurse	20.18	21.74	11.76	26.47
IT staff	32.46	19.57	55.88	26.47
Warehouse staff	12.28	13.04	-	23.53
Finance staff	5.26	8.70	-	5.88
Procurement staff	0.88	0.00	-	2.94
Experience (year)				
<1	12.28	4.35	23.53	11.76
1-2	14.04	4.35	29.41	11.76
3-4	14.04	26.09	5.88	5.88
>4	59.65	65.22	41.18	70.59

Table 4.3 shows the basic hospital characteristics for each group of the hospitals. In term of number of pharmaceutical products; all small-size public hospitals have 201-500 SKUs, large-size public hospitals have more than 1,000 SKUs, and almost all private hospitals except one have more than 1,000 SKUs. ICT systems used in pharmacy department are varied from SAP, HosXP, Easy Hos, SSB, and other. All hospital departments including procurement, warehouse, pharmacy, and finance use computers to manage pharmaceutical products. Four small-size public hospitals have got hospital accreditation (HA). Two hospitals have not accredited yet, but they

plan to do so. All large-size public hospitals in this study and two private hospitals have accredited. The HA is a self-assessment and external peer assessment process used by healthcare organizations to accurately assess their level of performance in relation to established standards and to implement ways for continuously improvement. The survey on using barcode technology for pharmaceutical products management in hospitals showed that all small-size public hospitals and private hospitals have not used barcode technology. Only, three large-size public hospitals have used barcode technology in pharmaceutical products.

Table 4.3 Descriptive for basic hospital characteristics

Hospital characteristic	No. of hospitals		
	Small-size public hospitals	**Large-size public hospitals**	**Private hospitals**
Total hospital	6	4	4
No. of pharmaceutical product (SKUs*)			
201-500	6	-	-
501-1,000	-	-	1
>1,000	-	4	3
ICT system			
SAP	-	1	-
HosXP	5	-	1
Easy Hos	-	1	-
SSB	1	-	2
Other	-	2	1
Departments have used computer			
Procurement/warehouse	6	4	4
Pharmacy	6	4	4
Finance	6	4	4

Table 4.3 Descriptive for basic hospital characteristics (cont.)

Hospital characteristic	No. of hospitals		
	Small-size public hospitals	Large-size public hospitals	Private hospitals
Hospital accreditation (HA) status			
Accredited	4	4	2
Not accredited but has made plan	2	-	2
Used the barcode technology			
Yes	-	3	-
No	6	1	4

*Stock Keeping Unit (SKU) is a number given to each item of pharmaceutical product (by category and brand) stocked in a warehouse for inventory and tracking purposes.

4.2 E-readiness factor' scores

The e-readiness factor' scores were divided into two parts; (1) "Importance" which is the importance of each readiness factor for implementation of barcode technology, and (2) "Performance" which is the actual readiness level of each factor. The five-point Likert scale [1-5] was used which 1 means very low importance or very poor performance and 5 mean very high importance or excellent performance. The respondents were asked to access each readiness factor and give the score. The detailed scores from all respondents were shown in Appendix F. The average scores of each factor are shown in Table 4.4 for each hospital group.

Table 4.4 The average scores of each factor of hospitals

Factors	Small-size public hospitals		Large-size public hospitals		Private hospitals	
	Importance	Performance	Importance	Performance	Importance	Performance
People						
P1	3.83	3.63	3.97	3.56	3.88	3.65
P2	2.93	2.17	3.94	3.56	2.53	2.26

Table 4.4 The average scores of each factor of hospitals (cont.)

Factors	Small-size public hospitals		Large-size public hospitals		Private hospitals	
	Importance	Performance	Importance	Performance	Importance	Performance
P3	3.93	3.54	3.97	3.62	3.82	3.47
P4	3.74	3.59	4.00	3.59	3.44	3.56
P5	4.07	3.78	4.18	3.74	3.71	3.65
Process						
C1	3.72	3.11	3.97	3.65	3.68	3.44
C2	3.98	3.48	3.68	2.88	3.68	3.41
Technology						
T1	3.85	3.15	4.12	3.62	3.38	3.15
T2	3.93	3.37	4.09	3.47	3.35	3.18
T3	3.83	3.11	4.03	3.62	3.32	3.06
T4	3.78	3.11	4.21	3.76	3.44	3.09
T5	4.15	3.26	4.15	3.74	3.50	3.29
T6	3.93	3.13	4.03	3.35	3.50	3.06
T7	3.89	2.96	4.03	3.65	3.50	3.06
T8	3.85	3.15	4.15	3.56	3.47	3.12
T9	3.87	2.89	3.94	3.62	3.44	2.91
T10	3.93	3.17	4.06	3.18	3.53	3.18
Organization						
O1	4.09	3.30	4.15	3.88	3.76	3.26
O2	3.91	3.28	4.26	3.68	3.44	3.03
O3	3.78	3.24	4.09	3.41	3.47	3.15
O4	3.87	3.22	4.03	3.15	3.47	3.21
Government						
G1	4.00	2.89	3.65	3.44	1.91	1.65
G2	3.78	2.96	3.91	3.29	2.59	2.47
G3	4.11	3.78	4.06	3.82	3.59	3.53
G4	3.41	3.07	3.79	3.65	2.47	2.56
Hospital environment						
E1	4.04	3.50	4.29	4.03	3.85	3.59
E2	3.93	3.41	4.03	4.03	3.94	3.79
E3	3.76	2.91	4.12	3.71	3.71	3.29
E4	3.80	2.87	4.00	3.35	3.59	3.38
E5	4.09	3.57	4.18	3.74	3.85	3.71
Average	**3.86**	**3.22**	**4.04**	**3.58**	**3.43**	**3.17**

4.3 Fuzzy-IPA

The Fuzzy-IPA matrix was constructed using importance weights (Y axis) and performance defuzzification crisp numbers (X axis). The importance weights calculated from using fuzzy entropy weight and the performance defuzzification crisp numbers calculated from using fuzzy number, which the averages of both are used to intercept Y and X axes for four quadrant separation, respectively. These were shown in Appendix G.

4.3.1 Small-size public hospitals

The results of the IPA of the "e-readiness factors of small-size public hospitals" were placed in Fuzzy-IPA matrix (Figure 4.1 and Table 4.5). The first quadrant ("Keep up the Good Work") includes P1: Personality, T2: Internet availability and affordability, O1: Management, O2: Strategy, and G3: Legal and regulatory frameworks. This is the niche advantage of the hospitals which can perform well in the important factors for barcode technology implementation. "P1: Personality" and "G3: Legal and regulatory frameworks" are among the most important factors (0.98, 0.92) and the hospitals performance for these factors are good (63.63, 66.77).

The second quadrant ("Concentrate Here") shows the important factors, but the hospitals performance for these factors are low. Integrating the results, P2: Skills, C1: Resources, T7: Performance, T10: Linkage of information, and E4: Interruption require improvement and the prioritized investment of resources must be immediately taken into consideration.

The third quadrant ("Low Priority") shows the expectation of hospital staff is low and the degree of performance is low. Compiling the research results, T1: Infrastructure, T3: Innovation, T4: Security encryption, T6: Quality, T8: Access and equity, T9: Appropriateness of ICT, G1: Finance, G2: Policy, G4: Politics, and E3: Noise are among this quadrant and no need any immediate actor.

The fourth quadrant ("Possible Overkill") shows the expectation of hospital staff is low, but the hospitals have done well in these factors. Integrating the results, P3: Task, P4: Individual knowledge, P5: Self-development, C2: Operations, T5: ICT services and supports, O3: Structure, O4: Communication, E1: Lighting, E2:

Heat, and E5: Voluntariness are not considered as important factors. The resources used to develop these factors may be reallocated to other important factors in the first and second quadrants.

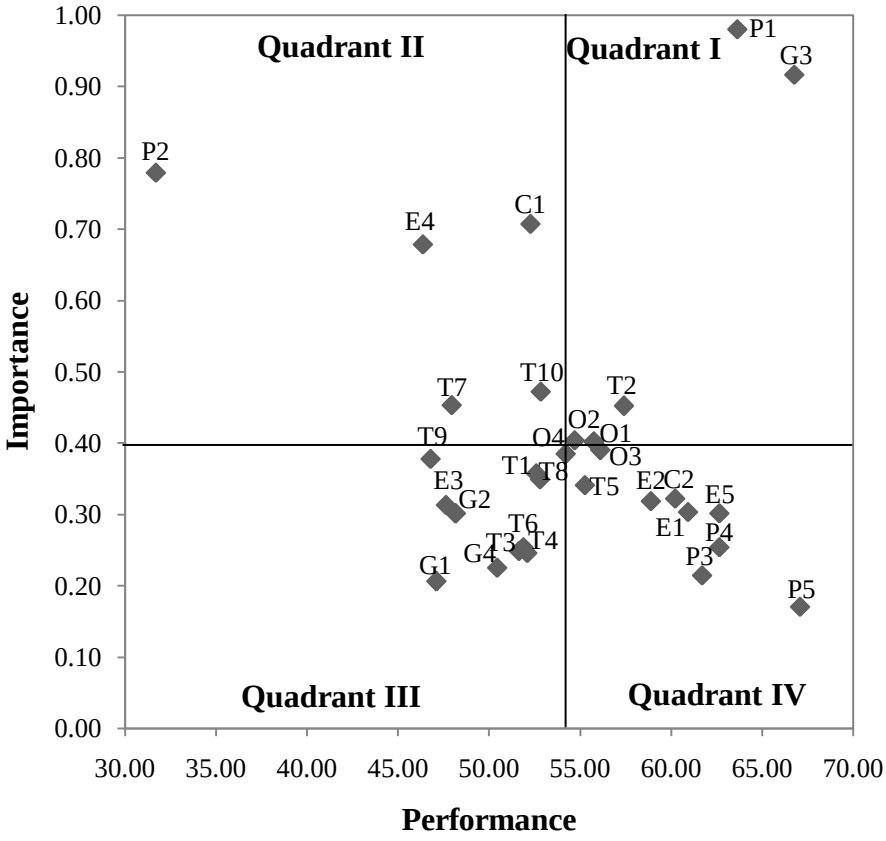


Figure 4.1 Fuzzy-IPA matrix of Small-size public hospitals

Table 4.5 IPA of the "e-readiness factors of small-size public hospitals"

IPA classification	Factor
Quadrant I	P1: Personality
"Keep up the Good Work"	T2: Internet availability and affordability
	O1: Management
	O2: Strategy
	G3: Legal and regulatory frameworks
Quadrant II	P2: Skills
"Concentrate Here"	C1: Resources
	T7: Performance
	T10: Linkage of information
	E4: Interruption

Table 4.5 IPA of the "e-readiness factors of small-size public hospitals" (cont.)

IPA classification	Factor
Quadrant III "Low Priority"	T1: Infrastructure T3: Innovation T4: Security encryption T6: Quality T8: Access and equity T9: Appropriateness of ICT G1: Finance G2: Policy G4: Politics E3: Noise
Quadrant IV "Possible Overkill"	P3: Task P4: Individual knowledge P5: Self-development C2: Operations T5: ICT services and supports O3: Structure O4: Communication E1: Lighting E2: Heat E5: Voluntariness

4.3.2 Large-size public hospitals

The results of the IPA of the "e-readiness factors of large-size public hospitals" were placed in Fuzzy-IPA matrix (Figure 4.2 and Table 4.6). The first quadrant ("Keep up the Good Work") includes C1: Resources, T7: Performance, O1: Management, O2: Strategy, G3: Legal and regulatory frameworks, E1: Lighting, and E5: Voluntariness. This is the niche advantage of the hospitals which can perform well in the important factors for barcode technology implementation. "O2: Strategy" and "E1: Lighting" are among the most important factors (0.96, 0.74) and the hospitals performance for these factors are good (64.10, 72.72).

The second quadrant ("Concentrate Here") shows the important factors, but the hospitals performance for these factors are low. Integrating the results, P1: Personality, P4: Individual knowledge, C2: Operations, T6: Quality, O3: Structure,

O4: Communication, and G2: Policy require improvement and the prioritized investment of resources must be immediately taken into consideration.

The third quadrant ("Low Priority") shows the expectation of hospital staff is low and the degree of performance is low. Compiling the research results, P2: Skills, P3: Task, T1: Infrastructure, T2: Internet availability and affordability, T3: Innovation, T8: Access and equity, T10: Linkage of information, G1: Finance, and E4: Interruption are among this quadrant and no need any immediate actor.

The fourth quadrant ("Possible Overkill") shows the expectation of hospital staff is low, but the hospitals have done well in these factors. Integrating the results, P5: Self-development, T4: Security encryption, T5: ICT services and supports, T9: Appropriateness of ICT, G4: Politics, E2: Heat, and E3: Noise are not considered as important factors. The resources used to develop these factors may be reallocated to other important factors in the first and second quadrants.

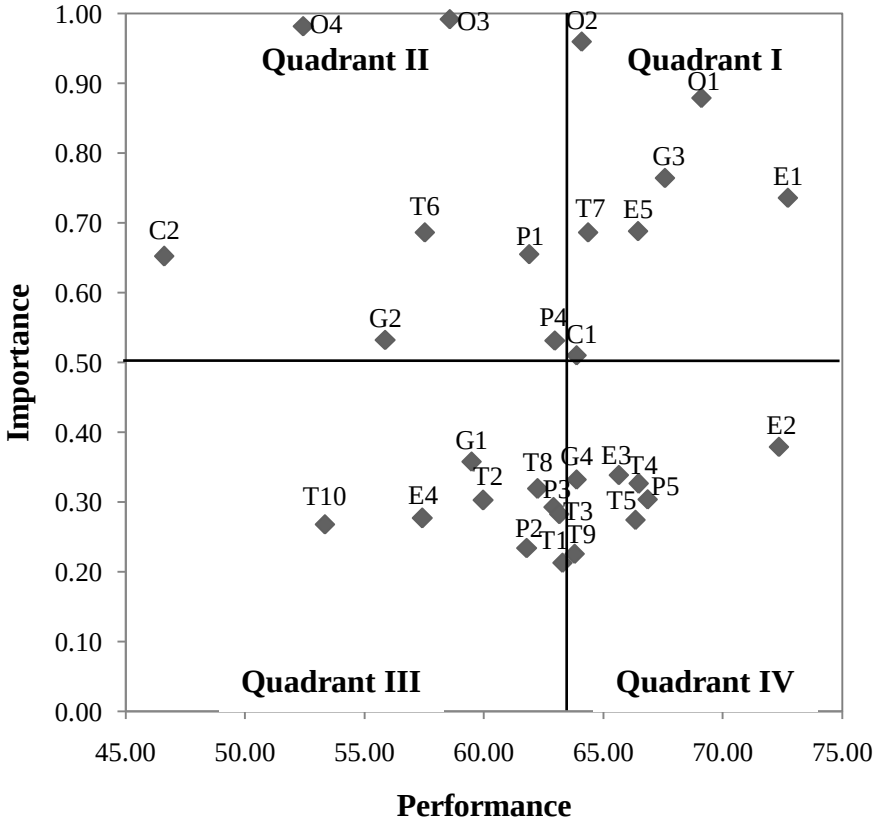


Figure 4.2 Fuzzy-IPA matrix of Large-size public hospitals

Table 4.6 IPA analysis of the "e-readiness factors of large-size public hospitals"

IPA classification	Factor
Quadrant I "Keep up the Good Work"	C1: Resources
	T7: Performance
	O1: Management
	O2: Strategy
	G3: Legal and regulatory frameworks
	E1: Lighting
	E5: Voluntariness
Quadrant II "Concentrate Here"	P1: Personality
	P4: Individual knowledge
	C2: Operations
	T6: Quality
	O3: Structure
	O4: Communication
	G2: Policy
Quadrant III "Low Priority"	P2: Skills
	P3: Task
	T1: Infrastructure
	T2: Internet availability and affordability
	T3: Innovation
	T8: Access and equity
	T10: Linkage of information
	G1: Finance
	E4: Interruption
Quadrant IV "Possible Overkill"	P5: Self-development
	T4: Security encryption
	T5: ICT services and supports
	T9: Appropriateness of ICT
	G4: Politics
	E2: Heat
	E3: Noise

4.3.3 Private hospitals

The results of the IPA of the "e-readiness factors of private hospitals" were placed in Fuzzy-IPA matrix (Figure 4.3 and Table 4.7). The first quadrant ("Keep up the Good Work") includes P5: Self-development, C1: Resources, C2: Operations, T5: ICT services and supports, O4: Communication, E1: Lighting, E4: Interruption, and E5: Voluntariness. This is the niche advantage of the hospitals which can perform well in the important factors for barcode technology implementation. "O4: Communication" and "P5: Self-development" are among the most important factors (0.65, 0.47) and the hospitals performance for these factors are good (53.71, 64.10).

The second quadrant ("Concentrate Here") shows the important factors, but the hospitals performance for these factors are low. Integrating the results, P2: Skills, T1: Infrastructure, T3: Innovation, and T4: Security encryption require improvement and the prioritized investment of resources must be immediately taken into consideration.

The third quadrant ("Low Priority") shows the expectation of hospital staff is low and the degree of performance is low. Compiling the research results, T6: Quality, T7: Performance, T8: Access and equity, T9: Appropriateness of ICT, T10: Linkage of information, O2: Strategy, O3: Structure, G1: Finance, G2: Policy, and G4: Politics are among this quadrant and no need any immediate actor.

The fourth quadrant ("Possible Overkill") shows the expectation of hospital staff is low, but the hospitals have done well in these factors. Integrating the results, P1: Personality, P3: Task, P4: Individual knowledge, T2: Internet availability and affordability, O1: Management, G3: Legal and regulatory frameworks, E2: Heat, and E3: Noise are not considered as important factors. The resources used to develop these factors may be reallocated to other important factors in the first and second quadrants.

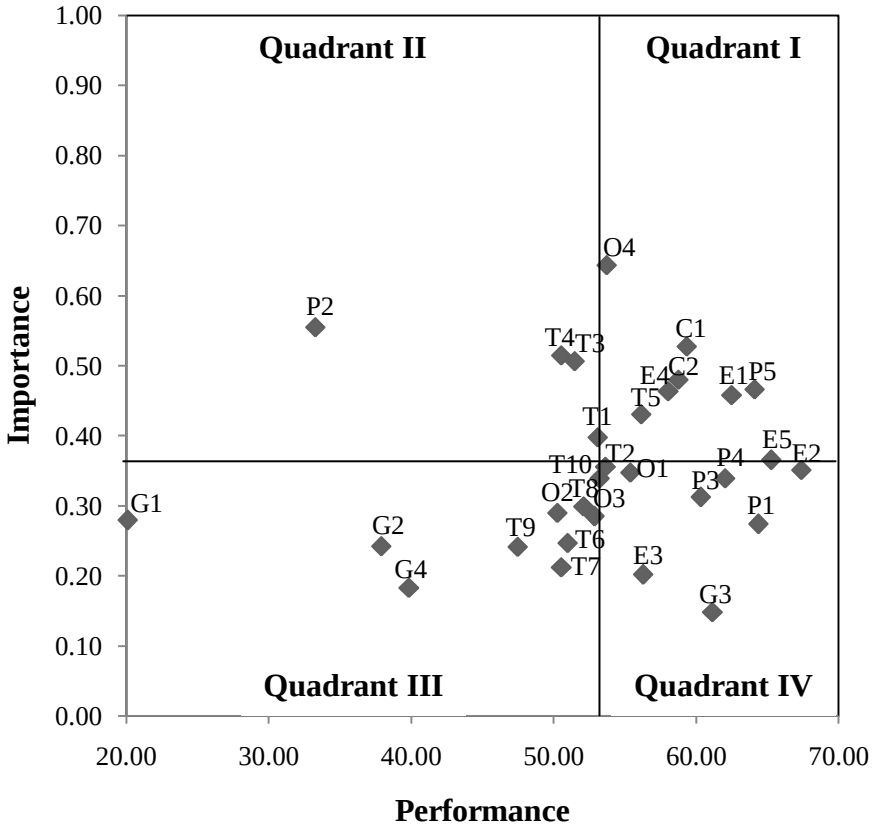


Figure 4.3 Fuzzy-IPA matrix of Private hospitals

Table 4.7 IPA analysis of the "e-readiness factors of private hospitals"

IPA classification	Factor
Quadrant I	P5: Self-development
"Keep up the Good Work"	C1: Resources
	C2: Operations
	T5: ICT services and supports
	O4: Communication
	E1: Lighting
	E4: Interruption
	E5: Voluntariness
Quadrant II	P2: Skills
"Concentrate Here"	T1: Infrastructure
	T3: Innovation
	T4: Security encryption

Table 4.7 IPA analysis of the "e-readiness factors of private hospitals" (cont.)

IPA classification	Factor
Quadrant III "Low Priority"	T6: Quality T7: Performance T8: Access and equity T9: Appropriateness of ICT T10: Linkage of information O2: Strategy O3: Structure G1: Finance G2: Policy G4: Politics
Quadrant IV "Possible Overkill"	P1: Personality P3: Task P4: Individual knowledge T2: Internet availability and affordability O1: Management G3: Legal and regulatory frameworks E2: Heat E3: Noise

4.4 Readiness-Check program

A Readiness-Check program is constructed to check the hospital readiness for barcode technology implementation for each hospital group. It will help the hospital which plan to implement barcode technology to aware of the factors they need to improve and allocate appropriate resources for suitable activities. It can divide into four steps for hospital assessment as follows:

Step 1: Home page

First, choose the type of your hospital whether it is a small-size public hospital (10-120 beds), large-size public hospital (over 120 beds), or private hospital (figure 4.4). Then click "Next" to the readiness questions. The program will direct to the suitable worksheet based on the type of the hospital.

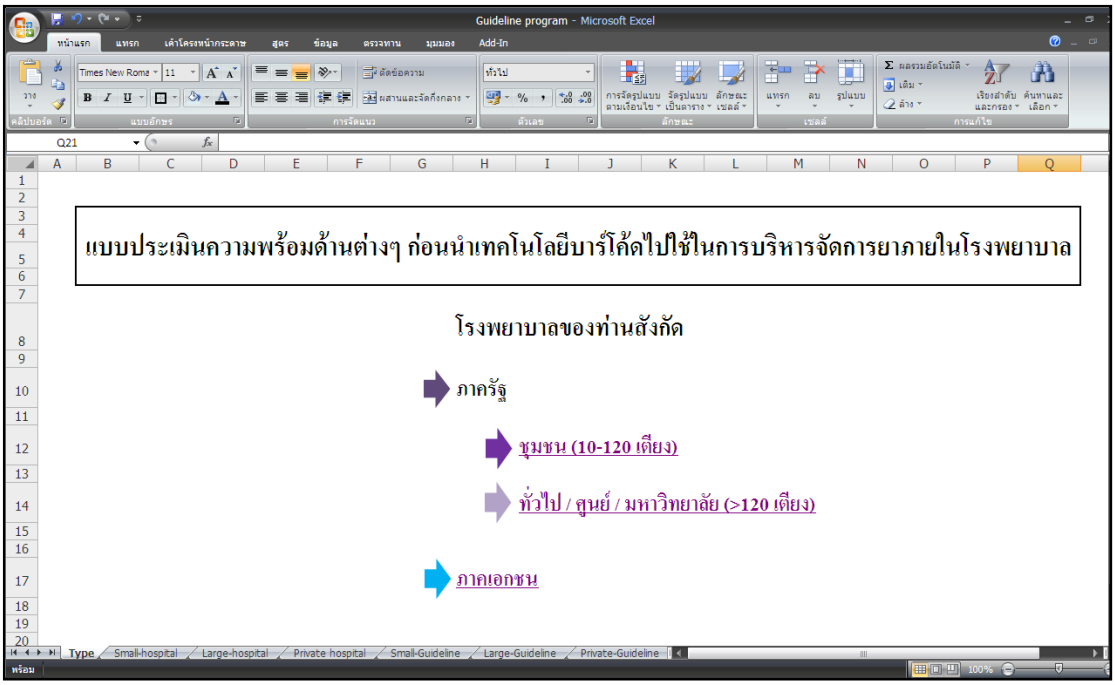


Figure 4.4 Home page

Step 2: Readiness Questions

Readiness Questions comprise six dimensions, and thirty questions. First, People dimension contains five questions. Second, Operation dimension contains two questions. Third, Technology dimension contains ten questions. Fourth, Organization dimension contains four questions. Fifth, Government dimension contains four questions. Finally, Hospital environment dimension contains five questions. Each question has its own definitions of the scores. The five-point Likert scale [1-5] was used which 1 means very poor performance to 5 mean excellent performance (Figure 4.5).

The next step is to put a score in the performance column of each question and click “Next” when all blank boxes have been filled (Figure 4.6).

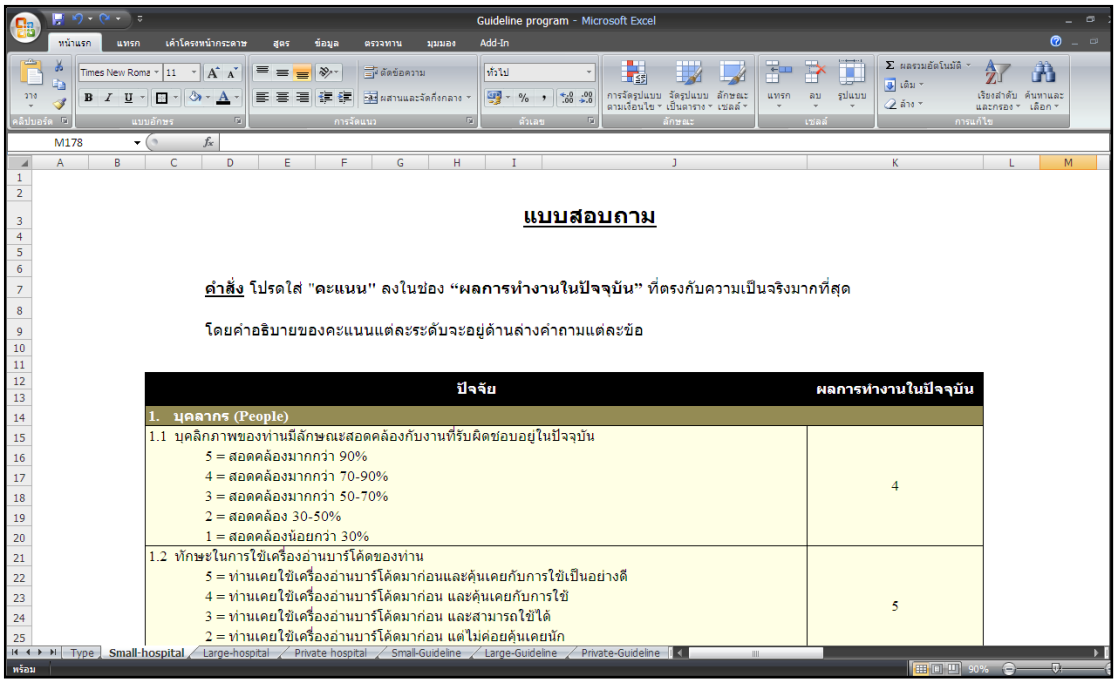


Figure 4.5 Readiness Questions 1

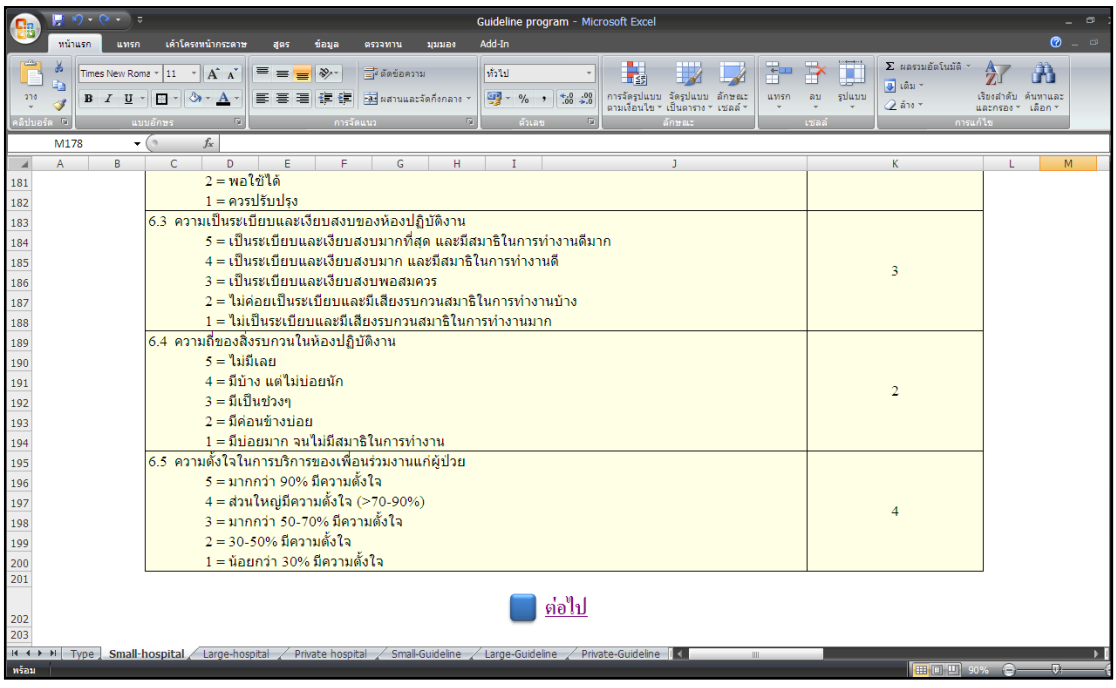


Figure 4.6 Readiness Questions 2

Step 3: List of Hospital's readiness

After all questions have been filled, the program will automatically calculate and illustrate the results. This page shows how the hospital be ready for barcode technology implementation in the hospital considering each factor. The hospital's readiness can be divided into four quadrants; Keep Up the Good Work, Concentrate Here, Low Priority, and Possible Overkill (Figure 4.7). Then click "Next" to guideline page, the final step.

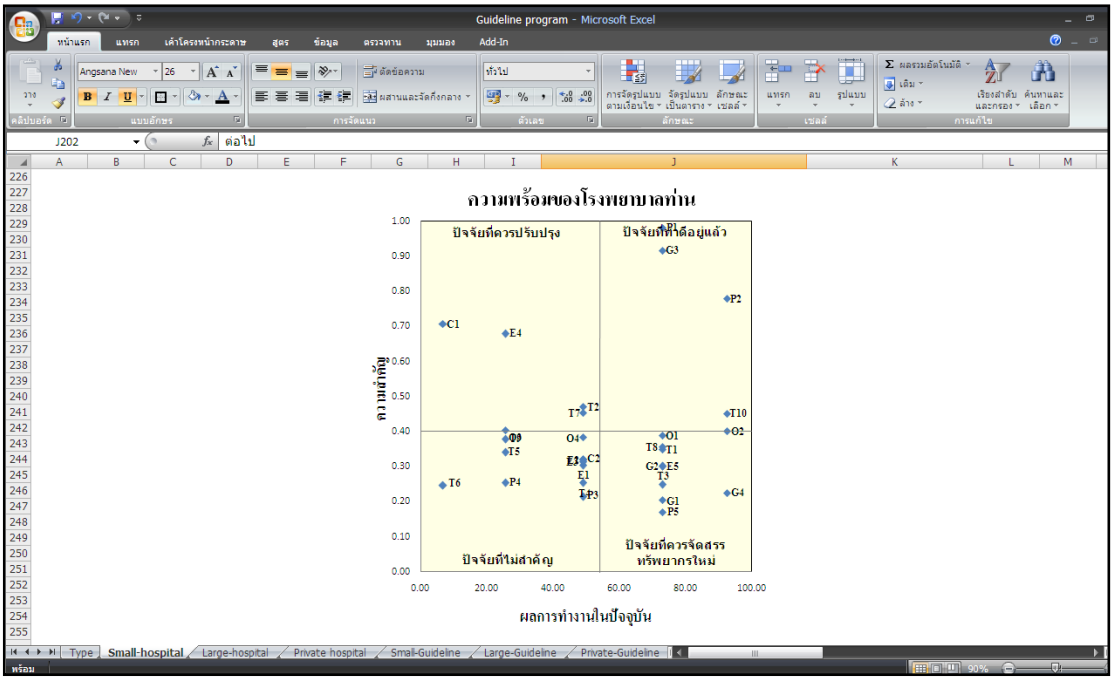


Figure 4.7 Hospital's readiness

Step 4: Guideline for barcode technology implementation

This page shows level of hospital's readiness and gives suggestions for barcode technology implementation in the hospital (Figure 4.8 – Figure 4.11). Then click "Back to Home" when you will be assessed your hospital again or click "Exit" if you would like to end the program (Figure 4.12).

The overall hospital's readiness scores will be shown ranking from 0 to 100. The ranking have received to calculated standard deviation (σ) of the performance defuzzification crisp number. Small-size public hospital defined 0 – 33 means that the hospital is not ready for barcode technology implementation at all, 34 – 48 means that the level of readiness is rather "low", 49 – 63 means that the level of

readiness is “medium”, 64 – 78 means that the level of readiness is “high”, and 79 – 100 means that the level of readiness is “Ready completely”.

Large-size public hospital defined 0 – 46 means that the hospital is not ready for barcode technology implementation at all, 47 – 57 means that the level of readiness is rather “low”, 58 – 69 means that the level of readiness is “medium”, 70 – 80 means that the level of readiness is “high”, and 81 – 100 means that the level of readiness is “Ready completely”.

Private hospital defined 0 – 24 means that the hospital is not ready for barcode technology implementation at all, 25 – 44 means that the level of readiness is rather “low”, 45 – 64 means that the level of readiness is “medium”, 65 – 84 means that the level of readiness is “high”, and 85 – 100 means that the level of readiness is “Ready completely”.

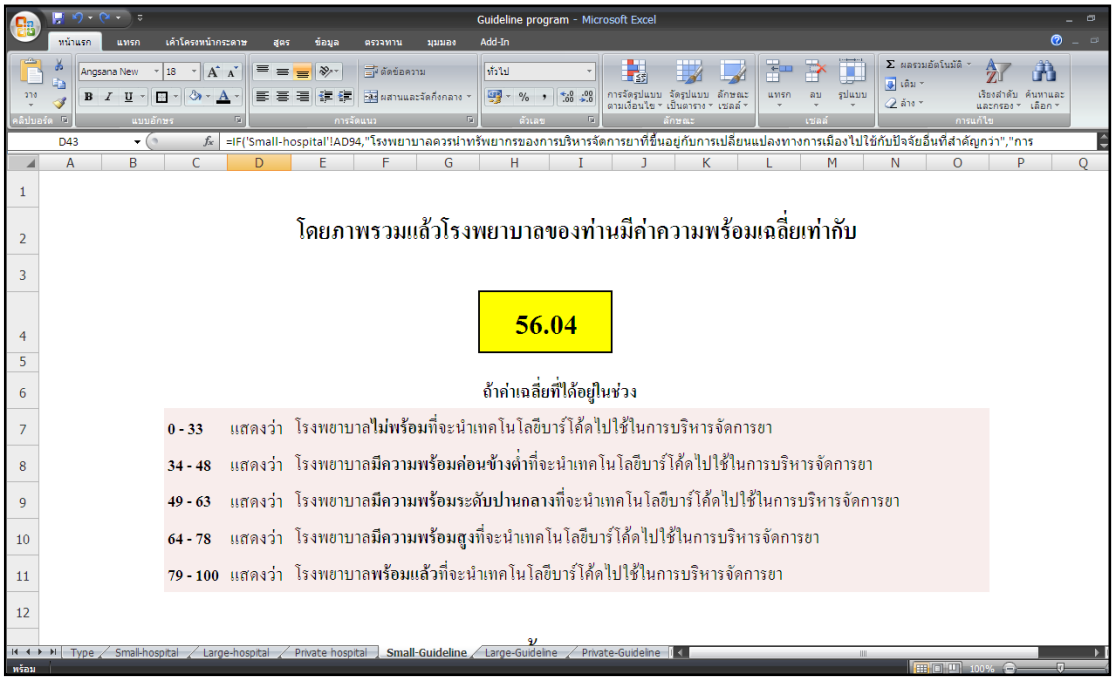


Figure 4.8 Hospital’s readiness level

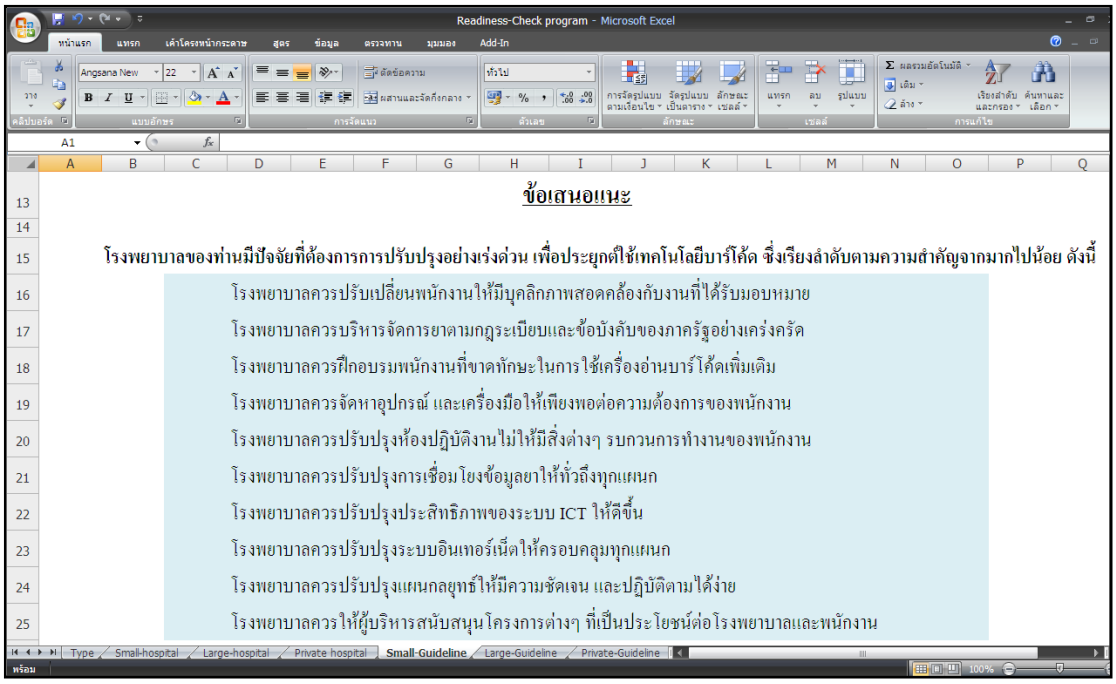


Figure 4.9 Guideline for barcode technology implementation 1

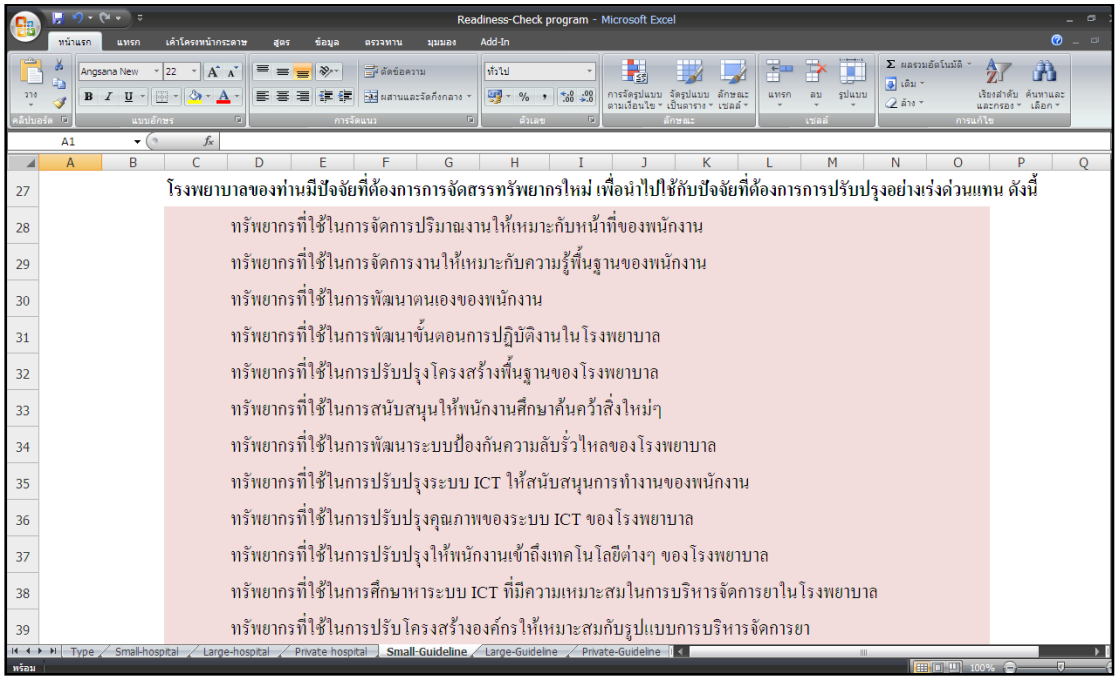


Figure 4.10 Guideline for barcode technology implementation 2

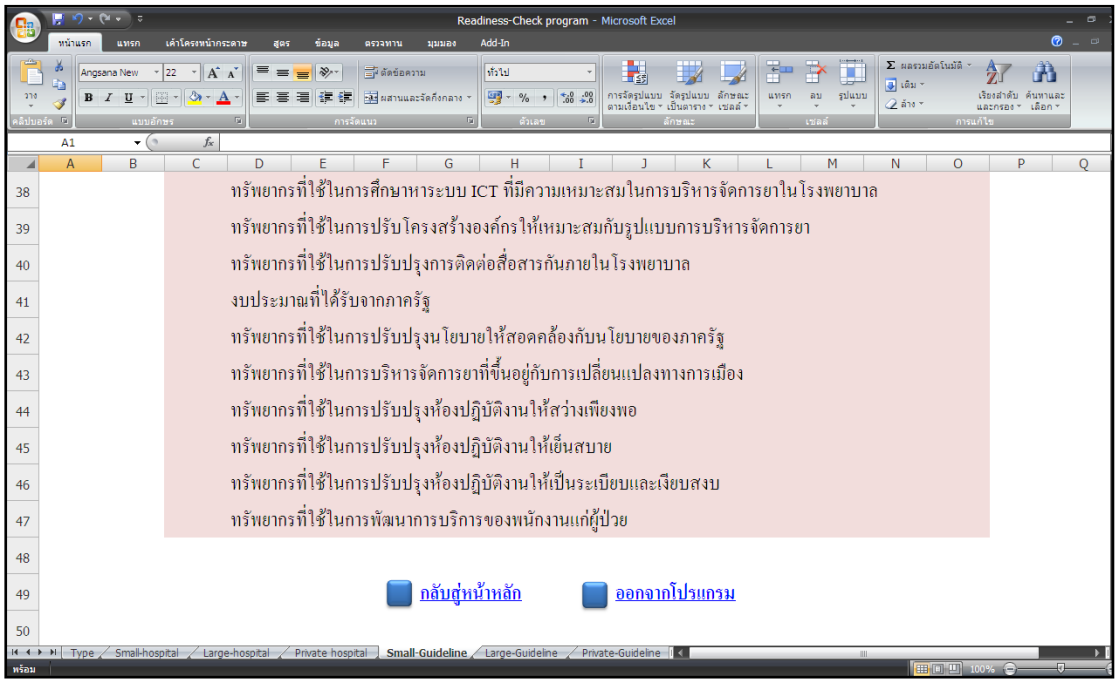


Figure 4.11 Guideline for barcode technology implementation 3

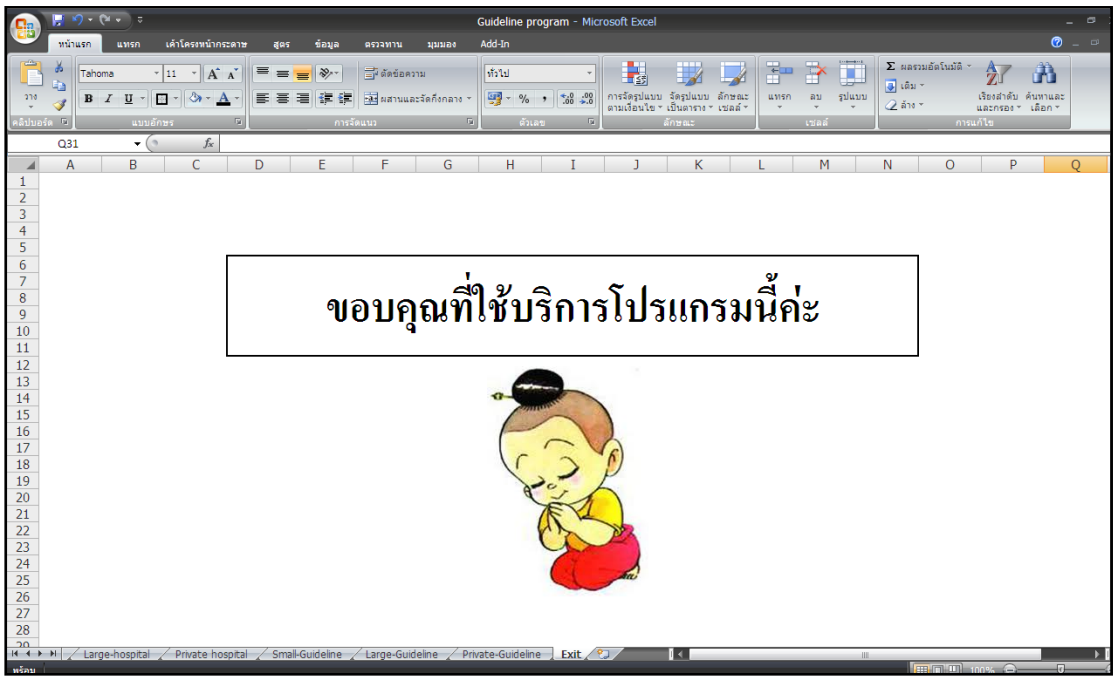


Figure 4.12 The end program

The guideline will also summarize the “weak” factors which are needed for urgent improvement and the factors that the hospitals put too much resources and the resources should be reallocated to the other important factors. The hospital can recheck the readiness level by changing the score of some factors and see the different results. This will help the hospital to know their performance and set appropriate strategy to increase their readiness level.

CHAPTER V
DISCUSSION

This research had developed e-readiness assessment that could be used to assess people, process, technology, organization, government, and hospital environment of small-size public hospitals, large-size public hospitals, and private hospitals. This assessment aimed to construct a guideline for e-readiness assessment of hospital operations to adopt barcode technology into Pharmaceutical Department. This chapter discussed in details of the research found out, and it was organized as follows:

5.1 State of hospitals for barcode technology implementation

5.1.1 Strength factors of Thai hospitals

This research found that factors are fell in "Keep up the Good Work" quadrant is the most importance and a major strength for adoption of barcode technology (Table 5.1). Small-size public hospitals managed 201-500 SKUs of pharmaceutical products. The hospitals are ready in the area of Personality, P1; Internet availability and affordability, T2; Management, O1; Strategy, O2; and Legal and regulatory frameworks, G3. The results shown that the working staff corresponded their personality, internet system is accessed almost all departments, manager supported staff working as well, hospital strategy cleared and easy to action, and hospital management followed law and regulations of the government.

Large-size public hospitals managed more than 1,000 SKUs of pharmaceutical products. The hospitals are ready in the area of Resources, C1; Performance, T7; Management, O1; Strategy, O2; Legal and regulatory frameworks, G3; Lighting, E1; and Voluntariness, E5. The results shown that the hospitals had enough resources the staff, technology very fast working, manager supported staff

working as well, hospital strategy cleared and easy to action, hospital management followed law and regulations of the government, lighting in working area is appropriate, and the staff have more service-mind.

Private hospitals managed more than 1,000 SKUs of pharmaceutical products. The hospitals are ready in the area of Self-development, P5; Resources, C1; Operations, C2; ICT services and support, T5; Communications, O4; Lighting, E1; Interruption, E4; and Voluntariness, E5. The results shown that the staff can developed themselves to ready for adoption of barcode technology, the hospitals had enough resources the staff, the working process are eased to action, the ICT system is supported working of staff, the organization emphasizes hospital staff to communicate, lighting in working area is appropriate, without interruption in working area, and the staff have more service-mind.

Table 5.1 Strength factors comparison among hospitals groups

Small-size public hospitals	**Large-size public hospitals**	**Private hospitals**
P1: Personality	C1: Resources	P5: Self-development
T2: Internet availability and affordability	T7: Performance	C1: Resources
O1: Management	O1: Management	C2: Operations
O2: Strategy	O2: Strategy	T5: ICT services and supports
G3: Legal and regulatory frameworks	G3: Legal and regulatory frameworks	O4: Communication
	E1: Lighting	E1: Lighting
	E5: Voluntariness	E4: Interruption
		E5: Voluntariness

Therefore, each hospital group considers the importance of factors for barcode technology implementation differently and they are ready in different areas for barcode technology implementation. However, there are some common factors between the small-size public hospitals and the large-size public hospitals (see Figure 5.1). These are Management (O1), Strategy (O2), and Legal and regulatory frameworks (G3). This is because they are under the government funding hospitals. Hence, their management, strategies, and policies are similar and follow the

government. The large-size public hospitals also have the commonalities with private hospitals in term of important factors which they are doing well. These include Resources (C1), Lighting (E1), and Voluntariness (E5). This means that both hospital groups have enough resources to initiate barcode technology implementation, the lighting and the voluntariness in the hospitals are good for work.

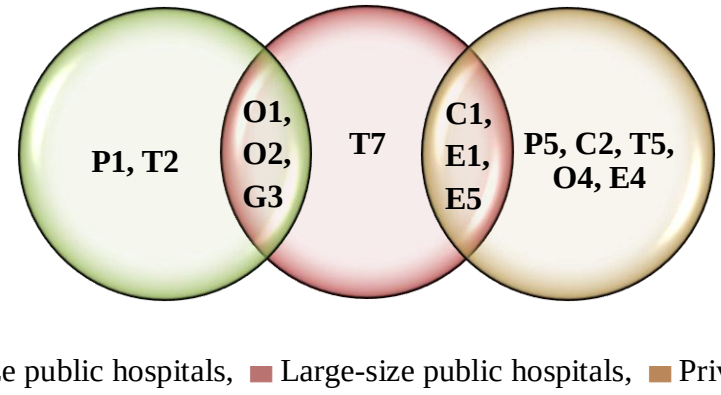


Figure 5.1 Factors that hospitals are ready for barcode technology implementation

5.1.2 Concentrate factors of Thai hospitals

Factors are perceived to be very important to hospital staff, but performance levels of hospitals are low. This sends a direct message that improvement efforts should “Concentrate Here” (Table 5.2). Factors of small-size public hospitals fell in this quadrant which need immediately improvement include Skills, P2; Resources, C1; Performance, T7; Linkage of information, T10; and Interruption, E4. These factors are shown that the hospitals should focus on developing skills for staff relevant to the use of barcode technology, allocating resources for implementing the barcode technology, developing the performance of ICT systems and linking among all departments in hospital, minimizing the interruption in working area which creates operation errors.

Factors of large-size public hospitals fell in this quadrant which need immediately improvement include Personality, P1; Individual knowledge, P4; Operations, C2; Quality, T6; Structure, O3; Communication, O4; and Policy, G2. These factors are shown that the hospitals should focus on corresponding between the

staff personality and work, individual knowledge for staff relevant the work, developing the processes for easy to action, using appropriate technology to support the implementation, restructuring their organization to accommodate barcode technology implementation, improving communication between staff, and improving the work to accord policy of government.

Factors of private hospitals fell in this quadrant which need immediately improvement include Skills, P2; Infrastructure, T1; Innovation, T3; and Security and encryption, T4. These factors are shown that the hospitals should focus on developing skills of hospital staff and encouraging internal innovation as well as developing good security and encryption system to protect hospital and patient information from intruders.

Table 5.2 Comparison of factors improvement among hospitals groups

Small-size public hospitals	**Large-size public hospitals**	**Private hospitals**
P2: Skills	P1: Personality	P2: Skills
C1: Resources	P4: Individual knowledge	T1: Infrastructure
T7: Performance	C2: Operations	T3: Innovation
T10: Linkage of information	T6: Quality	T4: Security encryption
E4: Interruption	O3: Structure	
	O4: Communication	
	G2: Policy	

Therefore, each hospital group focuses on the factors to improve immediately for barcode technology implementation differently. However, there is a factor between the small-size public hospitals and the private hospitals (see Figure 5.2). This is Skills (P2). This is because they are emphasized skills of hospital staff to ready for barcode technology implementation.

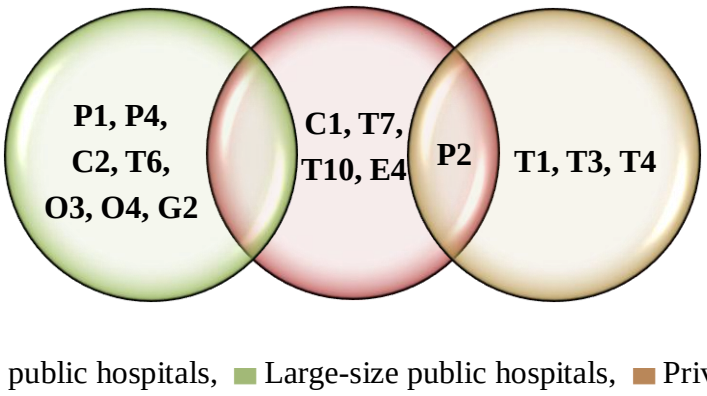


Figure 5.2 Factors that hospitals are immediately improved for barcode technology implementation

5.1.3 Resources reallocation

This research found that the hospital staff does not consider these factors as important factors. The resources used to develop these factors may be reallocated to other important factors in the first and second quadrants instead of the factors of this cell as being “Over Utilized” or “Possible Overkill” (Table 5.3). Factors of small-size public hospitals may be reallocated to other important factors include Task, P3; Individual knowledge, P4; Self-development, P5; Operations, C2; ICT services and supports, T5; Structure, O3; Communication, O4; Lighting, E1; Heat, E2; and Voluntariness, E5.

Factors of large-size public hospitals may be reallocated to other important factors include Self-development, P5; Security encryption, T4; ICT services and supports, T5; Appropriateness of ICT, T9; Politics, G4; Heat, E2; and Noise, E3.

Factors of private hospitals may be reallocated to other important factors include Personality, P1; Task, P3; Individual knowledge, P4; Internet availability and affordability, T2; Management, O1; Legal and regulatory frameworks, G3; Heat, E2; and Noise, E3.

Table 5.3 Factors of resources reallocation comparison among hospitals groups

Small-size public hospitals	Large-size public hospitals	Private hospitals
P3: Task	P5: Self-development	P1: Personality
P4: Individual knowledge	T4: Security encryption	P3: Task
P5: Self-development	T5: ICT services and supports	P4: Individual knowledge
C2: Operations	T9: Appropriateness of ICT	T2: Internet availability and affordability
T5: ICT services and supports	G4: Politics	O1: Management
O3: Structure	E2: Heat	G3: Legal and regulatory frameworks
O4: Communication	E3: Noise	E2: Heat
E1: Lighting		E3: Noise
E2: Heat		
E5: Voluntariness		

Therefore, each hospital group may be reallocated resources of factors for barcode technology implementation differently. However, there is a factor among the hospital groups (see Figure 5.3). This is Heat (E2). This is because heat did not relevant for barcode technology implementation in hospitals. The small-size public hospitals also have the factors with large-size public hospitals in term of low important factors which they are doing well. These include Self-development (P5); and ICT services and supports (T5). This means that both hospital groups may be allocated resources to other important factors in the first and second quadrants instead of the factors. The small-size public hospitals also have the factors with private hospitals in term of low important factors which they are doing well. These include Task (P3); and Individual knowledge (P4). This means that both hospital groups may be allocated resources to other important factors in the first and second quadrants instead of the factors. The large-size public hospitals also have the factors with private hospitals in term of low important factors which they are doing well. These include Noise (E3). This means that both hospital groups may be allocated resources to other important factors in the first and second quadrants instead of factor.

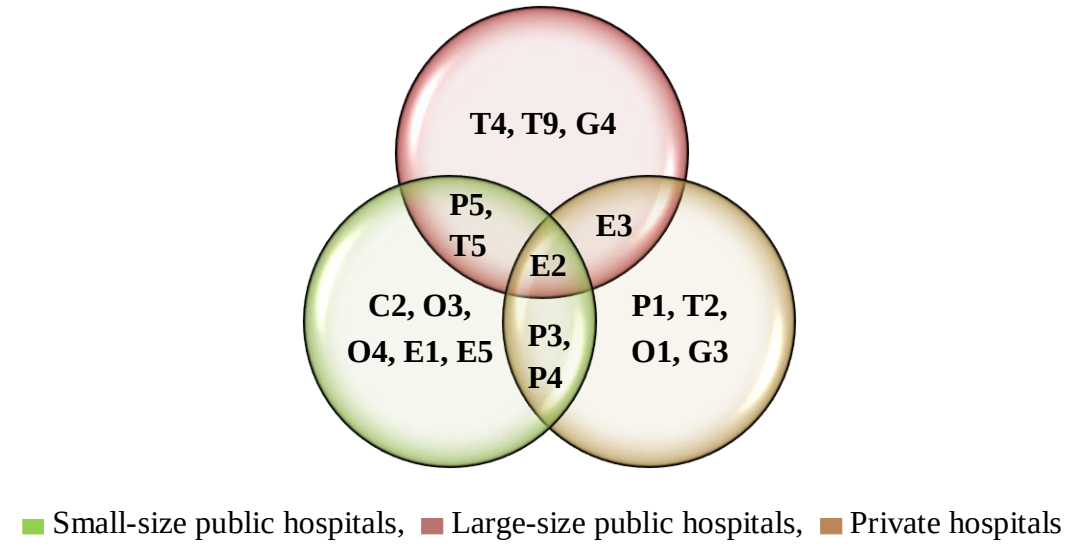


Figure 5.3 Factors that hospitals may be reallocated resources for barcode technology implementation

While the factors are fell in "Low Priority" quadrant which they are not considered. Therefore, this research has not discussed.

5.1.4 Comparison of e-readiness assessment between Fuzzy-IPA and Traditional IPA method

To determine the difference in management derived from the traditional IPA and the Fuzzy-IPA, the traditional IPA matrix was constructed using respondent-stated performance and importance data (in five-point Likert scale) to represent the X and Y axes, respectively.

5.1.4.1 Small-size public hospitals

Based on traditional IPA results, the hospitals should concentrate on Quality, T6; Performance, T7; Linkage of information, T10; and Finance, G1. However, analytical results for the Fuzzy-IPA indicate that the hospitals should concentrate on Skills, P2; Resources, C1; Performance, T7; Linkage of information, T10; and Interruption, E4 and use the following improvement priority for these factors: Skills, P2; Resources, C1; Interruption, E4; Linkage of information, T10; and Performance, T7. That is, Skills, P2 is the most importance and Performance, T7 is the least importance in Quadrant II. Furthermore, the hospitals may utilize

different management strategies for the same factor. For example, Personality (P1) was located in Quadrant IV in the traditional IPA matrix and is a minor strength for barcode technology implementation and the management scheme action is "Possible Overkill". The hospitals can decide to redirect resources to other factors that require resources. However, based on the Fuzzy-IPA matrix, Personality (P1) was located in Quadrant I and is a major factor for barcode technology implementation. The management scheme action is "Keep up the Good Work". Resources (C1) as another example, was located in Quadrant III in the traditional IPA matrix and is the minor weakness factor for barcode technology implementation and do not require additional effort. The management scheme action is "Low Priority". However, in the Fuzzy-IPA matrix, Resources (C1) was located in Quadrant II and is a competitive disadvantage for barcode technology implementation. The management scheme action is "Concentrate Here" (Figure 5.4 and Figure 5.5).

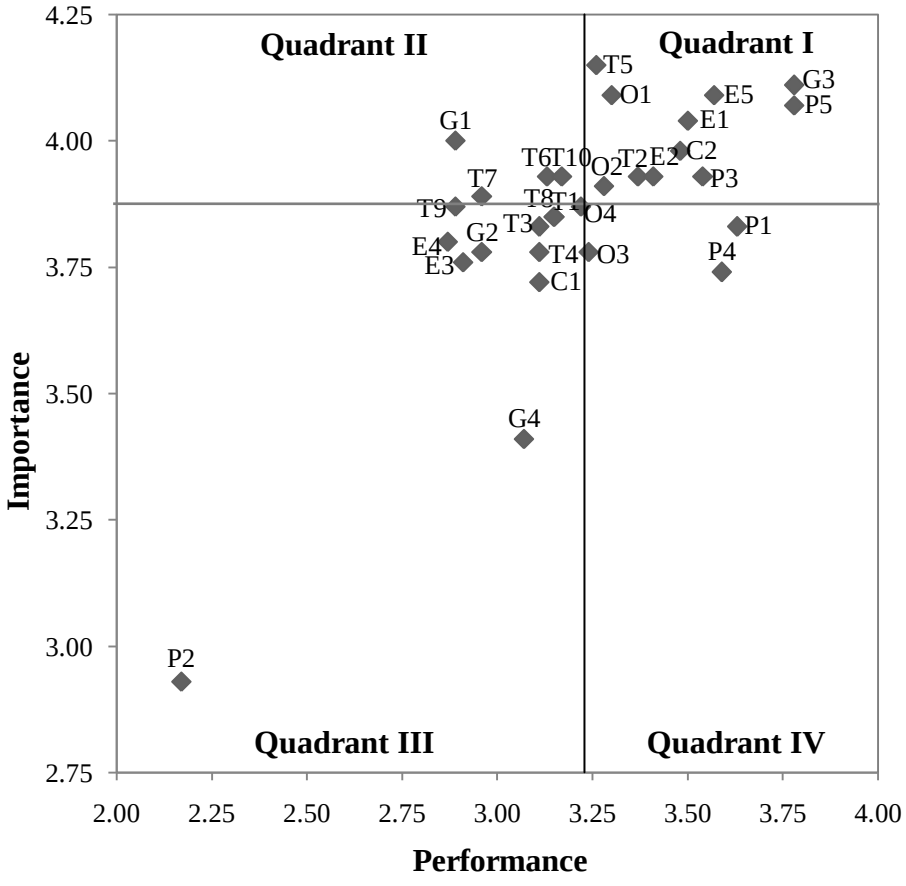


Figure 5.4 Traditional IPA matrix of small-size public hospitals

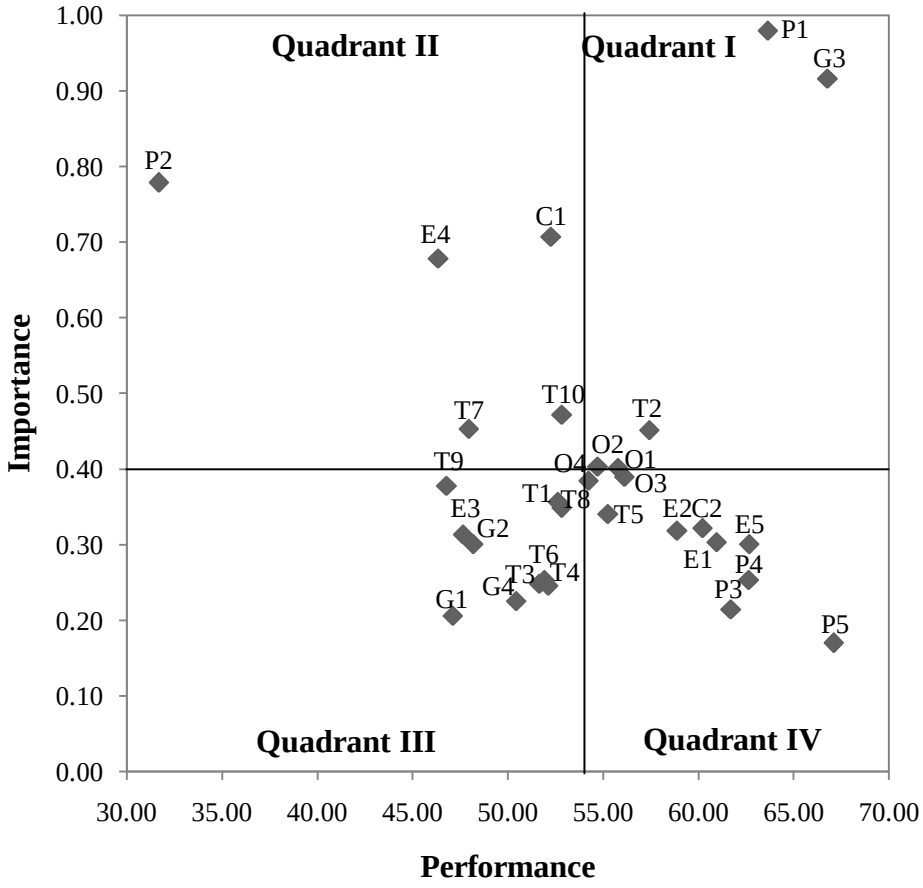


Figure 5.5 Fuzzy-IPA matrix of small-size public hospitals

5.1.4.2 Large-size public hospitals

Based on traditional IPA results, the hospitals should concentrate on Internet availability and affordability, T2; Quality, T6; Access and equity, T8; Linkage of information, T10; and Communication, O4. However, analytical results for the Fuzzy-IPA indicate that the hospitals should concentrate on Personality, P1; Individual knowledge, P4; Operations, C2; Quality, T6; Structure, O3; Communication, O4; and Policy, G2 and use the following improvement priority for these factors: Structure, O3; Communication, O4; Quality, T6; Operations, C2; Personality, P1; Individual knowledge, P4; and Policy, G2. That is, Structure, O3 is the most importance and Individual knowledge, P4, and Policy, G2 are the least importance in Quadrant II. Furthermore, the hospitals may utilize different management strategies for the same factor. For example, Resources (C1) was located in Quadrant IV in the traditional IPA matrix and is a minor strength for barcode

technology implementation and the management scheme action is “Possible Overkill”. The hospitals can decide to redirect resources to other factors that require resources. However, based on the Fuzzy-IPA matrix, Resources (C1) was located in Quadrant I and is a major factor for barcode technology implementation. The management scheme action is “Keep up the Good Work”. Operations (C2) as another example, was located in Quadrant III in the traditional IPA matrix and is the minor weakness factor for barcode technology implementation and do not require additional effort. The management scheme action is “Low Priority”. However, in the Fuzzy-IPA matrix, Operations (C2) was located in Quadrant II and is a competitive disadvantage for barcode technology implementation. The management scheme action is “Concentrate Here” (Figure 5.6 and Figure 5.7).

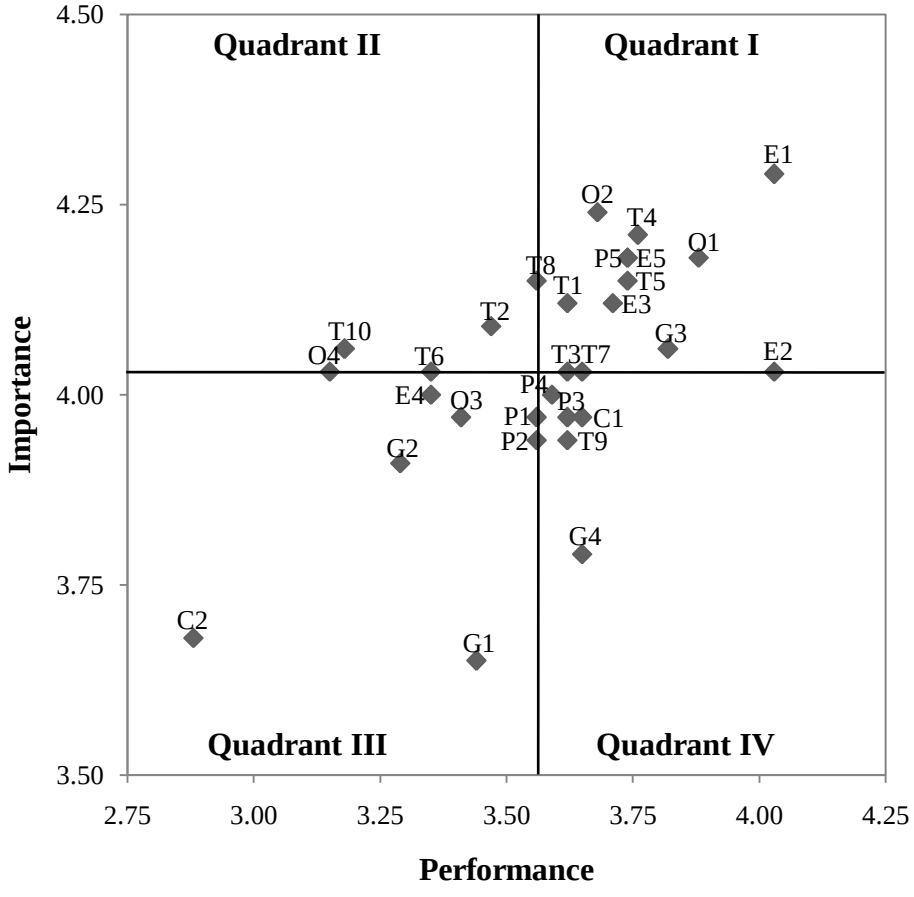


Figure 5.6 Traditional IPA matrix of large-size public hospitals

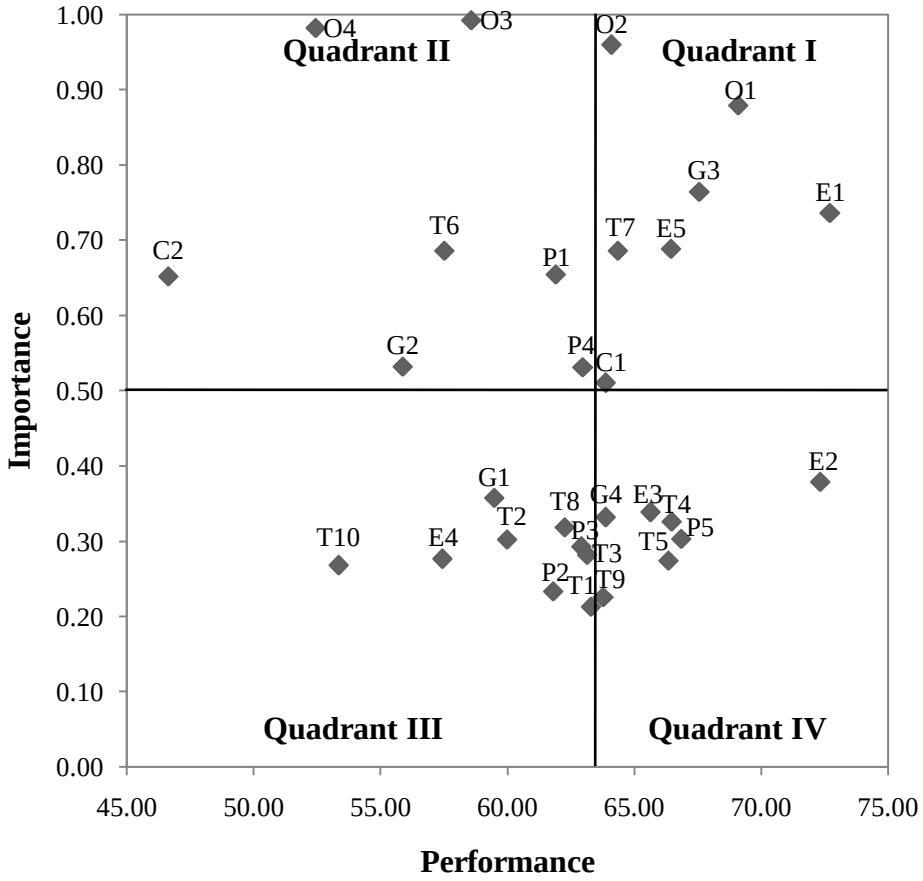


Figure 5.7 Fuzzy-IPA matrix of large-size public hospitals

5.1.4.3 Private hospitals

Based on traditional IPA results, the hospitals should concentrate on Security encryption, T4; Quality, T6; Performance, T7; Access and equity, T8; Appropriateness of ICT, T9; and Structure, O3. However, analytical results for the Fuzzy-IPA indicate that the hospitals should concentrate on Skills, P2; Infrastructure, T1; Innovation, T3; and Security encryption, T4 and use the following improvement priority for these factors: Skills, P2; Security encryption, T4; Innovation, T3; and Infrastructure, T1. That is, Skills, P2 is the most importance and Infrastructure, T1 is the least importance in Quadrant II. Furthermore, Skills (P2) as another example, was located in Quadrant III in the traditional IPA matrix and is the minor weakness factor for barcode technology implementation and do not require additional effort. The management scheme action is “Low Priority”. However, in the

Fuzzy-IPA matrix, Skills (P2) was located in Quadrant II and is a competitive disadvantage for barcode technology implementation. The management scheme action is “Concentrate Here” (Figure 5.8 and Figure 5.9).

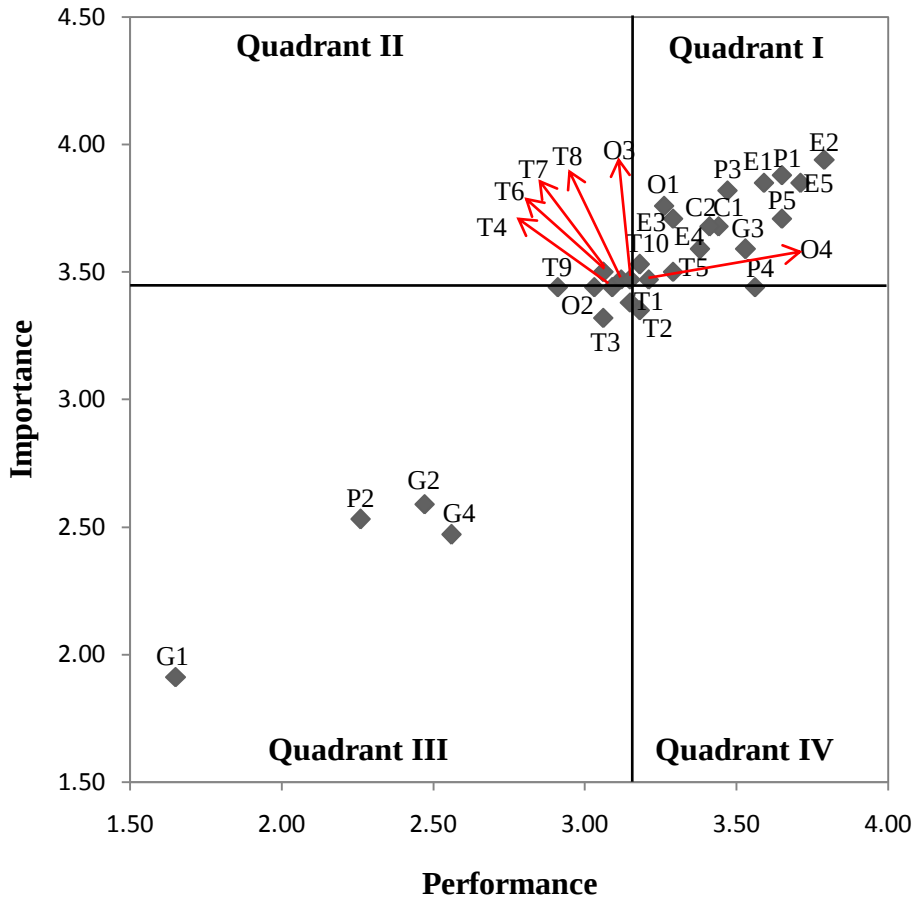


Figure 5.8 Traditional IPA matrix of private hospitals

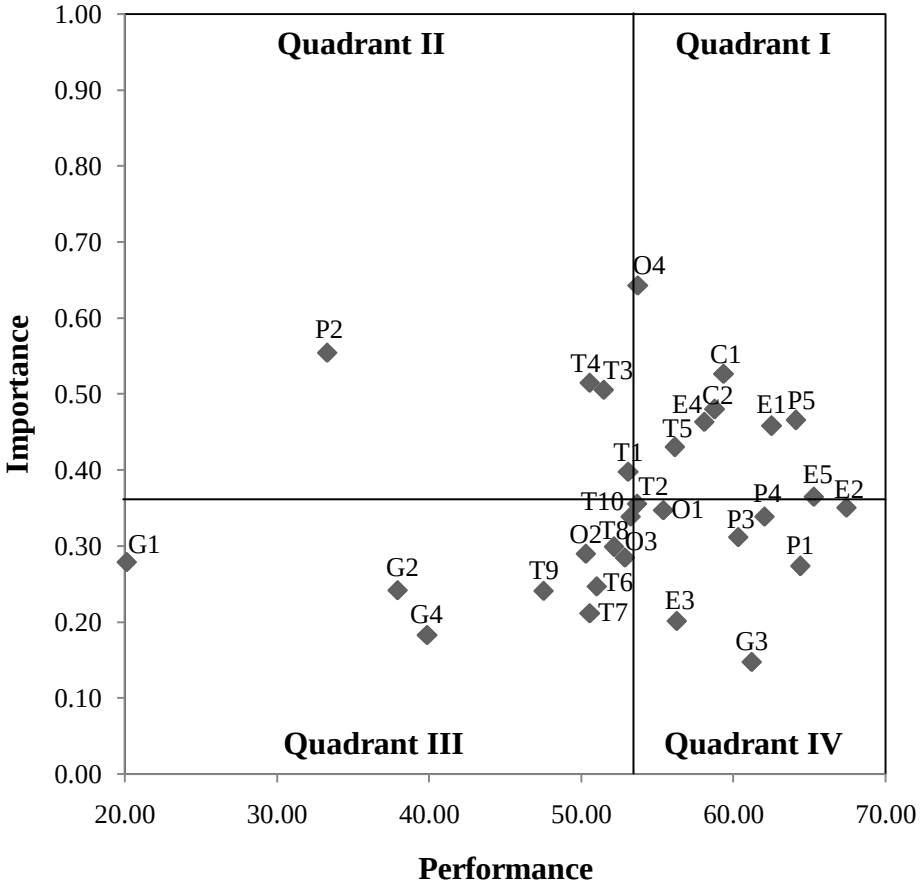


Figure 5.9 Fuzzy-IPA matrix of private hospitals

Therefore, the consequences of final management action would be inappropriate. Thus, the hospitals must note that traditional IPA did not utilize analysis of e-readiness assessment and did not consider the nature of fuzziness in human perception. The referential information acquired by traditional IPA can cause the hospitals take incorrect actions when attempting to adopt barcode technology in hospitals (Deng and Pei, 2009). In addition, due to the collected data have high variance, this research analyzed data with Fuzzy-IPA method (Appendix F).

5.2 Guideline for hospital development

Final results of e-readiness assessment for barcode technology implementation in Thai hospitals were constructed the Readiness-Check program. It will help the hospital which plan to implement barcode technology to aware of the factors they need to improve and allocate appropriate resources for suitable activities. If hospital readiness level of each factor is low, the program will help to suggest the hospitals to be ready for barcode technology implementation. The suggestion of each factor is shown in Table 5.4

Table 5.4 The suggestion of each factor

Factors		Suggestions
1.	**People (P)**	
1.1	Personality (P1)	Assign the right staff for the right tasks/ responsibilities.
1.2	Skills (P2)	Train the staff to be familiar with using barcode technology and the system.
1.3	Task (P3)	Reduce or increase workload for appropriateness.
1.4	Individual knowledge (P4)	Train the staff to apply their knowledge to the new takes or responsibilities.
1.5	Self-development (P5)	Encourage the staff for self-development and ready to accept innovation or new technology.
2.	**Process (C)**	
2.1	Resources (C1)	Increase resources to support the implementation.
2.2	Operations (C2)	Develop standard operating procedure (SOP).
3.	**Technology (T)**	
3.1	Infrastructure (T1)	Develop suitable infrastructure for the implementation.
3.2	Internet availability and affordability (T2)	Provide internet accessibility at all departments.
3.3	Innovation (T3)	Support new innovation.
3.4	Security and encryption (T4)	Improve the security and encryption system.

Table 5.4 The suggestion of each factor (cont.)

Factors		Suggestions
3.5	ICT services and support (T5)	Support ICT service system.
3.6	Quality (T6)	Enhance the ICT quality and reduce the opportunity for system failure.
3.7	Performance (T7)	Enhance the ICT performance to be faster and more reliable.
3.8	Access and equity (T8)	Increase the ICT accessibility at all departments.
3.8	Appropriateness of ICT (T9)	Develop the appropriate ICT system to align with the hospital for barcode technology implementation.
3.10	Linkage of information (T10)	Develop the seamless linkage of internet among the departments.
4.	**Organization (O)**	
4.1	Management (O1)	Increase management support to the implementation.
4.2	Strategy (O2)	Develop strategy to clear and easy to action.
4.3	Structure (O3)	Improve or change organization structure to support barcode technology implementation.
4.4	Communication (O4)	Emphasize internal communication in the hospital.
5.	**Government (G)**	
5.1	Finance (G1)	Seek government funding to support the implementation.
5.2	Policy (G2)	Ensure that the hospital's policy is in the same direction with the government's policy.
5.3	Legal and regulatory frameworks (G3)	Ensure hospital framework follow regulations of government.
5.4	Politics (G4)	Do not let the political change to affect the hospital management.

Table 5.4 The suggestion of each factor (cont.)

Factors	Suggestions
6. Hospital environment (E)	
6.1 Lighting (E1)	Improve lighting in working area.
6.2 Heat (E2)	Set appropriate temperature in working area.
6.3 Noise (E3)	Reduce noise in working area.
6.4 Interruptions (E4)	Avoid any interruption in working area.
6.5 Voluntariness (E5)	Encourage the staff to have more service-mind.

From this research, each hospital group focuses on the importance of factors for barcode technology implementation differently. Table 5.5 - Table 5.7 are shown guideline of each hospital group.

Table 5.5 Guideline for small-size public hospitals

Factors	Suggestions
1. Skills (P2)	Train the staff to be familiar with using barcode technology and the system.
2. Resources (C1)	Increase resources to support the implementation.
3. Performance (T7)	Enhance the ICT performance to be faster and more reliable.
4. Linkage of information (T10)	Develop the seamless linkage of internet among the departments.
5. Interruption (E4)	Avoid any interruption in working area.

Table 5.6 Guideline for large-size public hospitals

Factors	Suggestions
1. Personality (P1)	Assign the right staff for the right tasks/responsibilities.
2. Individual knowledge (P4)	Train the staff to apply their knowledge to the new takes or responsibilities.
3. Operations (C2)	Develop standard operating procedure (SOP).

Table 5.6 Guideline for large-size public hospitals (cont.)

Factors	Suggestions
4. Quality (T6)	Enhance the ICT quality and reduce the opportunity for system failure.
5. Structure (O3)	Improve or change organization structure to support barcode technology implementation.
6. Communication (O4)	Emphasize internal communication in the hospital.
7. Policy (G2)	Ensure that the hospital's policy is in the same direction with the government's policy.

Table 5.7 Guideline for private hospitals

Factors	Suggestions
1. Skills (P2)	Train the staff to be familiar with using barcode technology and the system.
2. Infrastructure (T1)	Develop suitable infrastructure for the implementation.
3. Innovation (T3)	Support new innovation.
4. Security and encryption (T4)	Improve the security and encryption system.

CHAPTER VI
CONCLUSION

This research measured e-readiness Thai hospitals for barcode technology implementation. The hospitals included in this study are classified into three groups: small-size public hospitals (10 – 120 beds), large-size public hospitals (over 120 beds), and private hospitals. The questionnaires were sent to collected data and returned 81%. The data analysis was used Fuzzy-IPA method. The concept of Fuzzy-IPA can be applied to classify factors for barcode technology implementation into four groups as per their importance and performance. Each hospital group should concentrate on the high important factors and allocate their resources, especially the resources used for "Possible Overkill" factors to the more important factors. The "Low Priority" factors should be ignored until the hospitals have extra resources. This research can be summarized into five sections.

The first, each hospital group considers the importance of factors for barcode technology implementation differently and they are ready in different areas for barcode technology implementation. Small-size public hospitals are ready in the staff personality corresponded their working, internet system is accessed almost all departments, manager supported staff working as well, hospital strategy clear and easy to action, and hospital management followed law and regulations of the government. Large-size public hospitals are ready in the resources have enough for the staff, technology very fast working, manager supported staff working as well, hospital strategy cleared and easy to action, hospital management followed law and regulations of the government, lighting in working area is appropriate, and the staff have more service-mind. Private hospitals are ready in the self-development staff for use barcode technology, the resources have enough for the staff, the working process are easy to action, ICT system supported staff working, the communication among the departments as well, lighting in working area is appropriate, without interruption in working area, and the staff have more service-mind. However, the small-size public

hospitals and the large-size public hospitals have common factors (management, strategy, and legal and regulatory frameworks). This is because they are under the government funding hospitals. Hence, their management, strategies, and policies are similar and follow the government. The large-size public hospitals also have the commonalities with private hospitals in term of important factors which they are doing well (resources, lighting, and voluntariness). This means that both hospital groups have enough resources to initiate barcode technology implementation, the lighting and the voluntariness in the hospitals are good for work.

The second, each hospital group focuses on the factors to improve immediately for barcode technology implementation differently. Small-size public hospitals should focus on developing skills for staff relevant to the use of barcode technology, allocating resources for implementing the barcode technology, developing the performance of ICT systems and linking among all departments in hospital, minimizing the interruption in working area which creates operation errors. Large-size public hospitals should focus on corresponding between the staff personality and work, individual knowledge for staff relevant the work, developing the processes for easy to action, using appropriate technology to support the implementation, restructuring their organization to accommodate barcode technology implementation, improving communication between staff, and improving the work to accord policy of government. Private hospitals should focus on developing skills of hospital staff and encouraging internal innovation as well as developing good security and encryption system to protect hospital and patient information from intruders. However, there is a factor between the small-size public hospitals and the private hospitals (skills). This is because they are emphasized skills of hospital staff to ready for barcode technology implementation.

The third, each hospital group may be reallocated resources of factors for barcode technology implementation differently. Small-size public hospitals consist of Task, Individual knowledge, Self-development, Operations, ICT services and supports, Structure, Communication, Lighting, Heat, and Voluntariness. Large-size public hospitals consist of Self-development, Security encryption, ICT services and supports, Appropriateness of ICT, Politics, Heat, and Noise. Private hospitals consist

of Personality, Task, Individual knowledge, Internet availability and affordability, Management, Legal and regulatory frameworks, Heat, and Noise.

The fourth, the Readiness-Check program is constructed to check the hospital's readiness for barcode technology implementation for each hospital group. It can help the hospital which plan to implement barcode technology to aware of the factors they need to improve and allocate appropriate resources for suitable activities.

The finally, the barcode technology can help the information flow of pharmaceutical products to accurate and efficient. This research measured e-readiness for barcode technology implementation in the hospitals especially. Therefore, it can be extended to measured e-readiness for implement barcode technology in the hospital supply chain include manufacturer, supplier, hospital, and patient or customer in the future research. Using of technology acceptance model (TAM) will help to verify and revise the program in the future.

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APPENDICES

APPENDIX A
READINESS AND BARRIER FACTORS

Table A.1 Readiness factors of people

Author, year	Industry	Country	Factors				
			Task	Skills	Individual knowledge	Self-development/Human capacity	User acceptance
Hanmer, 1999	Healthcare	South Africa					x
Snyder-Halpern, 2001	Healthcare	USA	x	x	x		
Lehman *et al.*, 2002	Healthcare	USA	x				
Aydin & Tasci, 2005	Turkish companies	Turkey				x	
Fathian *et al.*, 2008	SMEs	Iran	x	x			
Ghavamifar *et al.*, 2008	Developing countries	Iran				x	
Janom & Zakaria, 2009	SMEs	Malaysia			x		
Lai & Ong, 2010	Various industry	Taiwan	x				
Total			**4**	**2**	**2**	**2**	1

Table A.2 Readiness factors of process

Author, year	Industry	Country	Factors	
			Resources	Operations
Snyder-Halpern, 2001	Healthcare	USA	x	x
Lehman *et al.*, 2002	Healthcare	USA	x	
Mutula & Brakel, 2006	Developing countries	South Africa	x	
Janom & Zakaria, 2009	SMEs	Malaysia		x
Total			**3**	**2**

Table A.3 Readiness factors of technology

Author, year	Industry	Country	Factors										
			Innovation	Infrastructure	ICT services and support	Internet availability and affordability	Network speed and quality/connectivity	People and organizations online	Locally relevant content	Security and encryption	Appropriateness of ICT	ICT capacity and training	Flexibility
Hanmer, 1999	Healthcare	South Africa				x					x		
Rao, 2003	SMEs	India & Philippines				x	x		x			x	
Aydin & Tasci, 2005	Turkish companies	Turkey	x										
bridges.org, 2005	Developing countries	South Africa				x			x	x	x	x	
Mutula & Brakel, 2006	Developing countries	South Africa			x								
Fathian *et al.*, 2008	SMEs	Iran	x	x	x	x	x	x	x	x	x		
Ghavamifar *et al.*, 2008	Developing countries	Iran		x					x				
Janom & Zakaria, 2008	SMEs	Malaysia	x										
Gewald & Dibbern, 2009	Bank	Germany				x	x						
Janom & Zakaria, 2009	SMEs	Malaysia	x						x	x			x
Purnomo & Lee, 2010	Agriculture	Indonesia		x									
Total			**4**	**3**	**2**	**5**	**3**	1	**5**	**3**	**3**	**2**	1

Table A.4 Readiness factors of organization

Author, year	Industry	Country	Factors																
			Management	Work-environment	Information	ICT management and policy	Industry standards	Integration of ICT into peoples' lives	Socio-cultural	Use of ICT in business	Access to Specialized Resources	Structure	Core readiness	Cooperation	Values & goals	Motivational	Strategy	Communication	Human resource
Hanmer, 1999	Healthcare	South Africa																x	
Snyder-Halpern, 2001	Healthcare	USA	x												x				
Lehman *et al.*, 2002	Healthcare	USA														x			
Jones, 2003	SMEs	Australia							x										
Rao, 2003	SMEs	India & Philippines							x					x					
Aydin & Tasci, 2005	Turkish companies	Turkey	x																
bridges.org, 2005	Developing countries	South Africa						x	x	x									
Baroud, 2006	Healthcare	Palestine										x	x						
Mutula & Brakel, 2006	Developing countries	South Africa		x	x														x
Ruikar *et al.*, 2006	Construction	UK	x																
Fathian *et al.*, 2008	SMEs	Iran	x			x	x												x
Janom & Zakaria, 2008	SMEs	Malaysia	x																
Gewald & Dibbern, 2009	Bank	Germany									x				x				
Janom & Zakaria, 2009	SMEs	Malaysia	x												x		x		x
Lai & Ong, 2010	Various industry	Taiwan										x							
Lou & Goulding, 2010	Developing countries	UK		x															
Purnomo & Lee, 2010	Agriculture	Indonesia	x																
Keramati *et al.*, 2011	Education institute	Iran							x										
Total			**7**	**2**	1	1	1	1	**4**	1	1	**2**	1	1	**3**	1	1	1	**3**

Table A.5 Readiness factors of government

Author, year	Industry	Country	Factors					
			Legal environment and regulations	Revenue on electronic services	Government's role in driving e-readiness	Engagement	Capital	Policy
Rao, 2003	SMEs	India & Philippines					x	
bridges.org, 2005	Developing countries	South Africa	x		x			
Baroud, 2006	Healthcare	Palestine				x		
Fathian *et al.*, 2008	SMEs	Iran	x	x				
Ghavamifar *et al.*, 2008	Developing countries	Iran						x
Janom & Zakaria, 2009	SMEs	Malaysia	x					x
Total			**3**	1	1	1	1	**2**

Table A.6 Barrier factors of people

Author, year	Industry	Country	Factors								
			Personality	Learning style	Voluntariness	Age	Gender	Education	Skills	Self efficacy	Prior experience
Jones, 2003	SMEs	Australia	x								
Mungania, 2003	Various industries	USA	x	x							
Baroud, 2006	Healthcare	Palestine	x								
Howard *et al.*, 2006	Automotive	UK							x		
Soekartawi, 2008	Education institute	Indonesia	x								
Kijsanayotin *et al.*, 2009	Healthcare	Thailand	x		x						
Verhoeven *et al.*, 2009	Healthcare	Netherlands	x								

Table A.6 Barrier factors of people (cont.)

Author, year	Industry	Country	Factors								
			Personality	Learning style	Voluntariness	Age	Gender	Education	Skills	Self efficacy	Prior experience
Purnomo & Lee, 2010	Agriculture	Indonesia	x								
Sicotte & Pare, 2010	Healthcare	Canada	x								
Yucel *et al.*, 2011	Healthcare	Germany				x	x	x	x	x	x
Total			**8**	1	1	1	1	1	**2**	1	1

Table A.7 Barrier factors of process

Author, year	Industry	Country	Factors
			Implement
Malhotra and Ho, 2010	Bank	Taiwan	x
Total			1

Table A.8 Barrier factors of technology

Author, year	Industry	Country	Factors															
			Instructional	Content suitability	Usability	Performance	Quality	Technology architecture	Infrastructure	Appropriateness of technology	Capacity	Access and Equity	Internet	Perceived ease of use	Perceived usefulness	Compatibility	Impact	Enjoyment	Security
Jones, 2003	SMEs	Australia										x	x						
Mungania, 2003	Various industries	USA	x	x															

Table A.8 Barrier factors of technology (cont.)

Author, year	Industry	Country	Factors																
			Instructional	Content suitability	Usability	Performance	Quality	Technology architecture	Infrastructure	Appropriateness of technology	Capacity	Access and Equity	Internet	Perceived ease of use	Perceived usefulness	Compatibility	Impact	Enjoyment	Security
bridges.org, 2005	Developing countries	South Africa										x							
Baroud, 2006	Healthcare	Palestine									x								
Howard *et al.*, 2006	Automotive	UK										x							
Menou & Mchombu, 2007	Developing countries	Africa							x										
Khoja *et al.*, 2007/2008	Healthcare	Pakistan		x						x	x								
Soekartawi, 2008	Education institute	Indonesia				x	x	x											
Kijsanayotin *et al.*, 2009	Healthcare	Thailand				x													
Verhoeven *et al.*, 2009	Healthcare	Netherlands				x	x												
Malhotra and Ho, 2010	Bank	Taiwan	x																
Sicotte & Pare, 2010	Healthcare	Canada			x														
Khan *et al.*, 2011	Outsource	UK					x		x		x								x
Tran *et al.*, 2011	Enterprise	China							x										
Yucel *et al.*, 2011	Healthcare	Germany												x	x	x	x	x	
Total			**2**	**2**	1	**3**	**3**	1	**3**	1	**3**	**3**	1	1	1	1	1	1	1

Table A.9 Barrier factors of organization

Author, year	Industry	Country	Factors																
			Management	Social influence	Work related	Strategy	Geographical	Culture and tradition	Trust	Ongoing Research	Integration	Insufficient trained staff	Communication	Coordination	Organizational commitment	User participation	Size	Structure	Language
Mungania, 2003	Various industries	USA					x	x											
Jones, 2003	SMEs	Australia								x		x							
Baroud, 2006	Healthcare	Palestine		x			x	x				x							
Howard *et al.*, 2006	Automotive	UK	x					x											
Menou & Mchombu, 2007	Developing countries	Africa		x			x	x											
Khoja *et al.*, 2007/2008	Healthcare	Pakistan		x				x	x		x								
Kijsanayotin *et al.*, 2009	Healthcare	Thailand		x															
Verhoeven *et al.*, 2009	Healthcare	Netherlands			x			x											
Gewald & Dibbern, 2009	Outsource	Germany		x		x													
Purnomo & Lee, 2010	Agriculture	Indonesia						x											
Sicotte & Pare, 2010	Healthcare	Canada	x																
Malhotra and Ho, 2010	Bank	Taiwan				x													
Yucel *et al.*, 2011	Healthcare	Germany										x	x	x	x	x	x		
Khan *et al.*, 2011	Outsource	UK	x			x							x						x
Tran *et al.*, 2011	Enterprise	China	x			x		x										x	
Total			**4**	**5**	1	**4**	**3**	**8**	1	1	1	**3**	**2**	1	1	1	1	1	1

Table A.10 Barrier factors of government

Author, year	Industry	Country	Factors				
			Policy	Political	Financial	Legal and regulatory frameworks	Poor commitment of policy-makers
Jones, 2003	SMEs	Australia			x		
Baroud, 2006	Healthcare	Palestine	x		x		x
Howard *et al.*, 2006	Automotive	UK			x	x	
Menou & Mchombu, 2007	Developing countries	Africa			x		
Khoja *et al.*, 2007/2008	Healthcare	Pakistan	x	x	x	x	
Soekartawi, 2008	Education institute	Indonesia	x		x		
Verhoeven *et al.*, 2009	Healthcare	Netherlands	x				
Gewald & Dibbern, 2009	Outsource	Germany	x		x		
Purnomo & Lee, 2010	Agriculture	Indonesia	x				
Sicotte & Pare, 2010	Healthcare	Canada	x	x			
Khan *et al.*, 2011	Outsource	UK			x		
Tran *et al.*, 2011	Enterprise	China				x	
Total			**7**	**2**	**8**	**3**	1

Table A.11 Healthcare factors

Author, year	Industry	Country	Factors											
			Trust	Lighting	Appropriateness and accessibility	Policy	Operation	Communication	Politics	Heat	Noise	Interruptions	Voluntariness
Hanmer, 1999	Healthcare	South Africa			x			x					
Snyder-Halpern, 2001	Healthcare	USA					x						

Table A.11 Healthcare factors (cont.)

Author, year	Industry	Country	Factors											
			Trust	Lighting	Appropriateness and accessibility	Policy	Operation	Communication	Politics	Heat	Noise	Interruptions	Voluntariness
Ragan *et al.*, 2005	Healthcare	USA		x						x	x	x	
Baroud, 2006	Healthcare	Palestine				x							
Khoja *et al.*, 2007/2008	Healthcare	Pakistan	x										
Kijsanayotin *et al.*, 2009	Healthcare	Thailand											x
Sicotte & Pare, 2010	Healthcare	Canada							x				
Total			1	1	1	1	1	1	1	1	1	1	1

APPENDIX B
PERFORMANCE DEFINITIONS

Table B.1 The range of each factor performance

Factor	Score	Meaning	Description
1. Personality	5	Excellent	Your personality and work are very corresponding (>90%).
	4	Good	Your personality and work are corresponding (>70-90%).
	3	Average	Your personality and work are corresponding (>50-70%).
	2	Poor	Your personality and work are somewhat corresponding (30-50%).
	1	Very poor	Your personality and work are not corresponding at all (<30%).
2. Skills	5	Excellent	Your skills of barcode scanner use are excellent.
	4	Good	Your skills of barcode scanner use are good.
	3	Average	Your skills of barcode scanner use are medium.
	2	Poor	Your skills of barcode scanner use are poor.
	1	Very poor	Your skills of barcode scanner use are very poor.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
3. Task	5	Excellent	Your workloads are very appropriate (>90%).
	4	Good	Your workloads are appropriate (>70-90%).
	3	Average	Your workloads are very appropriate (>50-70%).
	2	Poor	Your workloads are not appropriate (30-50%).
	1	Very poor	Your workloads are not very appropriate at all (<30%).
4. Individual knowledge	5	Excellent	You apply all knowledge to working (>90%).
	4	Good	You apply almost all knowledge to working (>70-90%).
	3	Average	You apply somewhat knowledge to working (>50-70%).
	2	Poor	You apply a little knowledge to working (30-50%).
	1	Very poor	You don’t apply knowledge to working (<30%).
5. Self-development	5	Excellent	The capability in developing your work is excellent.
	4	Good	The capability in developing your work is good.
	3	Average	The capability in developing your work is medium.
	2	Poor	The capability in developing your work is poor.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	1	Very poor	The capability in developing your work is very poor.
6. Resources	5	Excellent	Hospital's resources are very sufficient (>90%).
	4	Good	Hospital's resources are sufficient (>70-90%).
	3	Average	Hospital's resources are somewhat sufficient (>50-70%).
	2	Poor	Hospital's resources are not sufficient (30-50%).
	1	Very poor	Hospital's resources are not sufficient at all (<30%).
7. Operations	5	Excellent	The steps in hospital operations are very easy to action.
	4	Good	The steps in hospital operations are easy to action.
	3	Average	The steps in hospital operations are somewhat easy to action.
	2	Poor	The steps in hospital operations are not easy to action.
	1	Very poor	The steps in hospital operations are not easy to action at all.
8. Infrastructure	5	Excellent	Hospital's infrastructures have very appropriateness to apply internet.
	4	Good	Hospital's infrastructures have appropriateness to apply internet.
	3	Average	Hospital's infrastructures have somewhat appropriateness to apply internet.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	2	Poor	Hospital's infrastructures have not appropriateness to apply internet.
	1	Very poor	Hospital's infrastructures have not appropriateness to apply internet at all.
9. Internet availability and affordability	5	Excellent	The internet in hospital services all departments (>90%).
	4	Good	The internet in hospital services more than 70-90% of all departments.
	3	Average	The internet in hospital services more than 50-70% of all departments.
	2	Poor	The internet in hospital services 30-50% of all departments.
	1	Very poor	The internet in hospital services less than 30% of all departments.
10. Innovation	5	Excellent	The frequency of innovation project/product is every month.
	4	Good	The frequency of innovation project/product is every 3 months.
	3	Average	The frequency of innovation project/product is every 6 month.
	2	Poor	The frequency of innovation project/product is every year.
	1	Very poor	The frequency of innovation project/product is every 2 years.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
11. Security and encryption	5	Excellent	The IT security systems in hospital are very high quality and trust worthy.
	4	Good	The IT security systems in hospital are high quality.
	3	Average	The IT security systems in hospital are medium quality.
	2	Poor	The IT security systems in hospital are low quality.
	1	Very poor	The IT security systems in hospital are very low quality.
12. ICT services and support	5	Excellent	The ICT systems support all departments in the hospital (>90%).
	4	Good	The ICT systems support more than 70-90% of all departments in the hospital.
	3	Average	The ICT systems support more than 50-70% of all departments in the hospital.
	2	Poor	The ICT systems support 30-50% of all departments in the hospital.
	1	Very poor	The ICT systems support less than 30% of all departments in the hospital.
13. Quality	5	Excellent	The ICT systems in hospital have not defect at all.
	4	Good	The ICT systems in hospital have somewhat low defect.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	3	Average	The ICT systems in hospital have sometime defect.
	2	Poor	The ICT systems in hospital have somewhat high defect.
	1	Very poor	The ICT systems in hospital have high defect.
14. Performance	5	Excellent	The ICT systems in hospital are very fast.
	4	Good	The ICT systems in hospital are fast.
	3	Average	The ICT systems in hospital are somewhat fast.
	2	Poor	The ICT systems in hospital are slow.
	1	Very poor	The ICT systems in hospital are very slow.
15. Access and equity	5	Excellent	The ICT systems access all departments of hospital (>90%).
	4	Good	The ICT systems access more than 70-90% of all departments of hospital.
	3	Average	The ICT systems access more than 50-70% of all departments of hospital.
	2	Poor	The ICT systems access 30-50% of all departments of hospital.
	1	Very poor	The ICT systems access less than 30% of all departments of hospital.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
16. Appropriateness of ICT	5	Excellent	The ICT systems in hospital are very appropriate.
	4	Good	The ICT systems in hospital are appropriate.
	3	Average	The ICT systems in hospital are somewhat appropriate.
	2	Poor	The ICT systems in hospital are not appropriate.
	1	Very poor	The ICT systems in hospital are not appropriate at all.
17. Linkage of information	5	Excellent	The hospital links more than 90% of information all departments.
	4	Good	The hospital links more than 70-90% of information all departments.
	3	Average	The hospital links more than 50-70% of information all departments.
	2	Poor	The hospital links 30-50% of information all departments.
	1	Very poor	The hospital links less than 30% of information all departments.
18. Management	5	Excellent	The manager gives more than 90% support to all departments.
	4	Good	The manager gives more than 70-90% support to all departments.
	3	Average	The manager gives more than 50-70% support to all departments.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	2	Poor	The manager gives 30-50% support to all departments.
	1	Very poor	The manager gives less than 30% support to all departments.
19. Strategy	5	Excellent	The strategy and operations of hospital are very clear and easy to action (>90%).
	4	Good	The strategy and operations of hospital are clear and easy to action (>70-90%).
	3	Average	The strategy and operations of hospital are somewhat clear (>50-70%).
	2	Poor	The strategy and operations of hospital are not clear (30-50%).
	1	Very poor	The strategy and operations of hospital are not clear at all (<30%).
20. Structure	5	Excellent	Organization' structure is very appropriate and not change.
	4	Good	Organization' structure is appropriate and somewhat to change.
	3	Average	Organization' structure is appropriate and should to change.
	2	Poor	Organization' structure is not appropriate and must to change.
	1	Very poor	Organization' structure is not appropriate and must to change now.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
21. Communication	5	Excellent	The communication within organization is more than 90%.
	4	Good	The communication within organization is more than 70-90%.
	3	Average	The communication within organization is more than 50-70%.
	2	Poor	The communication within organization is 30-50%.
	1	Very poor	The communication within organization is less than 30%.
22. Finance	5	Excellent	The government funding supports more than 90% of hospital.
	4	Good	The government funding supports more than 70-90% of hospital.
	3	Average	The government funding supports more than 50-70% of hospital.
	2	Poor	The government funding supports 30-50% of hospital.
	1	Very poor	The government funding supports less than 30% of hospital.
23. Policy	5	Excellent	The policies of hospital follow more than 90% of government policies.
	4	Good	The policies of hospital follow more than 70-90% of government policies.
	3	Average	The policies of hospital follow more than 50-70% of government policies.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	2	Poor	The policies of hospital follow 30-50% of government policies.
	1	Very poor	The policies of hospital follow less than 30% of government policies.
24. Legal and regulatory framework	5	Excellent	The hospital framework is according to regulations of government (>90%).
	4	Good	The hospital framework is according to regulations of government (>70-90%).
	3	Average	The hospital framework is according to regulations of government (>50-70%).
	2	Poor	The hospital framework is according to regulations of government (30-50%).
	1	Very poor	The hospital framework is according to regulations of government (<30%).
25. Politics	5	Excellent	The politics change is affecting the hospital management (<30%).
	4	Good	The politics change is affecting the hospital management (30-50%).
	3	Average	The politics change is affecting the hospital management (>50-70%).
	2	Poor	The politics change is affecting the hospital management (>70-90%).
	1	Very poor	The politics change is affecting the hospital management (>90%).

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
26. Lighting	5	Excellent	The lighting in working place is very appropriate.
	4	Good	The lighting in working place is appropriate.
	3	Average	The lighting in working place is somewhat appropriate.
	2	Poor	The lighting in working place is not appropriate.
	1	Very poor	The lighting in working place is not appropriate at all.
27. Heat	5	Excellent	The temperature in working place is very appropriate.
	4	Good	The temperature in working place is appropriate.
	3	Average	The temperature in working place is somewhat appropriate.
	2	Poor	The temperature in working place is not appropriate.
	1	Very poor	The temperature in working place is not appropriate at all.
28. Noise	5	Excellent	The working place is very quiet and no disturbance at all.
	4	Good	The working place is quiet with a little disturbance.
	3	Average	The working place is somewhat quiet with some disturbance.
	2	Poor	The working place is noisy and some disturbance.

Table B.1 The range of each factor performance (cont.)

Factor	Score	Meaning	Description
	1	Very poor	The working place is very noisy and very disturbance.
29. Interruptions	5	Excellent	None.
	4	Good	Has some, but not frequently.
	3	Average	Has periodically.
	2	Poor	Quite often.
	1	Very poor	Very often.
30. Voluntariness	5	Excellent	The staff volunteers to service very impressive (>90%).
	4	Good	The staff volunteers to service impressive (>70-90%).
	3	Average	The staff volunteers to service somewhat impressive (>50-70%).
	2	Poor	The staff volunteers to service no impressive (30-50%).
	1	Very poor	The staff volunteers to service no impressive al all (<30%).

APPENDIX C
THE ENGLISH VERSION OF QUESTIONNAIRES

E-readiness assessment survey of Thai hospitals for barcode technology implementation

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Explanation

These questionnaires are designed for data collection concerning e-readiness factors: people, process, technology, organization, government, and patient safety in order to adopt barcode technology in your hospital. The adoption will help the information flow of pharmaceutical product both internally and externally to increase efficiency.

These questionnaires were developed by Miss Jiraporn Saesor a master's student in Industrial Engineering, Faculty of Engineering, Mahidol University. These will be a part of her thesis to want the readiness of the hospitals comparing different sizes of the hospitals. The resent of the study will be kept in confidential.

Thank you for your participation in this study.

.....

<u>Section 1</u> Respondent's Information

1. What is your gender?

[ ] Male

[ ] Female

2. How old are you?

[ ] 20 - 30 years

[ ] 31 - 40 years

[ ] > 40 years

3. What is current position in this hospital?

[ ] Pharmacist

[ ] Nurse

[ ] IT staff

[ ] Warehouse staff

[ ] Finance staff

[ ] Purchasing staff

[ ] Other. Please specify .....

4. How many years have you worked in this hospital?

[ ] < 1 year

[ ] 1 - 2 year/s

[ ] 3 - 4 years

[ ] ≥ 5 years

<u>Section 2</u> E-readiness of hospital

Please mark ✓ in the blank of both **"Importance"** and "**Performance**" which matches with your opinion. If you think there are more factors to affect hospital e-readiness for barcode technology implementation to be concerned, please specify the factors and give the scores.

"Implementation of barcode technology" is used the implementation of barcode technology to manage pharmaceutical products in the procurement and inventory in hospitals. The pharmaceutical products of all kinds and types had barcode labeling to derive from the suppliers to the pharmaceutical warehouse in hospital.

Then, staff used a barcode scanner to read information of pharmaceutical products and forwards the data to all computers involved in hospital in order to save the details such as name, type, and expiration date of pharmaceutical products.

Column

"Importance" = You think that the important of each factor to hospital readiness for implementation of barcode technology in order to help your work and service much more efficiently.

Scores 5 = Very high 4 = High 3 = Medium 2 = Low 1 = Very low

"Performance" = The actual readiness level of each factor in your hospital.

Scores 5 = Excellent 4 = Good 3 = Average 2 = Poor 1 = Very poor

Factors	Importance					Performance				
	Very high	High	Medium	Low	Very low	Excellent	Good	Average	Poor	Very poor
1. People										
1.1 Personality match your work.	5	4	3	2	1	5	4	3	2	1
1.2 Your skills of barcode scanner.	5	4	3	2	1	5	4	3	2	1
1.3 The appropriateness of the quantity of your work.	5	4	3	2	1	5	4	3	2	1
1.4 Your knowledge can adopt working.	5	4	3	2	1	5	4	3	2	1
1.5 Capability in developing your work.	5	4	3	2	1	5	4	3	2	1
2. Process										
2.1 Resources sufficiency.	5	4	3	2	1	5	4	3	2	1
2.2 Steps in operations easy of work.	5	4	3	2	1	5	4	3	2	1
3. Technology in management of pharmaceutical products										
3.1 Infrastructure which is related to barcode technology implementation.	5	4	3	2	1	5	4	3	2	1
3.2 Internet services at all departments/units in hospital.	5	4	3	2	1	5	4	3	2	1

Factors	Importance					Performance				
	Very high	High	Medium	Low	Very low	Excellent	Good	Average	Poor	Very poor
3.3 Innovation is happening always.	5	4	3	2	1	5	4	3	2	1
3.4 The protection of data against unauthorized access of hospital.	5	4	3	2	1	5	4	3	2	1
3.5 ICT system for supporting hospital staff.	5	4	3	2	1	5	4	3	2	1
3.6 The quality of ICT system in hospital.	5	4	3	2	1	5	4	3	2	1
3.7 The performance of ICT system in hospital.	5	4	3	2	1	5	4	3	2	1
3.8 Ability to access ICT system of hospital.	5	4	3	2	1	5	4	3	2	1
3.9 The appropriateness of ICT systems for hospital.	5	4	3	2	1	5	4	3	2	1
3.10 The capability for linking information in every unit in hospital.	5	4	3	2	1	5	4	3	2	1
4. Organization										
4.1 Management's support for barcode technology implementation.	5	4	3	2	1	5	4	3	2	1
4.2 Clear strategy of the hospital.	5	4	3	2	1	5	4	3	2	1
4.3 Appropriateness of hospital structure for barcode technology implementation.	5	4	3	2	1	5	4	3	2	1
4.4 Communication within hospitals.	5	4	3	2	1	5	4	3	2	1
5. Government										
5.1 Financial support from government.	5	4	3	2	1	5	4	3	2	1
5.2 Consistency between the policies of the government and the operations of the hospital staff.	5	4	3	2	1	5	4	3	2	1
5.3 Hospital operations under law and regulations of the government.	5	4	3	2	1	5	4	3	2	1
5.4 The impact of political changes to the management of the hospitals.	5	4	3	2	1	5	4	3	2	1

Factors	Importance					Performance				
	Very high	High	Medium	Low	Very low	Excellent	Good	Average	Poor	Very poor
6. Hospital environment										
6.1 The appropriate of lightness in working area.	5	4	3	2	1	5	4	3	2	1
6.2 The appropriate of temperature in working area.	5	4	3	2	1	5	4	3	2	1
6.3 The appropriate of well-ordered and loudness in working area.	5	4	3	2	1	5	4	3	2	1
6.4 The frequency of disturbance in the working area.	5	4	3	2	1	5	4	3	2	1
6.5 The feeling of staff to intention of colleague's services.	5	4	3	2	1	5	4	3	2	1
7. Other (Please specify)										
7.1	5	4	3	2	1	5	4	3	2	1
7.2	5	4	3	2	1	5	4	3	2	1
7.3	5	4	3	2	1	5	4	3	2	1
7.4	5	4	3	2	1	5	4	3	2	1
7.5	5	4	3	2	1	5	4	3	2	1

Section 3 Hospital Profile

1. Is your hospital a public or private hospital?

[ ] Public

[ ] Private

2. How many beds does your hospital currently have?

[ ] 10 - 120 beds

[ ] > 120 beds

3. How many SKUs of pharmaceutical product does your hospital currently have? (SKU or Stock Keeping Unit is a number given to each item of pharmaceutical product (by category and brand) stocked in a warehouse for inventory and tracking purposes.)

[ ] 1 - 200 SKU/s

[ ] 201 - 500 SKUs

[ ] 501 - 1000 SKUs

[ ] > 1000 SKUs

4. What is ICT system used for pharmaceutical inventory management in your hospital?

[ ] SAP

[ ] HosXP

[ ] E-phis2

[ ] Easy Hos

[ ] SSB

[ ] Other. Please specify.....

5. What departments have used computer in their operation? (Selected more than 1)

[ ] Procurement/warehouse

[ ] Pharmacy

[ ] Finance

[ ] Other. Please specify.....

6. Which of the following best describes your hospital accreditation (HA) status?

[ ] Is currently accredited.

[ ] Is currently not accredited but has made significant progress toward accreditation.

[ ] Is currently not accredited and has no plan in place toward accreditation.

7. Have your hospital used the barcode technology for pharmaceutical management?

[ ] Yes

[ ] No

Section 4 Comments/Suggestions

……...

……...……

……...

……...……

……..

APPENDIX D
THE THAI VERSION OF QUESTIONNAIRES

แบบสอบถามเพื่อประเมินความพร้อมของโรงพยาบาล ในการประยุกต์ใช้เทคโนโลยีบาร์โค้ด

.....

คำชี้แจง

แบบสอบถามฉบับนี้จัดทำขึ้นเพื่อรวบรวมข้อมูลเกี่ยวกับความพร้อมด้านเทคโนโลยี บุคลากร องค์กร กระบวนการทำงาน รัฐบาลและความปลอดภัยของผู้ป่วยของโรงพยาบาล เพื่อที่จะนำเทคโนโลยีบาร์โค้ดมาประยุกต์ใช้กับผลิตภัณฑ์ยาในโรงพยาบาลของท่าน ทั้งนี้เพื่อให้การส่งต่อข้อมูลยาภายในและภายนอกโรงพยาบาลมีประสิทธิภาพมากขึ้น

ผู้วิจัยคือนางสาวจิราภรณ์ แซ่ส่อ นักศึกษาคณะวิศวกรรมศาสตร์ มหาวิทยาลัยมหิดล และแบบสอบถามฉบับนี้เป็นส่วนหนึ่งของงานวิจัยเพื่อประเมินความพร้อมของโรงพยาบาลแต่ละขนาด และผู้วิจัยขอรับรองว่าข้อมูลที่เกี่ยวกับผู้ตอบแบบสอบถามจะไม่มีการเผยแพร่ใดๆ ทั้งสิ้น

ผู้วิจัยขอขอบคุณท่านที่สละเวลาในการให้ข้อมูลและข้อเสนอแนะที่เป็นประโยชน์ในการพัฒนาและวางแผนการใช้เทคโนโลยีบาร์โค้ดยาให้มีประสิทธิภาพสูงสุดแก่หน่วยงานของท่านและตลอดทั้งโซ่อุปทานยาในอนาคต

.....

<u>ส่วนที่ 1</u> ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

1. โปรดระบุเพศของท่าน

[ ] ชาย

[ ] หญิง

2. อายุของท่าน

[ ] 20 - 30 ปี

[ ] 31 - 40 ปี

[ ] มากกว่า 40 ปี

3. ตำแหน่งที่ท่านปฏิบัติงานอยู่ ณ โรงพยาบาลแห่งนี้

[ ] เภสัชกร

[ ] พยาบาล

[ ] เจ้าหน้าที่ด้าน IT

[ ] เจ้าหน้าที่คลังยา

[ ] เจ้าหน้าที่การเงิน

[ ] เจ้าหน้าที่จัดซื้อ

[ ] อื่นๆ โปรดระบุ.....

4. ท่านปฏิบัติงาน ณ โรงพยาบาลแห่งนี้ในตำแหน่งปัจจุบันเป็นเวลากี่ปี

[ ] น้อยกว่า 1 ปี

[ ] 1 - 2 ปี

[ ] 3 - 4 ปี

[ ] 5 ปีขึ้นไป

<u>ส่วนที่ 2</u> ความพร้อมของโรงพยาบาล

โปรดทำเครื่องหมาย ✓ ลงในช่องว่างทั้งช่อง **“ความสำคัญ ”** และ **“ผลการทำงานในปัจจุบัน”** ที่ตรงกับความเห็นของท่านมากที่สุด และถ้าหากท่านมีปัจจัยเพิ่มเติมที่คิดว่ามีผลต่อความพร้อมของโรงพยาบาลในการประยุกต์ใช้เทคโนโลยีบาร์โค้ด กรุณากรอกในช่องปัจจัยอื่นๆ

“การประยุกต์ใช้เทคโนโลยีบาร์โค้ด ” เป็นการนำเทคโนโลยีบาร์โค้ดมาใช้ในการบริหารจัดการยาในส่วนของการจัดซื้อจัดหา สินค้าคงคลัง ตลอดจนการจ่ายยาให้แก่ผู้ป่วย เพื่อเพิ่มประสิทธิภาพในการให้บริการและลดความผิดพลาดจากการจ่ายยาผิดให้แก่ผู้ป่วยได้ โดยให้

ผลิตภัณฑ์ยาทุกชนิดและทุกประเภทที่รับมาจากซัพพลายเออร์มีฉลากบาร์โค้ด ที่ประกอบด้วย ชื่อยา วิธีการใช้ วันหมดอายุ เป็นต้น

คอลัมน์

"ความสำคัญ" คือ ท่านคิดว่าปัจจัยแต่ละข้อมีความสำคัญต่อความพร้อมของโรงพยาบาลในการนำเทคโนโลยีบาร์โค้ดมาประยุกต์ใช้ เพื่อให้การทำงานและการบริการของท่านมีประสิทธิภาพเพิ่มขึ้นมากน้อยเพียงใด

คะแนน 5 = มากที่สุด 4 = มาก 3 = ปานกลาง 2 = น้อย 1 = น้อยที่สุด

"ผลการทำงานในปัจจุบัน" คือ ท่านคิดว่าปัจจุบันโรงพยาบาลของท่านมีผลการดำเนินงานแต่ละปัจจัยอยู่ในระดับใด

คะแนน 5 = ดีมาก 4 = ดี 3 = ปานกลาง 2 = พอใช้ 1 = ควรปรับปรุง

ปัจจัย	ความสำคัญ					ผลการทำงานในปัจจุบัน				
	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด	ดีมาก	ดี	ปานกลาง	พอใช้	ควรปรับปรุง
1. บุคลากร (People)										
1.1 บุคลิกภาพของท่านมีลักษณะสอดคล้องกับงานที่รับผิดชอบอยู่ในปัจจุบัน	5	4	3	2	1	5	4	3	2	1
1.2 ทักษะในการใช้เครื่องอ่านบาร์โค้ดของท่าน	5	4	3	2	1	5	4	3	2	1
1.3 ความเหมาะสมของปริมาณงานที่ท่านรับผิดชอบอยู่ในปัจจุบัน	5	4	3	2	1	5	4	3	2	1
1.4 ความรู้พื้นฐานของท่านสามารถประยุกต์ใช้ให้เข้ากับงานที่รับผิดชอบอยู่ในปัจจุบัน	5	4	3	2	1	5	4	3	2	1
1.5 การพัฒนาตนเองให้สามารถเรียนรู้สิ่งใหม่ๆ ของท่าน	5	4	3	2	1	5	4	3	2	1
2. กระบวนการ (Process)										
2.1 ทรัพยากรของโรงพยาบาลมีเพียงพอต่อความต้องการของพนักงาน เช่น คอมพิวเตอร์ โทรศัพท์ เป็นต้น	5	4	3	2	1	5	4	3	2	1
2.2 ขั้นตอนการปฏิบัติงานที่เข้าใจง่าย ถูกต้อง แม่นยำ และไม่ซับซ้อน	5	4	3	2	1	5	4	3	2	1

ปัจจัย	ความสำคัญ					ผลการทำงานในปัจจุบัน				
	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด	ดีมาก	ดี	ปานกลาง	พอใช้	ควรปรับปรุง
3. เทคโนโลยี (Technology) ที่ใช้ในการบริหารจัดการยา										
3.1 โครงสร้างพื้นฐานเกี่ยวกับเทคโนโลยีสารสนเทศและระบบอินเทอร์เน็ตของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
3.2 ความทั่วถึงของการบริการด้านอินเทอร์เน็ตของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
3.3 การศึกษาค้นคว้าสิ่งใหม่ๆ ที่มีประโยชน์ต่อโรงพยาบาลและพนักงาน	5	4	3	2	1	5	4	3	2	1
3.4 ระบบป้องกันการละเมิดกฎระเบียบในการใช้เทคโนโลยีของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
3.5 มีระบบ ICT สนับสนุนการการทำงานของพนักงานทุกแผนก	5	4	3	2	1	5	4	3	2	1
3.6 คุณภาพของระบบ ICT	5	4	3	2	1	5	4	3	2	1
3.7 ประสิทธิภาพในการทำงานของระบบ ICT	5	4	3	2	1	5	4	3	2	1
3.8 การเข้าถึงเทคโนโลยีต่างๆ ของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
3.9 ระบบ ICT มีความเหมาะสมกับการบริหารจัดการยาในโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
3.10 การเชื่อมโยงข้อมูลยาภายในโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
4. องค์กร (Organization)										
4.1 การสนับสนุนจากผู้บริหารของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
4.2 ความชัดเจนของแผนกลยุทธ์ในการบริหารจัดการยาของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
4.3 ความเหมาะสมของโครงสร้างองค์กรกับรูปแบบการบริหารจัดการยาในโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
4.4 การติดต่อสื่อสารกันภายในองค์กร	5	4	3	2	1	5	4	3	2	1
5. ภาครัฐ (Government)										
5.1 การสนับสนุนด้านการเงินจากภาครัฐ	5	4	3	2	1	5	4	3	2	1
5.2 ความสอดคล้องระหว่างนโยบายของภาครัฐกับการปฏิบัติงานของพนักงานในโรงพยาบาล เช่น ขั้นตอน	5	4	3	2	1	5	4	3	2	1

ปัจจัย	ความสำคัญ					ผลการทำงานในปัจจุบัน				
	มากที่สุด	มาก	ปานกลาง	น้อย	น้อยที่สุด	ดีมาก	ดี	ปานกลาง	พอใช้	ควรปรับปรุง
การปฏิบัติงาน เป็นต้น										
5.3 โรงพยาบาลบริหารจัดการยาภายใต้กฎระเบียบและข้อบังคับของภาครัฐ	5	4	3	2	1	5	4	3	2	1
5.4 การเปลี่ยนแปลงทางการเมืองส่งผลกระทบต่อการบริหารจัดการยาของโรงพยาบาล	5	4	3	2	1	5	4	3	2	1
6. สิ่งแวดล้อมภายในโรงพยาบาล (Hospital environment)										
6.1 ความเหมาะสมของแสงสว่างในห้องปฏิบัติงาน	5	4	3	2	1	5	4	3	2	1
6.2 ความเหมาะสมของอุณหภูมิในห้องปฏิบัติงาน	5	4	3	2	1	5	4	3	2	1
6.3 ความเป็นระเบียบและเงียบสงบของห้องปฏิบัติงาน	5	4	3	2	1	5	4	3	2	1
6.4 ความถี่ของสิ่งรบกวนในห้องปฏิบัติงาน ที่ทำให้ไม่มีสมาธิในการทำงาน	5	4	3	2	1	5	4	3	2	1
6.5 ความตั้งใจในการบริการของเพื่อนร่วมงานแก่ผู้ป่วย	5	4	3	2	1	5	4	3	2	1
7. อื่นๆ										
7.1	5	4	3	2	1	5	4	3	2	1
7.2	5	4	3	2	1	5	4	3	2	1
7.3	5	4	3	2	1	5	4	3	2	1
7.4	5	4	3	2	1	5	4	3	2	1
7.5	5	4	3	2	1	5	4	3	2	1

<u>ส่วนที่ 3</u> ข้อมูลทั่วไปของโรงพยาบาล

1. โรงพยาบาลที่ท่านปฏิบัติงานอยู่สังกัดหน่วยงานใด

[ ] ภาครัฐ

[ ] ภาคเอกชน

2. โรงพยาบาลที่ท่านปฏิบัติงานอยู่มีจำนวนเตียงผู้ป่วยในทั้งหมดกี่เตียง

[ ] 10 - 120 เตียง

[ ] > 120 เตียง

3. โรงพยาบาลที่ท่านปฏิบัติงานอยู่มีจำนวนยาที่มีการบริหารและ /หรือใช้งานในคลังยาประมาณเท่าไร (SKU ย่อมาจาก Stock keeping unit คือ หน่วยนับที่เล็กที่สุดในการจัดเก็บยา เพื่อแยกความแตกต่างของยาแต่ละประเภท)

[ ] 1 - 200 SKU/s

[ ] 201 - 500 SKUs

[ ] 501 - 1000 SKUs

[ ] 1001 SKUs ขึ้นไป

4. ชื่อระบบ ICT และ/หรือชื่อโปรแกรมที่ใช้บริหารจัดการยาในโรงพยาบาล

[ ] SAP

[ ] HosXP

[ ] E-phis2

[ ] Easy Hos

[ ] SSB

[ ] อื่นๆ โปรดระบุ.....

5. โรงพยาบาลของท่านมีการใช้คอมพิวเตอร์ในการบันทึกข้อมูลยาในแผนกใดบ้าง (ตอบได้มากกว่า 1 ข้อ)

[ ] จัดซื้อและคลังยา

[ ] ห้องจ่ายยา

[ ] การเงิน

[ ] อื่นๆ โปรดระบุ.....

6. โรงพยาบาลที่ท่านปฏิบัติงานอยู่ได้รับการรับรองคุณภาพโรงพยาบาล (Hospital Accreditation/HA) หรือไม่

[ ] ผ่านการรับรองแล้ว

[ ] ยังไม่ได้รับการรับรอง แต่มีการเตรียมแผนงานเพื่อขอรับการตรวจรับรอง

[ ] ยังไม่ได้รับการรับรอง และไม่มีแผนที่จะขอรับการตรวจรับรอง

7. ปัจจุบันโรงพยาบาลที่ท่านปฏิบัติงานอยู่มีการนำเทคโนโลยีบาร์โค้ดมาใช้บริหารจัดการยาหรือไม่

[ ] มี

[ ] ไม่มี

<u>ส่วนที่ 4</u> ความคิดเห็น / ข้อเสนอแนะ

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APPENDIX E
HOSPITAL LISTS

Table E.1 The lists of hospital and number of respondent

No.	Hospital name	Type	Size	No. of respondent
1	Phutthamonthon	Public	Small	10
2	Golden Jubilee Medical Center	Public	Small	8
3	Pak Kret	Public	Small	7
4	Bang Bua Thong	Public	Small	7
5	Bang Yai	Public	Small	7
6	Bang Kruai	Public	Small	7
7	Sirikit Medical Center	Public	Large	7
8	Ramathibodi	Public	Large	10
9	Somdech Phra Debaratana Medical Center	Public	Large	10
10	Nakhon Pathom	Public	Large	7
11	Thonburi 2	Private	-	10
12	Pyathai 1	Private	-	9
13	Eye Ear Nose Throat	Private	-	7
14	Salaya	Private	-	8

APPENDIX F
IMPORTANCE AND PERFORMANCE SCORES

Table F.1 Importance scores of small-size public hospitals

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
1	3	2	4	4	4	4	4	4	5	5	5	5	5	5	4	3	4	5	4	4	4	3	4	3	3	4	4	4	3	4
2	5	3	5	5	5	5	5	4	5	5	5	5	5	5	4	3	5	5	5	4	4	4	4	4	5	4	4	3	4	4
3	3	3	3	4	4	4	4	5	5	5	5	5	5	5	5	3	4	5	5	5	4	3	3	3	3	4	4	3	5	4
4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	5	5	4	5	4	4	4	4	5	4	4	5	4	4	4
5	4	5	3	3	4	5	3	5	4	4	3	5	3	4	3	4	5	4	3	3	4	5	3	5	4	2	2	2	2	3
6	4	4	5	4	5	4	4	4	3	4	4	4	4	3	3	4	4	5	4	4	4	3	3	4	3	5	5	4	3	4
7	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
8	3	3	4	4	4	5	5	4	3	4	4	4	4	4	4	4	5	5	4	4	5	5	4	4	5	5	5	5	5	5
9	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
11	4	4	5	4	4	4	5	4	4	4	4	4	4	4	4	3	4	5	5	4	3	4	4	5	2	4	4	4	4	4
12	5	4	5	5	5	5	5	4	5	4	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5
13	4	3	2	4	4	1	3	1	4	4	1	5	5	4	2	5	2	2	1	3	1	1	3	3	2	4	1	1	4	4
14	4	4	4	3	4	4	4	5	3	3	4	3	3	3	3	4	3	4	4	5	5	5	4	4	2	4	4	4	4	4
15	3	4	4	3	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4
16	4	4	4	3	4	4	4	5	3	3	4	3	3	3	3	4	3	4	4	5	5	5	4	4	2	4	4	4	4	4

Table F.1 Importance scores of small-size public hospitals (cont.)

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
17	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	3	4	3	4	2	4	4	4	3	4
18	5	5	5	3	5	4	5	3	5	5	3	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	3	4
19	5	1	4	4	4	3	5	4	3	1	3	3	3	2	4	3	3	3	3	3	3	4	3	4	4	4	4	2	2	3
20	5	1	5	5	5	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
21	3	1	4	4	4	1	4	1	2	3	4	4	4	4	4	4	4	4	3	3	3	5	4	4	2	3	4	5	3	4
22	3	3	4	2	1	4	3	5	4	4	5	5	5	5	5	5	4	5	5	4	4	5	4	4	4	5	5	5	5	5
23	4	4	5	3	3	3	4	5	4	3	3	5	4	4	3	3	4	4	4	3	3	4	5	4	3	5	4	4	4	5
24	4	3	4	4	5	2	3	3	5	4	3	4	3	4	3	3	5	5	4	4	5	5	4	4	4	4	3	3	4	4
25	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	2	2	3	2	3	3	2	3	2
26	3	2	3	2	5	5	4	4	4	4	5	4	4	4	3	4	4	4	4	3	5	4	4	4	2	3	3	3	4	4
27	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4
28	5	4	4	5	5	4	5	5	5	4	4	5	4	4	5	4	4	5	4	4	5	5	5	5	2	5	5	5	4	5
29	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
30	4	1	4	4	4	2	3	3	2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	2	3	4	4
31	3	3	3	4	4	5	4	5	4	4	3	4	4	4	4	4	4	3	3	3	3	3	3	4	3	4	4	5	2	5
32	3	4	4	4	4	1	4	2	2	4	3	3	2	2	2	3	3	3	4	4	3	2	3	4	4	4	4	2	4	3
33	4	3	4	3	4	3	3	3	3	3	2	2	3	3	3	4	2	3	3	3	3	3	3	3	4	3	3	3	3	3
34	3	1	4	2	3	3	2	2	4	2	4	3	1	2	3	2	2	5	4	3	5	5	4	5	1	4	5	5	4	5
35	3	1	3	4	4	1	4	3	3	3	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
36	3	1	3	4	4	2	4	4	4	4	4	5	4	4	4	2	4	3	3	3	3	4	3	3	2	3	4	4	4	4

Table F.1 Importance scores of small-size public hospitals (cont.)

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
37	3	3	3	3	4	4	3	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4
38	4	4	4	4	4	4	4	4	4	5	4	4	4	3	4	4	4	4	4	4	4	4	4	5	4	4	3	3	4	4
39	4	1	4	4	3	4	3	4	5	3	4	4	4	3	4	3	3	3	2	2	2	3	2	3	3	3	3	3	3	4
40	4	1	4	4	4	5	4	4	4	4	5	5	4	5	4	4	4	3	4	3	4	4	4	4	4	4	4	4	4	4
41	4	1	4	4	3	4	4	3	3	3	3	5	3	4	3	3	3	4	3	3	4	4	4	4	3	4	4	4	4	3
42	3	3	4	3	4	4	3	3	5	3	3	4	4	3	4	4	4	4	4	4	3	4	3	5	4	3	3	3	3	3
43	3	3	4	4	4	5	4	3	4	4	4	4	4	4	4	4	4	5	4	4	4	5	4	4	3	4	4	5	4	5
44	5	1	3	5	5	5	5	5	3	5	3	4	5	4	4	5	5	3	4	4	3	3	3	4	3	5	5	2	2	3
45	3	1	1	1	4	3	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	5
46	3	4	4	3	4	3	3	4	5	3	3	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4
Average	**3.83**	**2.93**	**3.93**	**3.74**	**4.07**	**3.72**	**3.98**	**3.85**	**3.93**	**3.83**	**3.78**	**4.15**	**3.93**	**3.89**	**3.85**	**3.87**	**3.93**	**4.09**	**3.91**	**3.78**	**3.87**	**4.00**	**3.78**	**4.11**	**3.41**	**4.04**	**3.93**	**3.76**	**3.80**	**4.09**
S.D.	**0.77**	**1.34**	**0.85**	**0.91**	**0.77**	**1.20**	**0.77**	**1.03**	**0.90**	**0.88**	**0.99**	**0.84**	**0.90**	**0.88**	**0.82**	**0.86**	**0.90**	**0.86**	**0.89**	**0.79**	**0.96**	**0.99**	**0.81**	**0.71**	**1.09**	**0.76**	**0.93**	**1.06**	**0.86**	**0.76**

Table F.2 Importance scores of large-size public hospitals

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
1	3	5	3	3	3	2	3	4	4	4	4	4	4	4	4	4	4	3	2	2	2	3	2	3	3	3	2	3	3	4
2	4	4	4	4	4	4	5	4	4	4	4	4	4	4	5	4	5	5	5	4	5	4	5	5	4	5	4	4	4	4

Table F.2 Importance scores of large-size public hospitals (cont.)

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
3	3	4	4	5	5	5	4	4	3	4	5	4	5	4	4	4	5	4	4	3	5	3	4	4	3	5	5	5	5	5
4	5	3	5	5	5	4	5	5	5	4	5	4	4	4	4	4	4	5	5	5	5	4	4	4	4	4	4	4	4	4
5	4	5	5	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	4	4	5	4	5	5	5
6	5	5	4	4	5	5	2	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5
7	5	5	4	4	5	5	2	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	5	5	5
8	3	4	4	5	5	5	4	4	3	4	5	4	5	5	4	4	5	4	4	3	5	3	4	4	3	5	5	5	5	5
9	3	5	3	3	3	2	3	4	4	4	4	4	5	4	4	4	4	3	2	3	2	3	2	3	3	3	2	3	3	3
10	4	4	4	4	4	4	5	4	4	4	4	4	5	5	5	4	5	5	5	4	5	4	5	5	4	5	4	4	4	4
11	5	5	4	4	5	5	2	5	5	5	5	5	5	5	5	5	5	4	5	5	5	3	5	5	5	5	5	5	5	5
12	5	5	4	4	5	5	2	5	5	5	5	5	5	5	5	5	5	4	5	5	5	4	5	5	5	5	5	5	5	5
13	4	5	5	4	4	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	4	5	4	4	5	4	5	5	5
14	5	3	5	5	5	4	5	5	5	4	5	4	4	4	4	4	4	5	5	5	5	4	4	4	4	4	4	4	4	4
15	4	5	4	5	5	5	4	5	5	4	4	5	4	4	5	4	4	5	4	4	5	3	4	3	4	4	5	5	4	4
16	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	3	5	5	3	5	5	5	5	5
17	4	4	4	4	4	4	3	4	4	4	5	3	3	4	4	4	4	3	5	3	3	4	4	4	4	4	4	4	4	4
18	4	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
19	3	3	3	3	3	3	3	3	4	3	3	2	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3
20	3	4	3	3	3	3	3	3	2	4	4	4	4	3	3	4	4	5	5	5	4	3	3	5	5	5	3	4	2	4
21	4	4	5	4	4	4	4	4	4	4	4	5	4	4	5	4	4	4	4	4	4	4	5	4	4	4	4	4	5	5
22	5	5	5	4	4	4	4	5	5	5	5	5	4	4	5	5	5	4	4	5	5	5	4	4	4	5	5	4	4	5

Table F.2 Importance scores of large-size public hospitals (cont.)

No.	Factors																													
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
23	4	4	4	4	4	3	4	3	3	3	3	4	3	3	3	3	4	3	4	4	3	3	3	3	3	3	3	3	3	3
24	4	3	4	4	3	3	3	4	4	3	4	4	4	4	4	3	2	2	4	4	3	4	4	3	3	3	4	5	4	4
25	4	3	3	3	4	4	3	3	3	3	4	4	3	3	3	3	3	4	3	4	3	4	3	4	4	4	4	4	4	4
26	4	3	3	4	4	4	3	4	4	3	3	5	3	3	3	2	3	4	4	4	3	4	3	4	4	5	3	4	1	4
27	4	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	4	4	4	4	4
28	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4
29	4	3	4	4	5	3	3	4	4	4	4	4	4	4	4	4	4	5	5	4	2	3	3	3	3	4	4	4	3	4
30	4	4	3	3	4	4	4	3	3	4	3	3	4	4	4	4	4	4	3	3	4	3	3	3	3	3	3	3	3	3
31	3	3	2	3	2	4	2	1	4	2	2	2	3	3	2	1	1	4	4	3	1	2	4	4	2	5	4	3	5	3
32	4	1	4	4	4	3	4	3	3	3	3	3	3	3	3	3	2	4	4	4	4	2	2	3	3	4	4	4	4	4
33	3	3	4	4	4	2	4	5	4	4	4	4	3	3	4	3	3	3	3	3	3	3	2	5	3	4	4	2	3	3
34	3	3	5	4	5	4	5	5	4	5	5	5	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average	**3.97**	**3.94**	**3.97**	**4.00**	**4.18**	**3.97**	**3.68**	**4.12**	**4.09**	**4.03**	**4.21**	**4.15**	**4.03**	**4.03**	**4.15**	**3.94**	**4.06**	**4.15**	**4.26**	**4.09**	**4.03**	**3.65**	**3.91**	**4.06**	**3.79**	**4.29**	**4.03**	**4.12**	**4.00**	**4.18**
S.D.	**0.72**	**0.98**	**0.80**	**0.65**	**0.80**	**0.94**	**1.01**	**0.91**	**0.79**	**0.76**	**0.81**	**0.82**	**0.72**	**0.72**	**0.82**	**0.92**	**1.01**	**0.82**	**0.86**	**0.87**	**1.17**	**0.81**	**1.03**	**0.78**	**0.81**	**0.76**	**0.83**	**0.81**	**0.98**	**0.72**

Table F.3 Importance scores of private hospitals

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
1	4	3	4	4	5	5	5	5	4	5	4	5	5	5	4	5	5	5	5	5	5	1	1	2	2	5	5	5	5	5
2	4	1	4	3	2	4	4	4	4	4	4	3	3	3	3	3	3	4	4	4	4	1	1	4	2	4	4	4	2	3
3	4	2	4	3	4	4	4	3	3	4	4	3	3	3	3	3	3	4	4	4	4	1	1	4	1	4	4	3	2	4
4	4	2	3	3	3	3	3	3	2	4	4	4	4	4	4	4	4	3	4	4	4	1	3	3	2	3	3	3	3	3
5	5	2	4	4	4	5	4	4	4	5	5	4	4	4	4	4	4	4	4	4	4	1	5	5	1	4	4	4	5	4
6	4	3	4	5	5	5	5	5	4	4	5	4	4	4	4	4	5	5	4	4	5	3	5	5	4	5	5	5	4	5
7	4	2	4	5	5	4	4	5	4	4	5	4	4	4	4	4	4	5	4	4	5	1	5	5	1	5	5	4	4	5
8	4	1	4	3	3	4	4	4	3	3	4	3	3	3	3	3	3	4	3	3	3	1	3	4	1	4	4	4	3	3
9	4	1	4	4	3	4	4	4	3	3	4	3	4	4	4	3	2	5	4	3	4	1	1	4	1	4	3	4	3	4
10	4	2	4	3	3	4	3	3	3	4	4	3	4	4	4	4	4	4	3	3	3	3	3	3	3	4	4	4	3	3
11	4	3	4	3	4	3	4	4	4	4	4	4	4	4	4	3	4	3	4	4	3	3	3	4	3	3	3	3	3	4
12	4	3	4	3	3	3	4	4	4	4	3	4	4	4	4	4	3	3	4	3	4	3	3	4	3	3	3	3	3	4
13	4	2	5	4	4	4	5	4	4	4	4	4	5	5	4	5	5	4	4	4	5	1	1	5	4	4	4	4	5	5
14	4	4	4	4	3	4	3	5	5	5	5	5	4	3	5	4	5	5	4	3	4	1	1	4	4	5	5	5	5	5
15	4	1	5	4	4	4	3	4	5	2	4	5	3	3	5	3	4	5	4	3	3	1	1	1	4	3	4	3	3	4
16	5	2	4	4	4	2	4	2	3	3	2	2	2	2	3	2	3	2	3	3	2	2	3	3	2	2	4	4	3	4
17	5	3	4	4	4	2	4	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3	4	4	4	3	4
18	4	4	4	5	4	4	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5	3	4	4	2	5	5	5	5	5
19	4	3	4	4	4	4	4	4	5	3	4	5	3	4	5	5	5	5	4	4	5	1	3	5	4	5	5	5	4	4
20	4	1	4	4	4	4	3	4	3	4	4	4	2	3	4	1	5	5	1	3	5	1	3	5	1	5	5	4	4	5

Table F.3 Importance scores of private hospitals (cont.)

No.	Factors																													
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
21	5	3	5	4	5	4	4	4	3	4	5	5	5	5	4	5	5	5	4	4	4	5	4	5	5	5	5	5	5	5
22	3	3	3	4	4	4	3	4	4	3	5	3	4	4	3	4	5	3	3	3	4	3	3	4	3	4	4	4	3	4
23	5	4	4	3	3	5	5	4	4	3	3	2	5	5	4	4	3	5	5	4	4	3	3	2	2	5	5	4	4	3
24	3	1	4	3	3	4	3	1	1	2	2	3	3	3	1	3	3	2	3	3	2	1	2	5	1	4	5	4	5	5
25	4	3	5	4	5	4	4	1	1	2	1	3	4	3	3	3	2	3	3	3	3	3	3	3	2	4	4	3	4	3
26	3	1	4	3	4	3	3	1	1	2	1	3	3	2	1	2	3	3	3	3	2	1	1	1	2	4	4	3	4	3
27	3	4	3	3	3	3	3	3	4	3	2	4	3	3	2	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
28	2	3	2	1	2	2	2	2	2	2	1	2	3	3	3	3	2	3	2	2	2	1	1	4	2	2	4	3	4	4
29	3	2	3	2	3	3	2	2	1	2	2	2	1	1	1	2	1	1	2	2	2	1	2	3	1	3	2	3	3	3
30	3	2	2	1	3	2	2	2	2	2	1	2	3	3	3	3	2	3	2	3	2	1	1	4	2	2	3	2	3	3
31	4	4	4	5	5	3	4	1	3	2	1	3	1	2	2	2	1	1	1	3	2	2	2	2	2	2	2	1	2	2
32	4	3	3	3	5	5	4	3	5	4	5	3	4	4	5	3	3	5	4	3	3	5	4	3	4	3	3	4	4	4
33	3	3	3	2	3	3	3	3	4	2	2	3	3	3	3	3	3	3	2	4	2	1	3	3	3	4	3	3	2	2
34	4	5	4	3	3	4	5	5	4	3	5	4	4	4	4	5	5	5	5	5	4	5	5	5	4	5	4	4	4	4
Average	**3.88**	**2.53**	**3.82**	**3.44**	**3.71**	**3.68**	**3.68**	**3.38**	**3.35**	**3.32**	**3.44**	**3.50**	**3.50**	**3.50**	**3.47**	**3.44**	**3.53**	**3.76**	**3.44**	**3.47**	**3.47**	**1.91**	**2.59**	**3.59**	**2.47**	**3.85**	**3.94**	**3.71**	**3.59**	**3.85**
S.D.	**0.69**	**1.08**	**0.72**	**0.99**	**0.87**	**0.88**	**0.84**	**1.26**	**1.18**	**1.01**	**1.42**	**0.96**	**1.02**	**0.96**	**1.11**	**1.02**	**1.21**	**1.21**	**1.05**	**0.75**	**1.11**	**1.29**	**1.35**	**1.23**	**1.16**	**0.99**	**0.89**	**0.91**	**0.96**	**0.89**

Table F.4 Performance scores of small-size public hospitals

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
1	3	2	4	4	4	4	4	4	5	5	5	5	5	5	4	3	4	5	4	4	4	3	4	3	3	4	4	4	3	4
2	5	3	5	5	5	5	5	4	5	5	5	5	5	5	4	3	5	5	5	4	4	4	4	4	5	4	4	4	3	4
3	3	3	3	4	4	4	4	5	5	5	5	5	5	5	5	3	5	5	5	5	4	3	3	3	3	4	4	3	3	4
4	4	2	1	2	4	4	3	5	5	5	5	5	4	3	5	3	5	4	3	3	3	3	3	5	5	4	5	4	3	4
5	4	1	4	4	3	4	4	3	4	2	3	5	3	3	4	3	2	4	4	3	4	2	3	5	2	5	4	3	3	4
6	4	4	4	4	5	4	4	4	3	4	4	4	4	3	3	4	4	5	4	4	4	3	3	4	3	5	5	4	3	4
7	5	1	4	5	5	4	5	4	5	3	4	4	4	4	3	3	5	5	4	4	3	1	3	5	3	2	3	2	2	4
8	3	1	5	3	4	4	3	3	4	5	2	5	3	3	5	4	5	4	5	4	5	1	2	5	5	4	4	2	2	4
9	3	3	3	3	3	1	4	2	1	1	1	1	3	2	2	3	3	3	4	4	3	3	3	3	3	4	3	3	3	3
10	4	1	4	5	5	3	4	4	3	3	3	5	3	3	3	3	4	4	4	3	5	4	3	5	1	4	4	2	3	4
11	4	4	5	4	4	3	2	4	4	4	4	4	2	3	3	3	2	3	4	2	3	4	2	4	2	4	4	4	4	4
12	4	3	4	5	4	3	3	3	4	3	4	3	3	3	3	3	3	4	3	2	3	3	4	4	4	4	4	3	3	4
13	4	2	2	4	4	1	3	1	2	1	1	1	1	2	2	1	2	2	1	3	1	1	3	3	2	4	1	1	5	4
14	3	4	3	2	3	3	3	2	3	2	4	2	2	2	2	2	3	3	2	4	4	2	3	3	2	3	3	4	3	3
15	3	3	4	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4
16	3	4	3	2	3	3	3	2	3	2	4	2	2	2	2	2	3	3	2	4	4	2	3	3	2	3	3	4	3	3
17	4	3	4	3	3	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	3	4	3	4	3	4	4	4	3	4
18	4	3	3	3	3	3	3	3	5	3	3	3	3	3	3	3	4	3	3	1	2	4	2	5	3	5	3	4	3	3
19	5	1	4	4	4	3	5	4	3	1	3	3	3	2	4	3	3	3	3	3	3	4	3	4	4	4	4	2	2	3
20	5	1	5	5	5	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Table F.4 Performance scores of small-size public hospitals (cont.)

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
21	4	1	5	4	5	1	4	1	2	2	1	1	1	1	1	1	1	1	1	2	2	1	1	4	2	2	2	1	1	2
22	3	3	3	2	2	1	2	1	1	1	2	1	2	2	2	1	2	3	4	4	3	3	3	3	2	4	3	1	1	1
23	4	3	5	4	4	4	4	4	5	4	4	3	5	4	3	3	4	4	4	3	4	5	3	4	4	4	4	3	4	4
24	4	3	3	4	4	4	3	4	4	5	4	4	5	4	4	5	3	4	3	5	4	5	4	5	3	4	5	5	3	4
25	3	3	3	3	3	3	3	2	3	3	2	3	3	2	2	3	3	3	3	3	3	2	2	3	2	3	3	2	3	2
26	4	1	2	4	5	4	3	4	3	2	3	4	3	2	3	3	4	2	4	3	2	3	2	4	2	3	3	3	4	4
27	4	2	4	4	4	4	4	4	3	4	3	3	4	4	4	3	2	3	3	4	4	4	4	4	4	4	4	4	4	4
28	1	1	1	1	1	3	1	2	2	1	1	1	2	2	1	2	2	2	2	2	2	3	3	3	2	1	4	1	3	3
29	3	1	3	3	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	2	3	3	2	2	4
30	4	1	3	4	4	3	3	3	2	3	2	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3	4
31	3	1	2	4	4	1	3	3	2	3	2	2	3	2	3	2	2	2	2	2	2	3	2	3	2	3	4	4	2	4
32	3	4	4	4	4	1	4	2	2	4	3	3	2	2	2	3	3	3	4	4	3	2	3	4	4	4	4	2	3	3
33	4	3	4	3	4	3	3	4	3	3	2	2	3	3	3	4	2	3	3	3	2	3	3	3	4	3	3	3	3	3
34	3	1	4	2	3	3	2	2	4	2	4	3	1	2	3	2	2	2	3	3	3	1	3	5	5	4	1	1	2	4
35	5	1	3	4	4	1	4	3	3	3	3	2	2	2	2	2	3	3	3	3	3	3	4	4	4	1	1	1	1	4
36	3	1	3	4	4	2	4	3	3	3	3	2	2	2	2	1	2	3	3	3	3	3	3	3	2	3	3	2	2	4
37	3	3	3	3	3	3	3	2	2	3	3	2	2	2	2	2	2	3	3	3	3	3	3	3	2	4	3	3	3	3
38	4	4	4	4	4	4	4	4	4	5	4	4	4	3	4	4	4	4	4	4	4	4	4	5	4	4	3	4	4	4
39	3	2	4	4	3	3	3	3	4	3	3	4	3	3	3	3	3	3	2	2	2	3	2	3	3	3	3	3	3	4
40	4	1	4	4	4	3	3	2	1	2	2	4	3	3	3	3	3	3	3	3	2	1	2	3	3	4	3	4	4	4

Table F.4 Performance scores of small-size public hospitals (cont.)

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
41	4	1	4	4	3	4	4	3	3	3	4	4	3	4	3	2	3	4	3	3	4	4	3	4	4	4	4	4	4	4
42	3	3	4	3	4	4	3	3	5	3	3	4	4	3	4	4	4	4	4	4	3	4	3	5	4	3	3	3	3	3
43	3	1	4	4	4	3	4	3	4	3	4	3	3	3	3	2	2	3	3	3	4	2	2	3	3	3	4	3	3	4
44	5	1	3	5	5	5	5	5	3	5	2	4	4	3	5	5	5	4	4	4	3	3	3	4	3	3	5	2	1	3
45	3	1	3	3	3	3	4	2	4	1	1	4	3	3	4	3	3	1	2	3	4	1	3	3	3	3	4	3	2	3
46	3	4	4	3	4	3	3	4	5	3	3	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
Average	**3.63**	**2.17**	**3.54**	**3.59**	**3.78**	**3.11**	**3.48**	**3.15**	**3.37**	**3.11**	**3.11**	**3.26**	**3.13**	**2.96**	**3.15**	**2.89**	**3.17**	**3.30**	**3.28**	**3.24**	**3.22**	**2.89**	**2.96**	**3.78**	**3.07**	**3.50**	**3.41**	**2.91**	**2.87**	**3.57**
S.D.	**0.80**	**1.16**	**0.96**	**0.93**	**0.84**	**1.08**	**0.84**	**1.05**	**1.16**	**1.25**	**1.14**	**1.24**	**1.07**	**0.94**	**1.01**	**0.95**	**1.04**	**0.99**	**0.93**	**0.82**	**0.87**	**1.08**	**0.70**	**0.79**	**1.00**	**0.86**	**0.96**	**1.07**	**0.88**	**0.69**

Table F.5 Performance scores of large-size public hospitals

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
1	3	3	3	3	3	3	3	4	4	3	5	4	4	4	3	4	4	3	2	3	2	2	3	3	2	3	3	3	3	3
2	2	3	2	3	3	2	1	2	2	3	3	3	3	3	3	3	2	3	2	2	1	4	3	4	4	4	4	3	3	4
3	3	2	3	4	4	4	3	3	2	3	4	4	4	4	3	4	3	5	3	3	3	3	4	4	3	5	5	4	4	4
4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	4	4	4	4	4	4	4	4	4
5	3	4	3	3	3	5	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	3	4	4	4	4	4
6	5	5	5	4	4	5	2	5	2	5	5	4	4	4	4	4	2	4	5	4	2	4	2	5	4	4	5	4	2	4

Table F.5 Performance scores of large-size public hospitals (cont.)

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
7	5	5	5	4	4	5	2	5	2	5	5	4	4	4	4	4	2	4	5	4	2	4	2	5	4	4	5	4	2	4
8	3	2	3	4	4	4	3	3	2	3	4	4	3	3	3	4	4	5	3	3	3	3	4	4	3	5	5	4	4	4
9	3	3	3	3	3	3	3	4	4	3	4	4	3	3	3	4	4	3	2	4	2	2	3	3	2	3	3	3	3	3
10	2	3	2	3	3	2	1	2	2	3	3	3	2	3	3	3	2	3	2	2	1	4	3	4	4	4	4	3	3	4
11	5	5	5	4	4	5	2	5	2	5	5	4	2	4	4	4	2	4	5	4	2	3	2	5	4	4	5	4	2	4
12	5	5	5	4	4	5	2	5	5	2	5	4	3	4	4	4	2	4	5	4	2	4	2	5	4	4	5	4	2	4
13	3	4	3	3	3	3	3	4	4	4	4	4	3	4	4	4	4	4	4	4	4	3	4	3	3	4	4	4	4	4
14	4	4	5	4	4	4	4	4	4	4	4	4	3	4	4	4	4	5	5	5	5	4	4	4	4	4	4	4	4	4
15	4	5	4	5	4	4	3	4	4	3	4	4	3	4	4	3	3	5	4	3	5	4	4	4	5	4	5	5	4	4
16	2	2	2	1	3	3	3	4	5	3	3	3	3	4	4	3	3	4	4	2	5	3	4	5	2	5	5	3	3	3
17	4	4	4	4	4	4	3	3	3	3	4	2	2	4	4	4	3	3	4	2	3	4	3	3	3	4	4	4	4	4
18	4	3	3	4	4	3	3	3	3	3	3	4	4	4	3	4	3	3	3	3	3	3	3	3	3	5	3	4	2	4
19	3	3	3	3	3	3	3	3	4	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
20	3	4	3	3	3	3	3	3	2	4	4	4	4	3	3	4	4	5	5	5	4	3	3	5	5	5	3	4	2	4
21	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4
22	3	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
23	3	4	4	4	4	4	3	3	3	3	3	4	3	3	3	3	4	3	4	4	3	3	3	3	3	3	3	3	3	3
24	4	3	4	3	4	3	2	3	4	4	4	3	3	3	2	4	3	4	3	3	4	4	3	3	4	4	4	4	4	4
25	4	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	4	3	4	4	4	4	4	4	4
26	4	3	3	4	4	4	3	4	4	3	4	4	4	3	3	3	3	4	2	3	3	4	3	2	4	5	3	4	1	4

Table F.5 Performance scores of large-size public hospitals (cont.)

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
27	4	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5
28	4	4	4	4	4	4	4	4	4	5	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
29	4	3	4	3	4	3	2	4	4	4	4	4	4	4	4	4	4	4	5	4	3	4	4	4	4	4	4	4	5	4
30	4	4	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	3	4	3	3	3	3	3	3	3
31	3	4	3	3	2	4	2	3	5	3	1	4	5	5	3	2	2	2	4	1	1	2	2	2	5	3	3	3	4	3
32	4	1	4	4	4	3	4	3	3	3	3	3	3	3	3	3	2	3	3	3	3	2	2	3	3	4	4	4	4	3
33	3	3	4	4	4	2	3	3	4	4	4	4	3	3	4	3	3	3	3	3	3	3	2	5	3	4	4	3	3	3
34	3	3	4	4	5	4	2	3	4	5	1	4	1	3	5	3	2	4	3	2	3	4	5	5	5	4	5	2	4	3
Average	**3.56**	**3.56**	**3.62**	**3.59**	**3.74**	**3.65**	**2.88**	**3.62**	**3.47**	**3.62**	**3.76**	**3.74**	**3.35**	**3.65**	**3.56**	**3.62**	**3.18**	**3.88**	**3.68**	**3.41**	**3.15**	**3.44**	**3.29**	**3.82**	**3.65**	**4.03**	**4.03**	**3.71**	**3.35**	**3.74**
S.D.	**0.82**	**0.99**	**0.92**	**0.74**	**0.62**	**0.85**	**0.84**	**0.78**	**0.96**	**0.78**	**0.96**	**0.62**	**0.81**	**0.54**	**0.61**	**0.55**	**0.83**	**0.81**	**1.04**	**0.99**	**1.16**	**0.75**	**0.87**	**0.90**	**0.85**	**0.63**	**0.76**	**0.63**	**0.95**	**0.51**

Table F.6 Performance scores of private hospitals

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
1	4	1	4	4	4	4	4	3	3	4	4	3	3	3	3	3	2	3	3	3	3	1	1	2	1	4	4	3	3	4
2	4	2	4	3	3	4	3	4	4	4	4	3	4	4	4	3	3	4	4	4	4	1	1	5	2	4	4	4	4	4
3	4	2	3	4	3	4	3	3	4	3	4	4	4	4	4	3	3	4	4	4	4	1	1	4	4	4	4	4	4	4
4	3	1	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	3	3	3	3	1	3	3	2	3	3	3	3	3

Table F.6 Performance scores of private hospitals (cont.)

No.	Factors																													
	P1	P2	P3	P4	P5	C1	C2	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	O1	O2	O3	O4	G1	G2	G3	G4	E1	E2	E3	E4	E5
5	4	3	4	4	4	5	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	4	5	5	4	4	4	4	4	4
6	4	3	4	4	4	4	4	4	3	4	5	4	4	4	4	4	4	4	4	4	5	1	5	5	4	5	5	4	4	5
7	4	1	4	4	4	4	4	5	4	4	5	4	4	4	4	4	4	5	4	4	5	1	5	5	1	5	5	4	4	5
8	4	1	3	4	3	4	4	4	3	3	4	3	4	3	3	2	3	4	3	3	4	1	3	4	1	4	4	4	4	4
9	4	1	4	4	4	4	4	4	3	3	4	3	4	3	3	4	5	5	4	3	4	1	1	4	1	4	4	4	4	3
10	3	2	3	3	3	4	3	3	3	4	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3
11	4	3	3	3	4	3	4	4	4	4	3	4	4	4	4	3	4	3	3	3	3	3	3	4	4	3	3	3	3	3
12	4	3	3	3	3	3	4	4	4	3	3	4	3	3	4	4	3	3	3	3	4	3	3	4	4	3	3	3	3	4
13	4	1	4	4	3	4	4	4	4	3	3	4	3	3	3	3	3	4	4	4	3	1	1	4	4	4	4	4	3	4
14	3	2	3	3	3	3	3	3	3	3	4	4	2	2	2	1	4	4	3	3	4	1	1	4	4	4	4	1	2	4
15	4	1	4	4	4	4	3	4	5	2	4	5	3	3	5	3	4	5	4	3	3	1	1	1	4	3	4	3	3	4
16	3	3	4	4	4	2	3	2	3	3	2	1	1	2	3	1	3	1	3	3	1	2	3	3	2	2	4	4	3	4
17	3	3	4	4	4	2	4	2	3	3	2	1	1	2	3	1	3	2	3	3	2	1	1	1	3	2	4	4	3	4
18	4	3	4	5	4	4	4	4	4	5	4	4	3	3	4	3	4	4	4	4	4	2	4	4	2	4	4	4	4	5
19	4	3	4	4	4	4	4	4	5	3	3	5	3	3	5	4	5	4	4	4	5	1	3	5	4	4	4	2	3	4
20	4	1	4	4	4	4	3	4	2	4	4	4	2	3	4	1	5	5	1	3	5	1	3	5	1	5	5	4	4	5
21	4	3	4	5	5	3	4	3	3	3	4	4	4	4	3	5	4	4	4	4	4	3	4	5	4	5	5	5	4	4
22	4	3	4	4	4	3	3	4	4	3	3	3	3	4	3	3	4	3	3	3	4	3	3	3	3	4	4	4	3	4
23	5	4	4	3	3	5	5	4	4	3	3	2	5	5	4	4	3	5	5	4	4	3	3	2	2	5	5	4	4	3
24	3	1	4	3	3	4	3	1	1	2	2	3	3	3	1	3	3	2	3	3	2	1	2	5	1	4	5	4	5	5

Table F.6 Performance scores of private hospitals (cont.)

No.	Factors																												
	P1	**P2**	**P3**	**P4**	**P5**	**C1**	**C2**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**O1**	**O2**	**O3**	**O4**	**G1**	**G2**	**G3**	**G4**	**E1**	**E2**	**E3**	**E4**	**E5**
25	4	1	2	4	5	4	4	1	1	2	1	3	4	3	3	3	2	3	3	3	3	3	3	3	2	4	4	3	4	3
26	3	1	4	3	4	3	3	1	1	2	1	3	3	2	1	2	3	3	3	3	2	1	1	1	2	4	4	3	4	3
27	3	4	3	3	3	3	3	3	4	3	2	4	3	3	2	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3
28	3	3	2	2	3	3	3	3	3	3	3	3	4	4	4	4	3	3	2	3	2	1	1	4	2	2	4	3	4	4
29	4	2	3	2	4	3	2	3	1	2	2	2	1	1	1	2	1	1	2	1	2	1	3	3	1	2	1	3	3	3
30	3	2	2	2	3	2	2	3	3	3	4	3	4	4	4	4	3	3	2	3	2	1	1	4	3	2	3	2	3	3
31	4	4	4	5	5	3	4	1	3	1	1	3	1	2	2	2	1	1	1	3	2	2	2	2	2	2	2	1	2	2
32	2	2	2	3	3	3	2	2	2	2	4	3	3	2	2	3	2	1	1	3	2	1	3	3	3	3	3	2	3	3
33	3	3	3	3	3	3	3	3	4	3	2	3	3	3	3	3	3	2	2	2	2	1	3	3	3	4	3	3	2	3
34	4	4	4	4	4	2	3	3	4	4	1	4	2	2	2	2	2	2	1	1	3	2	1	4	1	4	4	3	3	3
Average	**3.65**	**2.26**	**3.47**	**3.56**	**3.65**	**3.44**	**3.41**	**3.15**	**3.18**	**3.06**	**3.09**	**3.29**	**3.06**	**3.06**	**3.12**	**2.91**	**3.18**	**3.26**	**3.03**	**3.15**	**3.21**	**1.65**	**2.47**	**3.53**	**2.56**	**3.59**	**3.79**	**3.29**	**3.38**	**3.71**
S.D.	**0.60**	**1.05**	**0.71**	**0.79**	**0.65**	**0.79**	**0.70**	**1.05**	**1.09**	**0.85**	**1.19**	**0.94**	**1.04**	**0.89**	**1.07**	**1.03**	**1.00**	**1.21**	**1.03**	**0.74**	**1.09**	**0.92**	**1.28**	**1.21**	**1.16**	**0.96**	**0.88**	**0.91**	**0.70**	**0.76**

APPENDIX G

FUZZY NUMBER OF IMPORTANCE AND PERFORMANCE

Table G.1 Importance weights of small-size public hospitals

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
People				
P1	0.00	0.42	3.08	0.98
P2	0.00	0.30	2.50	0.77
P3	0.00	0.09	0.67	0.21
P4	0.00	0.11	0.80	0.25
P5	0.00	0.07	0.54	0.17
Process				
C1	0.00	0.68	1.48	0.71
C2	0.00	0.32	0.66	0.32
Technology				
T1	0.00	0.10	1.20	0.35
T2	0.00	0.13	1.55	0.45
T3	0.00	0.07	0.86	0.25
T4	0.00	0.07	0.87	0.25
T5	0.00	0.10	1.17	0.34
T6	0.00	0.07	0.85	0.25
T7	0.00	0.13	1.56	0.45
T8	0.00	0.10	1.23	0.36
T9	0.00	0.11	1.30	0.38
T10	0.00	0.13	1.62	0.47
Organization				
O1	0.00	0.25	1.07	0.39
O2	0.00	0.25	1.10	0.40
O3	0.00	0.26	1.11	0.40
O4	0.00	0.24	1.06	0.39
Government				
G1	0.00	0.12	0.58	0.21
G2	0.00	0.18	0.84	0.30

Table G.1 Importance weights of small-size public hospitals (cont.)

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
G3	0.00	0.56	2.56	0.92
G4	0.00	0.14	0.63	0.23
Hospital environment				
E1	0.00	0.16	0.90	0.30
E2	0.00	0.17	0.95	0.32
E3	0.00	0.16	0.93	0.31
E4	0.00	0.35	2.01	0.68
E5	0.00	0.16	0.89	0.30
Average				**0.40**

Table G.2 Importance weights of large-size public hospitals

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
People				
P1	0.00	0.33	1.97	0.66
P2	0.00	0.12	0.70	0.23
P3	0.00	0.15	0.88	0.29
P4	0.00	0.27	1.60	0.53
P5	0.00	0.14	0.82	0.27
Process				
C1	0.00	0.44	1.17	0.51
C2	0.00	0.56	1.50	0.65
Technology				
T1	0.00	0.06	0.74	0.21
T2	0.00	0.08	1.04	0.30
T3	0.00	0.08	0.97	0.28
T4	0.00	0.08	1.05	0.30
T5	0.00	0.09	1.13	0.33
T6	0.00	0.19	2.37	0.69
T7	0.00	0.19	2.37	0.69
T8	0.00	0.09	1.10	0.32
T9	0.00	0.06	0.78	0.23

Table G.2 Importance weights of large-size public hospitals (cont.)

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
T10	0.00	0.07	0.93	0.27
Organization				
O1	0.00	0.23	3.05	0.88
O2	0.00	0.25	3.34	0.96
O3	0.00	0.26	3.45	0.99
O4	0.00	0.25	3.42	0.98
Government				
G1	0.00	0.18	1.07	0.36
G2	0.00	0.27	1.60	0.53
G3	0.00	0.39	2.30	0.77
G4	0.00	0.17	1.00	0.33
Hospital environment				
E1	0.00	0.30	2.34	0.74
E2	0.00	0.16	1.20	0.38
E3	0.00	0.14	1.08	0.34
E4	0.00	0.11	0.88	0.28
E5	0.00	0.28	2.19	0.69
Average				**0.50**

Table G.3 Importance weights of private hospitals

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
People				
P1	0.00	0.14	0.81	0.27
P2	0.00	0.27	1.68	0.56
P3	0.00	0.16	0.92	0.31
P4	0.00	0.17	1.01	0.34
P5	0.00	0.24	1.38	0.47
Process				
C1	0.00	0.52	1.08	0.53
C2	0.00	0.48	0.99	0.48

Table G.3 Importance weights of private hospitals (cont.)

Factor	Fuzzy entropy weight			Defuzzification crisp number
	W_j^l	W_j^m	W_j^u	
Technology				
T1	0.00	0.11	1.37	0.40
T2	0.00	0.10	1.23	0.36
T3	0.00	0.15	1.77	0.52
T4	0.00	0.14	1.75	0.51
T5	0.00	0.12	1.48	0.43
T6	0.00	0.07	0.85	0.25
T7	0.00	0.06	0.73	0.21
T8	0.00	0.08	1.03	0.30
T9	0.00	0.07	0.83	0.24
T10	0.00	0.10	1.17	0.34
Organization				
O1	0.00	0.22	0.96	0.35
O2	0.00	0.18	0.80	0.29
O3	0.00	0.18	0.78	0.29
O4	0.00	0.41	1.76	0.65
Government				
G1	0.00	0.31	0.49	0.28
G2	0.00	0.29	0.40	0.24
G3	0.00	0.18	0.23	0.15
G4	0.00	0.22	0.29	0.18
Hospital environment				
E1	0.00	0.25	1.34	0.46
E2	0.00	0.19	1.03	0.35
E3	0.00	0.11	0.59	0.20
E4	0.00	0.25	1.36	0.47
E5	0.00	0.20	1.07	0.37
Average				**0.36**

Table G.4 Performance fuzzy number of small-size public hospitals

Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
People				
P1	43.95	64.32	81.94	63.63
P2	17.04	29.92	49.84	31.68
P3	42.45	62.23	79.89	61.70
P4	43.17	63.24	80.90	62.64
P5	47.83	67.92	84.71	67.09
Process				
C1	33.86	52.04	71.09	52.26
C2	40.32	60.70	79.12	60.21
Technology				
T1	33.57	52.89	71.90	52.81
T2	38.87	57.94	74.91	57.42
T3	33.80	51.77	69.17	51.63
T4	33.34	51.88	70.50	51.90
T5	37.16	55.44	72.96	55.25
T6	32.99	52.30	70.79	52.10
T7	28.04	48.09	67.58	47.95
T8	33.10	52.83	71.65	52.60
T9	27.48	46.67	66.31	46.78
T10	33.30	53.24	71.54	52.83
Organization				
O1	36.66	56.48	74.80	56.11
O2	36.10	56.03	74.95	55.78
O3	34.52	54.99	74.36	54.71
O4	34.10	54.45	73.84	54.21
Government				
G1	28.74	46.77	66.15	47.11
G2	27.64	48.22	68.61	48.17
G3	47.31	67.82	84.15	66.77
G4	30.69	50.68	69.72	50.44
Hospital environment				
E1	41.27	61.29	79.88	60.94
E2	39.60	59.19	77.54	58.88
E3	28.98	47.28	66.99	47.63
E4	26.87	46.18	66.15	46.35

Table G.4 Performance fuzzy number of small-size public hospitals (cont.)

Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
E5	42.39	62.94	82.37	62.66
Average				**54.34**

Table G.5 Performance fuzzy number of large-size public hospitals

Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
People				
P1	41.93	62.56	80.54	61.90
P2	42.61	62.51	79.58	61.80
P3	43.44	63.84	80.56	62.92
P4	43.04	63.42	82.02	62.98
P5	46.13	66.93	85.40	66.34
Process				
C1	44.14	64.64	82.09	63.88
C2	26.72	46.47	66.81	46.62
Technology				
T1	43.31	63.99	81.87	63.29
T2	40.12	60.44	78.90	59.98
T3	43.24	63.95	81.46	63.15
T4	48.14	67.53	84.17	66.84
T5	46.20	66.96	85.81	66.49
T6	37.41	57.77	77.12	57.52
T7	43.84	64.85	83.86	64.35
T8	41.72	62.72	81.86	62.25
T9	43.17	64.18	83.62	63.79
T10	32.83	53.48	73.58	53.34
Organization				
O1	49.88	70.19	86.11	69.09
O2	45.09	65.15	80.99	64.10
O3	39.08	59.04	77.11	58.57
O4	33.88	52.68	70.54	52.44

Table G.5 Performance fuzzy number of large-size public hospitals (cont.)

Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
Government				
G1	39.04	59.86	79.17	59.48
G2	35.63	56.24	75.39	55.87
G3	48.51	68.72	84.34	67.57
G4	44.14	64.64	82.09	63.88
Hospital environment				
E1	53.45	73.79	89.86	72.72
E2	53.49	73.65	88.56	72.34
E3	45.40	66.22	84.73	65.64
E4	37.67	57.71	76.64	57.43
E5	46.04	66.98	85.84	66.46
Average				**62.43**

Table G.6 Performance fuzzy number of private hospitals

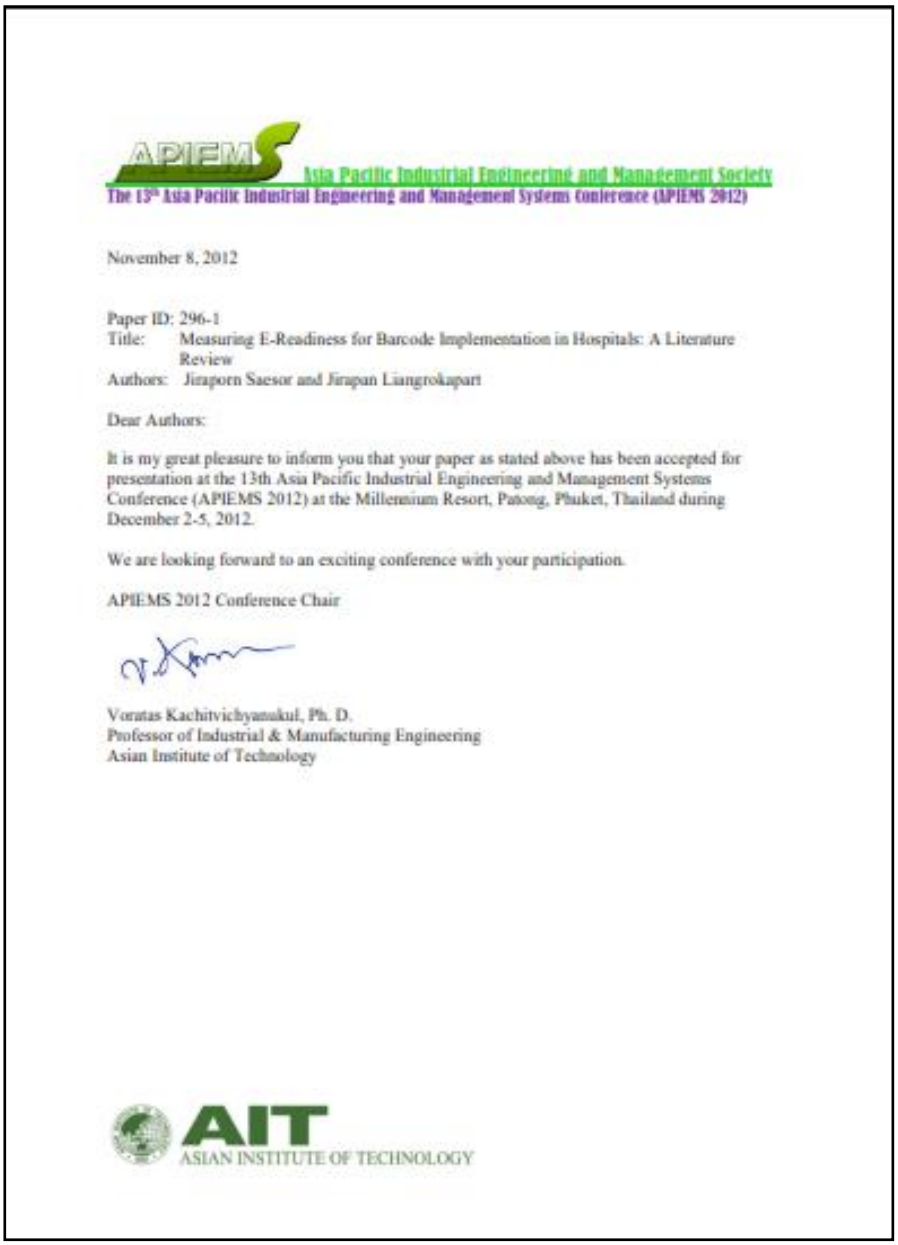
Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
People				
P1	43.92	64.84	83.85	64.36
P2	17.11	31.93	52.16	33.28
P3	39.75	60.61	80.26	60.31
P4	41.91	62.61	80.97	62.02
P5	43.87	64.76	83.00	64.10
Process				
C1	39.05	59.81	78.74	59.35
C2	38.22	59.15	78.53	58.76
Technology				
T1	34.23	52.93	72.23	53.08
T2	34.98	53.59	72.46	53.65
T3	30.40	50.65	70.45	50.54
T4	33.12	51.38	69.98	51.47
T5	36.61	56.35	75.28	56.14

Table G.6 Performance fuzzy number of private hospitals (cont.)

Factor	Fuzzy number			Defuzzification crisp number
	l	m	u	
T6	32.11	50.79	70.23	50.98
T7	30.49	50.64	70.43	50.55
T8	33.10	52.11	71.18	52.12
T9	28.61	47.23	66.90	47.49
T10	33.85	53.45	72.17	53.23
Organization				
O1	37.30	55.57	73.13	55.39
O2	31.38	50.08	69.57	50.28
O3	32.75	52.91	72.87	52.86
O4	34.36	54.04	72.41	53.71
Government				
G1	8.07	17.44	37.43	20.10
G2	22.53	36.84	55.48	37.92
G3	43.20	61.78	77.88	61.16
G4	22.65	38.90	59.00	39.86
Hospital environment				
E1	42.92	63.20	80.72	62.51
E2	48.31	68.20	84.90	67.40
E3	36.59	56.39	75.71	56.27
E4	37.49	58.44	77.87	58.06
E5	45.44	66.08	83.44	65.26
Average				**53.41**

APPENDIX H
2012 INTERNATIONAL CONFERENCE ON INDUSTRIAL ENGINEERING AND MANAGEMENT SYSTEMS SUBMITTED PAPER

H.1 ACCEPTANCE LETTER



APIEMS Asia Pacific Industrial Engineering and Management Society

The 13th Asia Pacific Industrial Engineering and Management Systems Conference (APIEMS 2012)

November 8, 2012

Paper ID: 296-1
Title: Measuring E-Readiness for Barcode Implementation in Hospitals: A Literature Review
Authors: Jiraporn Saesor and Jirapan Liangrokapart

Dear Authors:

It is my great pleasure to inform you that your paper as stated above has been accepted for presentation at the 13th Asia Pacific Industrial Engineering and Management Systems Conference (APIEMS 2012) at the Millennium Resort, Patong, Phuket, Thailand during December 2-5, 2012.

We are looking forward to an exciting conference with your participation.

APIEMS 2012 Conference Chair

Voratas Kachitvichyanukul, Ph. D.
Professor of Industrial & Manufacturing Engineering
Asian Institute of Technology

AIT ASIAN INSTITUTE OF TECHNOLOGY

H.2 FULL PAPER

Proceedings of the Asia Pacific Industrial Engineering & Management Systems Conference 2012
V. Kachitvichyanukul, H.T. Luong, and R. Pitakaso Eds.

Measuring E-Readiness for Barcode Implementation in Hospitals: A Literature Review

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Abstract. Information and Communication Technology (ICT) is playing an important role on the hospital efficiency, especially in the hospital warehouse management. The purpose of this study is to identify readiness and barrier factors for e-readiness assessment in order to adopt barcode technology in procurement and inventory management in hospitals. The study began with literature reviews and developing questionnaires for e-readiness assessment of hospital stakeholders. Using the general dimensions for e-readiness assessments in other industries. Then, specific dimension in healthcare supply chain has been identified which is "Patient Safety". The general dimensions combining with the healthcare dimensions include "People, Process, Technology, Organization, Government, and Patient safety". Finally, a fuzzy importance performance analysis (Fuzzy-IPA) will be applied and standard operation procedures will be recommended hospital staff to be ready for barcode technology implementation in the future.

Keywords: E-readiness assessment; Hospital; Barcode technology

1. INTRODUCTION

Currently, hospitals are facing the problems of information exchange between parties in its the supply chain which is not efficient and accurate. Pedroso and Nakano (2009) commented that the information flows are directly related to material flows and are crucial for the good performance of supply chains. When information do not flow quickly, smoothly and directly, it may lead to supply chain dysfunctional behavior, resulting in order quantity changes immediately, overestimated production lots and excessive inventory, as in the bullwhip effect (Sucky, 2009). Pothitong and Charoensiriwath (2011) supported that the problem of hospital in Thailand including inefficient information flow and human error which is an inefficient operation due to error during data input process. In their study, the ratio of wrong data input is 3 percent of all transactions, 5 percent of all product quantities, and 5.42 percent of all product values. This problem incurs a cost of at least U.S. $570 per month.

Information and Communication Technology (ICT) is playing an important role on the hospital efficiency, especially in the hospital warehouse management. The barcode technology is one of the applications of ICT. It is a machine-readable representation of information in a visual format and data on a surface, which can be transferred to a computer via a barcode scanner (Sutton and Mathias, 2002; Youssef and Salem, 2007). Barcodes are very well established and the technology associated with their use is mature, widely disseminated, relatively inexpensive, improving efficiency and eliminating human error if used correctly. In addition, barcode data entry is also much faster and more accurate than manual data entry (Merry and Webster, 2004). Barcode technology has been used in retail business, manufacturing business, and others for a long time, but its application in healthcare industry is limited. Therefore, this research is interested to study the hospital's readiness to implement barcode technology in hospital operations.

E-readiness assessment is meant to guide development efforts by providing some suitable tools for comparison and gauging progress (Mutula and van Brakel, 2006; Ghavamifar *et al*., 2008; Lou and Goulding, 2010). It enables government to set, measure and achieve realistic goals for an information society, information-based economy, or e-government. It is important to develop and

conduct e-readiness assessment so that the results can be leveraged to catalyze action, improve global competitiveness, and use limited resources wisely (Mutula and van Brakel, 2006; Ghavamifar *et al*., 2008). In addition, e-readiness assessment is important for healthcare to provide the public with a good quality of life (Ismail and Abdullah, 2011). However, hospitals have various organizational and geographical factors including hospital size, urban/rural location, system membership and leadership; the factors that have been shown to influence the ability for the hospital to innovate (Oktono *et al*., 2008).

The purpose of this study is to identify readiness and barrier factors for e-readiness assessment in order to adopt barcode technology in procurement and inventory management in hospitals. Figure 1 shows the framework of e-readiness assessment for barcode technology implementation in hospitals.

Figure 1: E-readiness assessment framework.

2. FACTOR IDENTIFICATION

Through an extensive literature review, e-readiness assessment factors are identified. The articles were identified through a computer search of database of published works and conference proceedings in the e-readiness area. Adopted from articles searching method used by Jaafar and Zakaria (2009), the articles were searched by the title based on the criteria such as it must contains either the keyword "e-readiness" or "readiness factors" or "barrier factors", which e-readiness assessment can be identified both positive and negative factors. Positive factors are the strength of industries or healthcare which the higher is the better and can be called "readiness factors". Negative factors are the weakness of industries or healthcare which the lower is the better and can be called "barrier factors".

2.1 Definition of e-readiness

E-readiness is one of the most important tools to determine internal strength and weakness, environmental opportunities and threats. It brings awareness of new markets, innovative opportunities and services, governmental potentials to make money and possible reduce of bottlenecks. Moreover, it is a relatively new concept that has been given impetus by the rapid rate of internet penetration throughout the world, and the dramatic advance in the use of ICT in business and industry (Mutula and van Brakel, 2006; Hanafizadeh *et al*., 2009). Therefore, e-readiness is important to implement the "right" ICT solutions for the right processes, to the right degree, with the right timing (Lou and Goulding, 2010). E-readiness also refers to a country's ability to take advantages of the internet as an engine of economic growth and human development (ZiaciPour *et al*., 2009).

There is no single definitive definition for e-readiness, as different things to different people, in different contexts, and for different purposes (Rurikar *et al*., 2006; ZiaciPour *et al*., 2009; Lou and Goulding, 2010). Various literatures defined e-readiness as shown in Table 1.

The various differences in e-readiness definitions raise the question of "what is the most accurate definition for e-readiness?" The answer to this question is an ongoing debate, reflecting that there is no complete literature definition for e-readiness (Lou and Goulding, 2010). Therefore, this study defined e-readiness as the degree to be ready for the use of ICT in hospitals.

2.2 Readiness factors

Normally, the factors affecting the e-readiness includes people, process, and technology which is "ICTs + e-skills people" (Rao, 2003). However, factors used in assessing e-readiness in various industries are different. This research studied the factors used in various industries including agriculture, SMEs, bank, education institute, and healthcare industries. Then, justified whether or not those factors could be applied in healthcare. A previous study from Ghavamifar *et al*. (2008) revealed that e-readiness assessment tools for developing countries are (1) infrastructure, (2) human capacity, (3) policy, (4) enterprise, and (5) content and applications. Lou and Goulding (2010) determined four readiness factors including (1) people, (2) process, (3) technology, and (4) work-environment in the various industries of global. Purnomo and Lee (2010) studied e-readiness assessment for agriculture industry in Indonesia and used four types of factors, namely: (1) farmer, (2) personal, (3) infrastructure, and (4) management readiness. A more recent study by Tran *et al*. (2011) showed the importance of government,

Table 1: Definitions of e-readiness.

Sources	Definition
Rao (2003)	"E-readiness = ICTs + e-skilled people." To underline, the "8Cs" (connectivity, content, community, commerce, capacity, culture, cooperation and capital) give insights into the success of countries like India and the Philippines call centre operations, technology support and content management services.
Center for International Development (CID, 2007), Harvard University (ZaeiPour *et al.*, 2009)	Readiness is the degree to which a community is prepared to participate in the networked world. It is gauged by assessing a community's relative advancement in the areas that are most critical for ICT adoption and the most important applications of ICT. When considered together in the context of a strategic planning dialogue, an assessment based on these elements provides a robust portrayal of a community's readiness. The value to a community of assessing its readiness lies in evaluating its unique opportunities and challenges.
United Nations (UN, 2008) (Lou and Goulding, 2010)	This UN report assesses e-government readiness of member states, according to a quantitative composite readiness of e-readiness based on website assessment; telecommunication infrastructure and human resource endowment.
The Computer Systems Policy Project (CSPP) (Bridge.org., 2005; Mutula and van Brakel, 2006; Ghavamifar *et al.*, 2008; ZaeiPour *et al.*, 2009)	To define e-readiness with respect to a community that had high-speed access as a competitive market; with constant access and application of ITs in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are favorable to promote connectedness and use of the network.

organization, and technology on a construction enterprises' e-procurement implementation readiness level in developing countries. The summary of readiness dimensions and factors used in other literatures is also shown in Table 2.

2.3 Barrier factors

A number of literatures have studied about the barrier factors for ICT implementation in various industries. A previous study from Mungania (2003) revealed that e-learning barriers for various industries in USA are heterogeneous, encompassing seven types of barrier, namely: (1) personal or dispositional, (2) learning style, (3) instructional, (4) situational, (5) organizational, (6) content suitability, and (7) technological barriers. Muilenburg and Berge (2005) determined eight barrier factors to online learning for education institute industry in USA including (1) administrative issues, (2) social interaction, (3) academic skills, (4) technical skills, (5) learner motivation, (6) time and support for studies, (7) cost and access to the internet, and (8) technical problems. Ali and Magalhaes (2008) divided the barriers in the adoption of e-learning for largest companies in Kuwait into four factors: (1) management support, (2) language, (3) IT problems, and (4) workload and time. A more recent study by Yucel *et al.* (2011) studied a fuzzy risk assessment model for hospital information system implementation in Turkey and showed that the important factors include technological, individual, and organizational factors. The summary of barrier dimensions and factors used in other literatures is also shown in Table 3.

2.4 E-readiness factors of barcode technology in hospitals

A number of literatures have studied about the readiness and barrier factors for ICT implementation in healthcare industry. A previous study from Yucel *et al.* (2011) and Yusof *et al.* (2008b) studied factors for health information system implementation in hospitals and showed that the important factors include technological, people, and organizational factors. Sicotte and Pare (2010) investigated the implementation and deployment of two large health information exchange (HIE) projects in Quebec, Canada and showed that the risk factors include technology, people, usability, managerial, and political. Kijsanayotin *et al.* (2009) studied the factors influencing health information technology to adopt in Thailand's community health centers and found that key factors include performance expectancy, effort expectancy, social influence, and voluntariness. Among these factors, performance expectancy exerted the strongest effect. In addition, Khoja *et al.* (2007/2008) studied barrier factors for e-health readiness assessment for developing countries and found that nine factors include appropriateness of technology, affordability, capacity, relevant content, integration, socio-cultural factors, trust, legal and regulatory frameworks, and political.

Barcode technology helps to improve efficiency and eliminating human error if used correctly. In developed countries this technology has been in place for over 25 years in healthcare and longer in other industries (Southard, 2005). However, the technology is quite new to healthcare industry in Thailand. In order to implement barcode

Table 2: Reviews of readiness dimensions and factors.

Dimensions	Factors	References
People	Task	Synder-Halpern, 2001; Pathian *et al.*, 2008; Jasem and Zakaria, 2008
	Skills	Synder-Halpern, 2001; Pathian *et al.*, 2008
	Individual knowledge	Synder-Halpern, 2001; Jasem and Zakaria, 2009
	Self-development	Aydin and Tasci, 2005; Ghavamifar *et al.*, 2008
Process	Resources	Synder-Halpern, 2001; Mutula and van Brakel, 2006; Jasem and Zakaria, 2008
	Operation	Synder-Halpern, 2001; Jasem and Zakaria, 2009
Technology	ICT services and support	Mutula and van Brakel, 2006; Pathian *et al.*, 2008
	Innovation	Aydin and Tasci, 2005; Pathian *et al.*, 2008; Jasem and Zakaria, 2008; Jasem and Zakaria, 2009
	Internet availability and affordability	Hanmer, 1999; Rao, 2003; Bridge.org.,2005; Pathian *et al.*, 2008; Gewald and Dibbern, 2009
	Infrastructure	Pathian *et al.*, 2008; Ghavamifar *et al.*, 2008; Purnomo and Lee, 2010
	Security and encryption	Bridge.org.,2005; Pathian *et al.*, 2008; Jasem and Zakaria, 2009
	Appropriateness of ICT	Hanmer, 1999; Bridge.org.,2005
	ICT capacity and training	Rao, 2003; Bridge.org.,2005
	Locally relevant content	Rao, 2003; Bridge.org.,2005; Pathian *et al.*, 2008; Ghavamifar *et al.*, 2008; Jasem and Zakaria, 2009
	Connectivity	Rao, 2003; Pathian *et al.*, 2008; Gewald and Dibbern, 2009
Organization	Structure	Barnad, 2006; Lai and Ong, 2010
	Socio-cultural factors that affect ICT use	Jones, 2005; Rao, 2003; Bridge.org.,2005; Keramati *et al.*, 2011
	Work-environment	Mutula and Brakel, 2006; Lou and Goulding, 2010
	Management	Aydin and Tasci, 2005; Raikar *et al.*, 2006; Pathian *et al.*, 2008; Jasem and Zakaria, 2008; Jasem and Zakaria, 2009; Purnomo and Lee, 2010
	Values & goals	Synder-Halpern, 2001; Gewald and Dibbern, 2009 Jasem and Zakaria, 2008
	Human resources	Mutula and van Brakel, 2006; Pathian *et al.*, 2008; Jasem and Zakaria, 2008
Government	Policy	Ghavamifar *et al.*, 2008; Jasem and Zakaria, 2009
	Legal environment and regulations	Bridge.org.,2005; Pathian *et al.*, 2008; Jasem and Zakaria, 2009

technology efficiently, the hospitals have to plan in details to ensure their readiness for the implementation. Factors the hospitals need to consider include both readiness and barrier factors. However, in addition to the general e-readiness factors, the ultimate goal that all parties in the hospital supply chain concern is the safety and well being of the patients. Therefore, this study added another group of factors to the e-readiness assessment framework which is related to "patient safety" as shown in Figure 2.

The American Hospital Association (Levin, 2005) and the American Society of Health-System Pharmacists (ASHP) (Ragan *et al.* (2005) listed the following reasons for drug management errors which lead to patient unsafety:

(1) Drug information flow can't link with the other departments in hospitals.
(2) Miscommunication of drug orders, which can involve poor handwriting, trailing zeros, or confusion of metric doses or other units of dosage.
(3) Lack of accuracy of drug administration and documentation.
(4) Inefficiency within process.
(5) Environment factors, such as lighting, heat, noise, and interruptions that distract the health professionals from their medical tasks

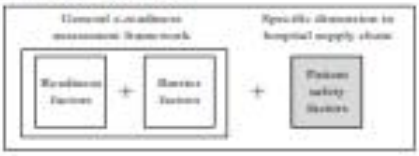

Figure 2: Dimension for e-readiness assessment in hospital supply chain.

Table 3: Reviews of barrier dimensions and factors

Dimensions	Factors	References
People	Personality	Jones, 2003; Mungania, 2003; Baroud, 2006; Sockartawi, 2008; Kijsanayotin *et al.*, 2009; Verhoeven *et al.*, 2009; Purnomo and Lee, 2010; Sicotte and Pare, 2010
	Skills	Howard *et al.*, 2006; Yucel *et al.*, 2011
Technology	Quality	Sockartawi, 2008; Verhoeven *et al.*, 2009; Khan *et al.*, 2011
	Infrastructure	Menou and Mchombu, 2007; Khan *et al.*, 2011; Tran *et al.*, 2011
	Access and Equity	Jones, 2003; Howard *et al.*, 2006
	Capacity	Baroud, 2006; Khoja *et al.*, 2007-2008; Khan *et al.*, 2011
	Content suitability	Mungania, 2003; Khoja *et al.*, 2007-2008
	Instructional	Mungania, 2003; Malhotra and Ho, 2010
	Performance	Sockartawi, 2008; Kijsanayotin *et al.*, 2009; Verhoeven *et al.*, 2009
Organization	Communication	Khan *et al.*, 2011; Yucel *et al.*, 2011
	Social influence	Baroud, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007-2008; Gewald and Dibbern, 2009; Kijsanayotin *et al.*, 2009
	Geographical	Baroud, 2006; Menou and Mchombu, 2007
	Culture and tradition	Baroud, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007-2008
	Insufficient trained staff	Jones, 2003; Baroud, 2006
	Management	Howard *et al.*, 2006; Sicotte and Pare, 2010; Khan *et al.*, 2011; Tran *et al.*, 2011
	Strategy	Gewald and Dibbern, 2009; Malhotra and Ho, 2010; Khan *et al.*, 2011; Tran *et al.*, 2011
Government	Politics	Khoja *et al.*, 2007-2008; Sicotte and Pare, 2010
	Policy	Baroud, 2006; Khoja *et al.*, 2007-2008; Sockartawi, 2008; Gewald and Dibbern, 2009; Verhoeven *et al.*, 2009; Purnomo and Lee, 2010; Sicotte and Pare, 2010
	Legal and regulatory frameworks	Howard *et al.*, 2006; Khoja *et al.*, 2007-2008; Tran *et al.*, 2011
	Finance	Jones, 2003; Baroud, 2006; Howard *et al.*, 2006; Menou and Mchombu, 2007; Khoja *et al.*, 2007-2008; Sockartawi, 2008; Gewald and Dibbern, 2009; Khan *et al.*, 2011

Patients were at risk of harm from medication errors (Morriss *et al.*, 2009). The implementation of barcode technology in hospitals and healthcare institutions in the United States has been found to effectively reduce the rate of human errors associated with dispensing, transcribing and administering medications (Paoletti *et al.*, 2007; DeYoung *et al.*, 2009; Morriss *et al.*, 2009). In addition, the use of personal digital assistant (PDAs) with barcode reader in healthcare is reported to improve decision-making, reduce medication errors, and to improve patient care (Baumgart, 2005; Lu *et al.*, 2005; Lindquist *et al.*, 2008).

Therefore, in our study, the readiness factors, barrier factors and the factors relevant to patient safety were combined. Concerning the drug management errors mentioned by previous literatures, this study included the factors of "linkage of information" into the "technology dimension" and add the "patient safety dimension" into the e-readiness assessment study. The patient safety dimension or the hospital specific factors include trust, lighting, heat, noise, interruptions, and voluntariness. The propose list of factors for assessing e-readiness for barcode technology implementation in hospitals can be summarized into six dimensions. The dimensions include 1) people, 2) process, 3) technology, 4) organization, 5) government, and 6) patient safety. The definition of each dimension is as follows:

(1) *People* means user's in hospitals such as pharmacist, nurse, IT staff, finance staff, warehouse staff, and purchasing staff.

(2) *Process* means a working procedure related to the use of barcode technology.

(3) *Technology* covers all aspects related to information technology (IT) and communication technology (CT) in hospitals.

(4) *Organization* covers all aspects related to the organizing the hospital administrational activities.

(5) *Government* will play a role as a driver or supporter to adoption of innovation by its policy, legal and regulatory framework, politics, and finance of hospitals.

Figure 3: Dimensions and factors for assessing e-readiness for barcode technology implementation in hospitals.

(6) *Patient safety* means the prevention of errors and adverse effects to patients associated with the hospitals.

In total, there are 40 factors to measure e-readiness of each hospital to implement barcode technology in the warehouse department and pharmacy department as shown in Figure 3.

3. DEVELOPING QUESTIONNAIRES AND DATA COLLECTION

Questionnaires were developed in order to measure the e-readiness level of each hospital and the importance of each factor. The five-point Likert scale is used to assess each factor which range from 1) very unimportant/very low readiness level to 5) very important/very high readiness level.

Questionnaires were sent to the target participants who are pharmacists working in the hospitals warehouse, pharmacists working in the pharmacy department, staff in procurement department management, IT staff, staff in finance department, nurses, drug manufacturers, distributors, and other who involve in the healthcare of the operation. The target number of respondents is 35 (The Central Limit Theorem). The Central Limit Theorem stated that the sampling distribution of any statistic will be normal or nearly normal, if the sample size is large enough or N>30 (Bartz, 1999).

4. DATA ANALYSIS

The method or tools used in data analysis are varied ranging from modified Delphi method (Snyder-Halpern, 2001), deductive analysis (Verhoeven, 2009), expert opinion (Jaroon and Zakaria, 2009), data envelopment analysis (Emrouznejad *et al.*, 2010), factor analysis (Pathian *et al.*, 2008; Lai and Ong, 2010; Lou and Goulding, 2010), regression analysis (Keramati et al., 2011), fuzzy analysis (Lin and Yeh, 2010; Erol *et al.*, 2011; Yucel *et al.*, 2011), and others. This paper is interesting in the integration of fuzzy and importance performance analysis (Fuzzy-IPA) to classified both readiness and barrier factors into four scenarios including "Keep Up the Good Work", "Concentrate Here", "Low Priority", and "Possible Overkill".

4.1 Fuzzy sets and Fuzzy Numbers

Definition 1: Fuzzy set

Let X be a universe of discourse, $\tilde{A}$ is a fuzzy subset of X such that for all x ε X. There is a number $\mu_{\tilde{A}}(x)$ which (Zadeh, 1965).

Definition 2: Fuzzy number

A fuzzy number $\tilde{A}$ is a normal and convex fuzzy subset of X. Here, the "convex" set implies that (Zadeh, 1965).

$$\forall x_1 \in X \quad , \quad x_2 \in X \quad \forall u \in [0,1]$$
$$\mu_{\tilde{A}}(ux_1 + (1-u)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2))$$

Definition 3: Triangular fuzzy number

A triangular fuzzy number $\tilde{A}$ can be defined by a triplet (l, m, u). The membership function is defined as

(Kaufmann and Gupta, 1988).

$$\mu_{\tilde{A}}(X) = \begin{cases} 0 & , & x < l \\ x - l/m - l & , & l \le x \le m \\ u - x/u - m & , & m \le x \le u \\ 0 & , & x > u \end{cases}$$

Where l, m, and u are real number and $l = m = u$.

A triangular fuzzy number can be shown as (l, m, u). The parameters l, m, and u, respectively, denote the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event. Triangular fuzzy membership functions defined is shown in Figure 4.

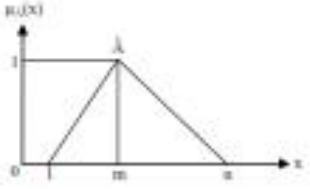

Figure 4: A triangular fuzzy number.

Each triangular fuzzy number has linear representations on its left and right sides such that its membership function can be defined as displayed in Zimmermann (2001).

4.2 Importance-performance analysis (IPA)

IPA, originally introduced by Martilla and James (1977), yields insights into which product or service attributes a firm should focus on to achieve customer satisfaction (Chu and Choi, 2000; Oh, 2001; Matzler *et al.*, 2004). A commonly seen IPA is a two-dimensional grid, depicted in Figure 5, constructed by plotting mean ratings of performance and importance. Importance is labeled as the y-axis, whereas performance is labeled as the x-axis. This four-quadrant matrix can be used to identify improvement opportunities as well as to guide strategic planning efforts (Wu and Shieh, 2009; Wang and Tseng, 2011; Ziegler *et al.*, 2012). The meanings of these four quadrants in IPA are as follows:

Quadrant I

Attributes are perceived to be very important to respondents, but performance levels are fairly low. This sends a direct message that improvement efforts should "Concentrate Here".

Quadrant II

Attributes are perceived to be very important to respondents, and at the same time, the organization seems to have high levels of performance on these activities. The message here is to "Keep up the Good Work".

Quadrant III

Attributes are with low importance and low performance. Although performance levels may be low in this cell, managers should not be overly concerned since the attribute in this cell is not perceived to be very important. Limited resources should be expended on this "Low Priority" cell.

Quadrant IV

This cell contains attributes of low importance, but relatively high performance. Respondents are satisfied with the performance of the organizations, but managers should consider present efforts on the attributes of this cell as being "Over Utilized".

Figure 5: Importance – performance analysis, IPA (Martilla and James, 1977).

4.3 Analyze data with Fuzzy-IPA

The Fuzzy-IPA method used in this study comprises six steps adapted from Deng and Pei (2009):

Step 1: Collect perceptions for importance and performance of each factor identified in Figure 3.

Step 2: Assign a final average triangular fuzzy number to the perceptions.

Step 3: Transform the fuzzy numbers of perceptions into crisp numbers by calculating average of all perceptions.

Step 4: Use the average of all importance and performance (derived from **Step 3**) for each factor to divide the Fuzzy-IPA matrix into four quadrants.

Step 5: Plot all factors' importance and performance on the Fuzzy-IPA matrix.

Step 6: The reasonable action plan for each factor in each quadrant will be determined the priority is given to factors fell in Quadrant I "Concentrate Here".

5. DEVELOPING GUIDELINE FOR HOSPITALS

After the data analysis using Fuzzy-IPA, each factor will be classified into each quadrant. Priority will be given to the factors fell in Quadrant I "Concentrate Here" and almost all resources showed be used to improve these factors to be ready for the barcode technology implementation. A clear step-by-step guideline should be made for the hospitals to follow in order to achieve a certain e-readiness level for these factors. If there still be some resources available, the factor in Quadrant II "Keep Up the Good Work" should be put into consideration and further action.

Currently, this study is in the process of data collection. The result of this study will be analyzed and used for developing the guideline later.

6. CONCLUSION

E-readiness assessments are useful for understanding and identifying the most key and relevant ICT based development opportunities. The e-readiness dimensions consisted of people, process, technology, organization, government, and patient safety. The 40 factors were identified as e-readiness factors to assess the e-readiness level of a hospital with respect to barcode technology implementation. The factors include readiness and barrier factors incorporating the healthcare unique goal of "patient safety" into the factors. The Fuzzy-IPA method was used to analyze the data. Finally, we will help to suggest standard operation procedures for hospital staff to be ready for barcode technology implementation in the future.

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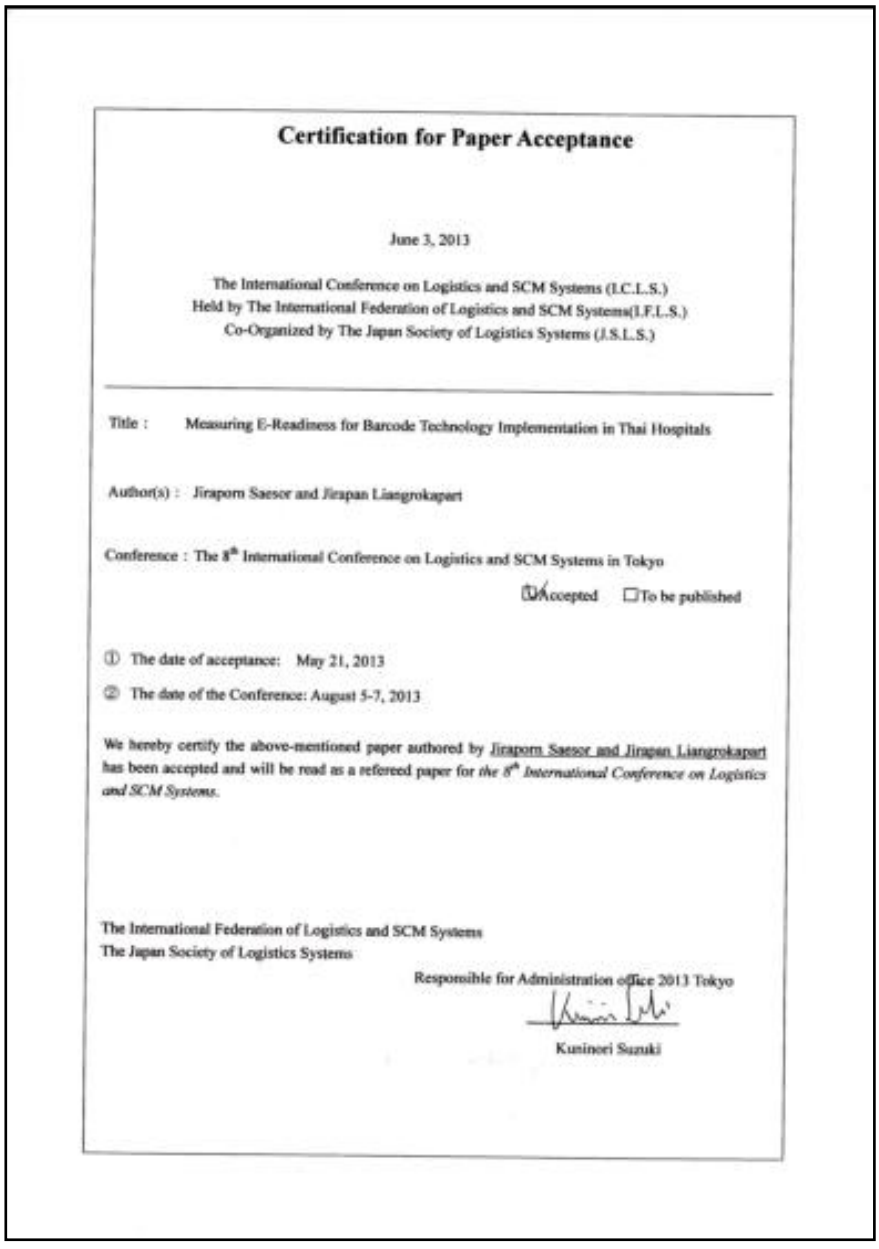
APPENDIX I
2013 INTERNATIONAL CONGRESS ON LOGISTICS AND SUPPLY CHAIN MANAGEMENT SYSTEMS SUBMITTED PAPER

I.1 ACCEPTANCE LETTER



Certification for Paper Acceptance

June 3, 2013

The International Conference on Logistics and SCM Systems (I.C.L.S.)
Held by The International Federation of Logistics and SCM Systems(I.F.L.S.)
Co-Organized by The Japan Society of Logistics Systems (J.S.L.S.)

Title : Measuring E-Readiness for Barcode Technology Implementation in Thai Hospitals

Author(s) : Jiraporn Saesor and Jirapan Liangrokapart

Conference : The 8th International Conference on Logistics and SCM Systems in Tokyo

☒Accepted ☐To be published

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② The date of the Conference: August 5-7, 2013

We hereby certify the above-mentioned paper authored by Jiraporn Saesor and Jirapan Liangrokapart has been accepted and will be read as a refereed paper for *the 8th International Conference on Logistics and SCM Systems*.

The International Federation of Logistics and SCM Systems
The Japan Society of Logistics Systems

Responsible for Administration office 2013 Tokyo

Kuninori Suzuki

I.2 FULL PAPER

MEASURING E-READINESS FOR BARCODE TECHNOLOGY IMPLEMENTATION IN THAI HOSPITALS

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ABSTRACT

Thai hospitals are facing the problems of information exchange between parties in its supply chain which is not efficient and accurate. Using barcode technology can help to improve efficiency and eliminate human errors in various industries including manufacturing, retail, and agriculture. However, the application of barcode technology in hospital services has just been taken into consideration. Therefore, the objective of this paper is to identify e-readiness factors of hospital operations to adopt barcode technology in Pharmaceutical Department and to compare the factors among hospital groups including small-size public hospitals, large-size public hospitals, and private hospitals. The factors related to the e-readiness have been identified and classified into "readiness" and "barrier" factors. Then, the total of thirty factors are classified into six dimensions including "people", "technology", "process", "organization", "government", and "hospital environment". A survey of one hundred and forty hospital staff has been conducted in order to get their inputs on each factor. Finally, the data have been analyzed using fuzzy importance-performance analysis (Fuzzy-IPA). The findings will help each hospital group to focus on importance factors and allocate enough resources to be ready for barcode technology implementation.

Keyword(s): E-readiness assessment, Thai Hospitals, Barcode Technology, Fuzzy-IPA

INTRODUCTION

Thai hospitals are facing the problems of information exchange between parties in its supply chain which is not efficient and accurate. Using barcode technology can help to improve efficiency and eliminate human errors in various industries including manufacturing, retail, and agriculture. However, the application of barcode technology in hospital services has just been taken into consideration. To effectively adopt barcode technology in hospitals, there are a lot of factors to be considered. Therefore, the objective of this paper is to identify e-readiness factors of hospital operations to adopt barcode technology in Pharmaceutical Department and to compare the factors among hospital groups including small-size public hospitals, large-size public hospitals, and private hospitals.

LITERATURE REVIEW

Through an extensive literature review, the authors have summarized factors for assessing e-readiness for barcode technology implementation in various industries. The research conducted by [1] concluded the thirty e-readiness factors for barcode technology implementation in hospitals and the six dimensions as shown in Figure 1.

In this study, questionnaires were developed based on those factors and sent to the target participants who are pharmacists working in the hospitals warehouse, pharmacists working in the pharmacy department, staff in procurement department, IT staff, staff in finance department, and nurses. Then, fuzzy importance-performance analysis (Fuzzy-IPA) method was used to analyze data and classify factors into four scenarios including "Keep Up the Good Work", "Concentrate Here", "Low Priority", and "Possible Overkill".

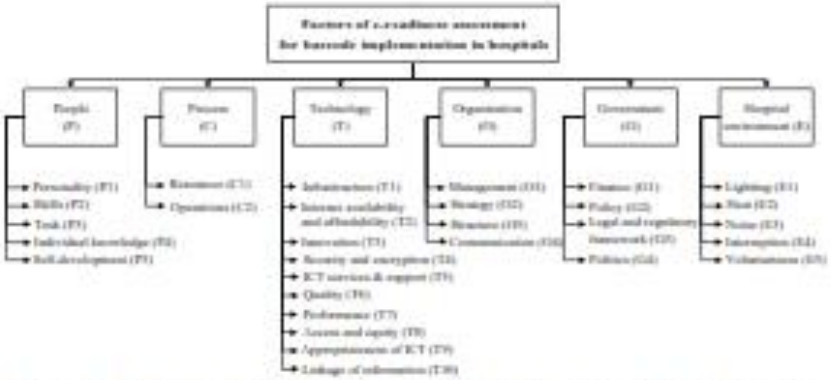

Figure 1: Dimensions and factors for assessing e-readiness for barcode technology implementation in hospitals [1].

METHODOLOGY

The propose e-readiness assessment consists of five steps as follows:

Step 1: Developing questionnaires and data collection

Questionnaires were developed based on the factors shown in Figure 1 in order to measure the e-readiness level of each hospital and the importance of each factor. The five-point Likert scale was used to assess each factor which range from 1: very unimportant/very low readiness level to 5: very important/very high readiness level. The questionnaires were sent to the small-size public hospitals (10-120 beds), large-size public hospitals (over 120 beds), and private hospitals for data collection.

Step 2: Using fuzzy entropy to find the importance weight of the factors

Fuzzy entropy weight method is entropy method based on fuzzy arithmetic (linguistic values). Traditional entropy method is an object empowerment approach, in which the weight values of individual factors are determined by calculating the entropy and entropy weight [2]. The formulas of calculation are referred from [3].

Step 3: Using fuzzy linguistic to find the performance values of the factors

A linguistic variable is defined as a variable, the values of which are expressed in words, phrases or sentences in a given language [4-7].

Table 1: Linguistic terms used by [8]

Linguistic terms	Linguistic values
Very low	(0.00; 2.38; 21.83)
Low	(5.56; 24.92; 46.75)
Medium	(27.70; 49.29; 69.76)
High	(52.62; 73.41; 92.22)
Very high	(78.02; 95.95; 100.00)

In this study, triangular fuzzy numbers are used as membership functions, corresponding to the elements in a set as shown in Figure 2. The reason for using a triangular fuzzy number is that it is intuitively easy for the decision makers to use and calculate. Fuzzy number A is a triangular fuzzy number if its membership function can be denoted as follows [9].

$$\mu_A(X) = \begin{cases} 0, & x < l \\ x - l/m - l, & l \le x \le m \\ u - x/u - m, & m \le x \le u \\ 0, & x > u \end{cases}$$

where l, m, and u are real number

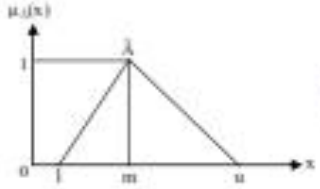

Figure 2:
A triangular fuzzy number.

Step 4: Plot all factors' importance and performance on the IPA matrix.
Importance-Performance Analysis or IPA, originally introduced by [10], yields insights into which product or service attributes a firm should focus on to achieve customer satisfaction [11-13]. A commonly seen IPA is a two-dimensional grid, depicted in Figure 3, constructed by plotting mean ratings of performance and importance. Importance is labeled as the y-axis, whereas performance is labeled as the x-axis. This four-quadrant matrix can be used to identify improvement opportunities as well as to guide strategic planning efforts [14-15]. The meanings of these four quadrants in IPA are as follows:

Figure 3:
IPA matrix [10].

Quadrant I: Factors are perceived to be very important to hospital staff, and at the same time, the hospitals seem to have high levels of performance on these factors. The message here is to "Keep Up the Good Work".
Quadrant II: Factors are perceived to be very important to hospital staff, but performance levels of hospitals are low. This sends a direct message that improvement efforts should "Concentrate Here".
Quadrant III: Factors are with low importance and low performance. There is no need any immediate action. Limited resources should be used for this "Low Priority" cell.
Quadrant IV: This cell shows the hospital staff does not consider these factors as important factors. The resources used to develop these factors may be reallocated to other important factors in the first and second quadrants instead of the factors of this cell as being "Over Utilized" or "Possible Overkill".

RESULTS AND DISCUSSIONS
A total of 140 questionnaires were sent to the target hospitals. After several continued follow-up, 114 questionnaires were returned, yielding a response rate of 81%. The factors which determine the difference in management strategies derived from the IPA matrix of small-size public hospitals, large-size public hospitals, and private hospitals are as follows:

1. Small-size public hospitals
Figure 4 shows the IPA matrix of the small-size public hospitals. Factors fell in Quadrant I which shows the hospitals are ready in the areas of Personality, P1; Legal and regulatory frameworks, G3; and Internet availability and affordability, T2. Factors fell in Quadrant II which need immediately improvement include Resources, C1; Interruption, E4; Skills, P2; Performance, T7; and Linkage of information, T10. Resources used to do activities in Quadrant IV should be reallocated to these activities instead.

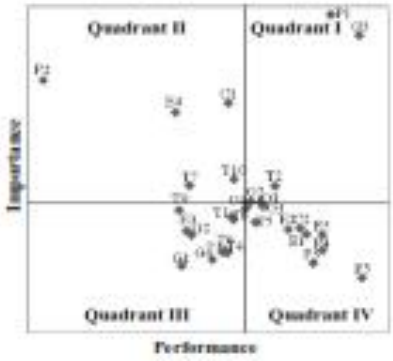

Figure 4:
IPA matrix of Small-size public hospitals.

2. Large-size public hospitals

Figure 5 shows the IPA matrix of the large-size public hospitals. Factors fell in Quadrant I which shows the hospitals are ready in the areas of Management, O1; Strategy, O2; Lighting, E1; Volunteriness, E5; Performance, T7; and Legal and regulatory frameworks, G3. Factors fell in Quadrant II which need immediately improvement include Structure, O3; Communication, O4; Quality, T6; Personality, P1; Individual knowledge, P4; Operations, C2; and Policy, G2. Therefore, resources used for factors in Quadrant IV should be reallocated to these factors.

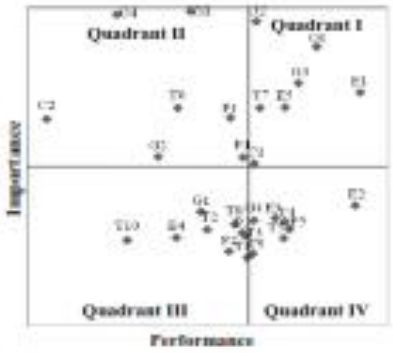

Figure 5:
IPA matrix of Large-size public hospitals.

3. Private hospitals

Figure 6 shows the IPA matrix of the private hospitals. Factors fell in Quadrant I which shows the hospitals are ready in the areas of Self-development, P5; Resources, C1; Operations, C2; Lighting, E1; Interruption, E4; Communications, O4; and ICT services and support, T5. Factors fell in Quadrant II which need immediately improvement include Skills, P2; Infrastructure, T1; Innovation, T3; and Security and encryption, T4. Therefore, resources used for factors in Quadrant IV should be reallocated to these factors.

4. Comparison among hospital groups

Each hospital group considers the importance of factors for barcode technology implementation differently and they are ready in different areas for barcode technology implementation. However, there are some common factors between the small-size public hospitals and the large-size public hospitals (see Figure 7). These are Management (O1), Strategy (O2), and Legal and regulatory frameworks (G3). This is because they are under the government funding hospitals. Hence, their management, strategies, and policies are similar and follow the government. The large-size public hospitals also have the commonalities with private hospitals in term of important factors which they are doing well. These include Resources (C1), and Lighting (E1). This means that both

hospital groups have enough resources to initiate barcode technology implementation and the lighting in the hospitals is good enough for work.

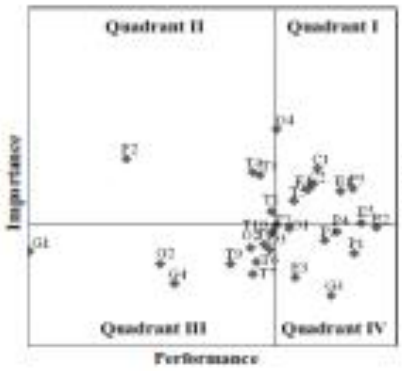

Figure 6:
IPA matrix of Private hospitals.

Comparing among the three groups of hospitals, private hospitals are more ready to implement barcode technology comparing to government hospitals. These are reflected from the number of "Keep Up the Good Work" factors which are higher than those of other hospital groups. They probably have enough resources, good operations, and enough lighting to implement the barcode technology.

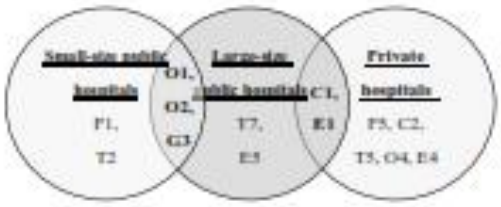

Figure 7:
Factors that hospitals are ready for barcode implementation.

Therefore, the private hospitals can be adopted the barcode technology easier than the small and large-size public hospitals. They have been sufficient resources and manage strategies of organization which are not respect government. In addition, organization emphasizes hospital staff to communicate. The result, quality and performance of staff and hospitals are better.

CONCLUSION

The concept of Fuzzy-IPA can be applied to classify factors for barcode technology implementation into four groups as per their importance and performance. Each hospital group should concentrate on the high important factors and allocate their resources, especially the resources used for "Possible Overkill" factors to the more important factors. The "Low Priority" factors should be ignored until the hospitals have extra resources.

From this study, small-size public hospitals should focus on developing skills for staff relevant to the use of barcode technology, allocating resources for implementing the barcode technology, minimizing the interruption in working area which creates operation errors. Large-size public hospitals should focus on restructuring their organization to accommodate barcode technology implementation, improving communication between staff and using appropriate technology to support the implementation. Private hospitals should focus on developing skills of hospital staff and encouraging internal innovation as well as developing good security and encryption system to protect hospital and patient information from intruders. Suggestions for future research include the development of a common guideline to check the hospital readiness for barcode technology implementation for each hospital group. It will help the hospital which plan to implement barcode

technology to aware of the factors they need to improve and allocate appropriate resources for suitable activities.

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