CHAPTER II

LITERATURE REVIEW

A. Hospital Information Systems

1. Information Communication and Technology (ICT)

Information Technology mainly refers to anything related to technology, this includes hardware, software, and also telecommunication networks. IT has a direct correlation with PCs, routers, network cables and servers, while being intangible to all kind of software. IT facilitates the collecting, processing, storing and distributing of information. The European Union referred IT as an ICT, because they view IT and telecommunications as something that is connected to each other [16].

2. Information Systems (IS)

A system according to an expert, can be interpreted into three things [17]. The first one, a system can be seen as an abstracted description of certain objects or processes that has been observed in the real world. Second, as a template of action that will connect those elements to each other. Third, as an artefact that are produced from the template of action mentioned before. Systems in general consists of a set of inputs that goes into elements in the system, resulting in a set of outputs.

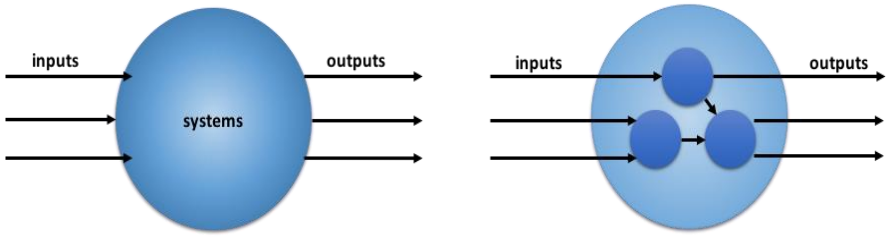

Figure 1. A system is a set of inputs and outputs that internally consist of a set of subsystems

Therefore, information systems can be concluded as elements, consisting of hardware, software, data, telecommunication networks and people that are linked to each other. These elements are built and used to collect, process, store and distribute meaningful data to support decision making, analysis or coordination in organizational setting [17,18].

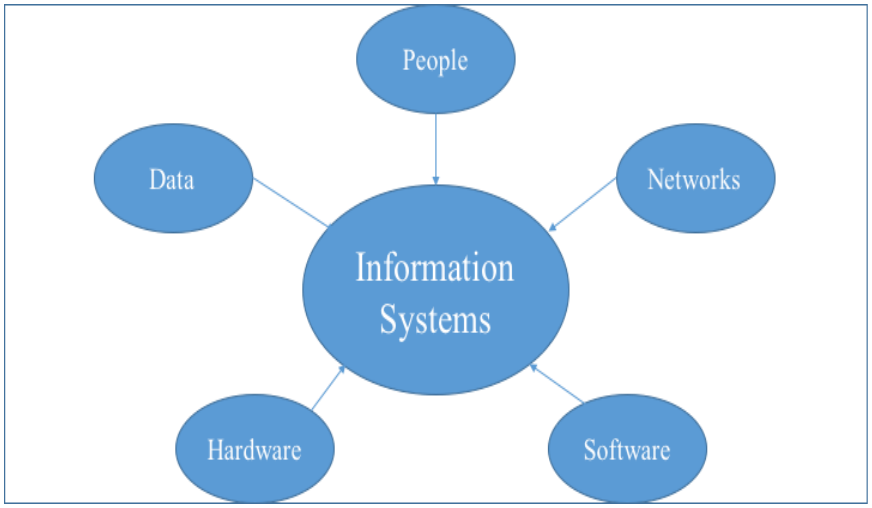

Figure 2. Elements inside information systems

3. Hospital Information Systems

Hospital Information Systems (HIS) is an integrated information system, consisting of a wide range of technologies that are designed to manage health information that will be used by various people on the field like providers, administrators and patients [5]. HIS provides great variability in usability and functionality, but the basic functionalities that are integrated to most systems include:

a. Electronic Health Record (allowing for patient's data storage and organization)
b. Computerized physician order entry (allowing for electronic prescription)
c. Computerized clinical decision support (allowing for better patient's health management through diagnostic supports and clinical guideline)

Other than that, HIS also provide non-patient care facilities such as administrative management (e.g. human resource, data management) and financing (e.g. inventory, purchasing, accounting)

In a bigger picture, HIS consists of certain components such as : enterprise functions, business processes, application components, and physical data processing components [18]. An enterprise function describes what is to be done in the hospital system, it is a continuous

act such as patient admission or clinical documentation. Therefore, it is focused on what human or machines needs to do in order to achieve sets of goals. A business processes on the other hand, describes a chronological and sequence of activities to achieve those goals. So, business processes focus on how it is done. These two are related together in information processing.

Whereas enterprise functions and business processes are considered as an information processing, application components and physical data processing components are then considered as tools for processing data. Application components consist of software that will support enterprise functions. Lastly, physical data processing components describe the information processing tools that are used to realize the application components. This include, but not limited to, human as an actor, and computer systems such as terminals, servers and personal computers.

4. History of Hospital Information Systems Technology

Information systems technology first started-out in around the 1940s with the first invention of early computers such as Eniac and Colossus [19]. Through the 1960s and 1970s, computing slowly moved from slow and expensive mainframes to a faster mini- and microcomputers that were powered by chip technology and integrated

circuits. Around these years, a mainframe was built in the HIS area with an ability to integrate patient health record in a single database. In the late 1970s, mini computers made it possible for health-care to link subsystem databases to a mainframe system. This subsystem consisted of specific clinical specialties or departments, and were able to integrate patient personal health records to the mainframe. In the 1980s, commercially available programs grew and were able to perform needed computational functions in healthcare settings. Microcomputer-based systems had already evolved independently for specialized services, and were part of a larger medical information system with an integrated central database management system. Computer storage capacities started to develop to become more advanced and were able to store massive amounts of data, but on the other hand also grew cheaper than before.

By the 1990s, there were already vast amounts of innovation such as mouses, touch screens, speech and hand writing recognitions, that were all made to ease out physician's tasks and increased acceptance of information systems for physicians. From 1990s onwards, computer communications evolved into a wireless system. The internet and the World Wide Web were created and became the main modes used in communication, enabling a global exchange of

medical information. By the 2010s, the invention of laptops starting to replace desktop computers, and tablets and smartphones were commonplace, enabling a mobile e-health care for patients.

5. Policy in Hospital Information Systems

One of the earliest policy regarding HIS is The Health Insurance Portability and Accountability Act of 1996 or HIPAA in United States [20]. The primary purpose of HIPAA is to guarantee a safe access in medical information, and the goal is to establish a national standard for electronic data exchange in healthcare. HIPAA started in 1996, authored by Senator Nancy Kassebaum under Clinton administration. It was not finalized until around 2001 during Bush administration. The finalization processed was long due to the fact that at that time the security and safety of medical information was a minor issue in legislation. However, once the act was finalized in December, 2000, it was then self-implemented throughout healthcare facilities in United States with a deadline for compliance within 24 months after adoption. The most important features of HIPAA include the following : the changing of software systems to a standardized format, the use of specific coding and security standards for software system and electronic record systems, and the application of new policies and procedures for electronic storage and maintenance of information. These belong to Protected Health Information (PHI), which translated

as individual identifiable health information that are transmitted and maintained in electronic media. HIPAA is limited in scope regarding the types of information the regulation protect and to whom it apply [12].

HIPAA then followed by Health Information Technology for Economic and Clinical Health (HITECH) Act, as part of the American Recovery and Reinvestment Act of 2009 that was signed into law on February 17, 2009 [21]. HITECH help strengthen HIPAA by extending the scope of health providers vendors that previously were not covered [12]. It also help to builds an infrastructure for the development and promote adoption of health IT. First, the HITECH Act creates a congressional support called the National Coordinator for Health Information Technology (ONC), to develop strategic plan and create policies that will give a standard to health IT. Second, giving approximately two billion dollar fund as a supportive act to increase implementation of HIS. Third, creates incentives for providers through additional payments of Medicare and Medicaid if they can establish a meaningful use of health IT. Fourth, recognizing that it is important to gain trust both from providers and patients that the use of health IT will follow by a secured and safety exchange of health information [21].

Different to United States, United Kingdom (UK) first policy regarding HIS started as early as 1992 through National Health Service (NHS) Information Management & Technology (IMT) [22]. The policy focused on five main aspects surrounded the use of information in health service, these were : 1. Information should be person-based; 2. IT systems should be integrated; 3. Information should be derived from existing operational systems; 4. Information should be secure and confidential; and 5. Information should be shared across the NHS. Some of the key elements in the policy are still exist in UK until today, such as the NHS Number, shared NHS administrative registers (NHSARs) and the NHS-wide information network *NHSnet.* However, the policy itself were considered as a failure, and later on was replaced with a newer policy.

This policy was called National Programme for Information Technology (NPfIT) . The program was launched in 2002 under Prime Minister's Tony Blair leadership, with approximately £12.4 billion on investment [23]. Its aim was to move England's National Health System (NHS) towards a single, centrally-mandated, electronic health record for patients. Making it possible for healthcare professionals to accessed patient's data all over the country, over its 300 hospitals through a secured and audited access. It consisted of

four key elements, these were : 1. An integrated electronic health records system; 2. An electronic prescription system; 3. An electronic appointment booking system; and 4. An underpinning IT infrastructure with sufficient capacity to support the national applications and local systems [24]. Unfortunately the policy was aborted and discontinued in 2011. There were many reasons behind the failure of this policy, such as lacked of engagement with users (e.g. clinicians, NHS executives), unrealistic timetable which lead to delayed in delivery of the system, and frequent turnover of senior leaders that made the aim of the project continually changed. With constant failure of policy in HIS, UK has no longer applying any program in this subject [23].

6. Building and Implementation Process of Hospital Information Systems

HIS are created by professionals in software development, collaborating with physicians as content experts on-the-field. At first, the software development process begins with understanding the purpose of the software itself, and how it is going to be used by health practitioners. This will be done through communication between content experts and professionals to establish the performance requirements that the software must meet. Content experts will

explain how they perform their daily work tasks, and how they want the software to work in helping them accomplishing those tasks. Afterwards professionals will be working in creating the prototype of the intended software, this is to ensure that physicians will have the chance to see how the system is going to work in the future. From this prototype, physicians will then give inputs to improve the overall system's functions. The numbers of prototypes varies depending on how complex the system needs to be, before it could be finalized.

After several trials in which vendors and users already satisfy with the result, vendors will then go through the implementation process of the system. An organization usually will use between two approaches in implementing a new system, one called the Big Bang Strategy and the other called Incremental Approach. A Big Bang Strategy is an approach in which the systems are applied throughout all departments and workstations at the same time. While the Incremental Approach is done by implementing the system in one small department, and gradually implementing it throughout every department. The benefit of this approach, even though would take more time, is related to the user's operational problem. By gradually and slowly implementing the system, hospitals will be able to solve and overcome the operational problems in the first implementation phase, before they go further with the process .

In short, these are several stages in the building and implementation process of HIS [17] :

a. Requirements Analysis (where vendors analyze the function of the systems, and user's need)
b. Functional Description (translation from user's need into technical listings)
c. Architecture Design (translation from functional description into a software architecture)
d. Software Programming (more descriptive and detailed architecture system is created)
e. Unit Test (to check for errors)
f. System Integration (if users environment already have a pre-existing information system, then integration is needed to connect the two systems)
g. Acceptance Test (to see the performance of the system and user's acceptance, also to find out if there are any unanticipated problems)
h. User Training (to prevent user's rejection towards the new system)
i. Outcomes Assessment (to measure the performance of the new system)

Whilst according to HIMSS, there are 7 stages [25]:

- Stages 7 : fully electronic of Medical record, CDO contributed to EHR
- Stages 6 : Physician documentation, and full CDSS
- Stages 5 : Closed loop medication administration
- Stages 4 : CPOE, CDSS (clinical protocols)
- Stages 3 : Clinical documentation, CDSS (error checking), PACS available
- Stages 2 : CDR, CMV, CDSS inference engine, may have Document imaging
- Stages 1 : ancillaries – lab, rad, pharmacy – all installed
- Stages 0 : all three ancillaries not installed

B. Hospital Information Systems Cost Evaluation

1. Hospital Information Systems Investment Cost

In general, cost in manufacturing or service industries can be divided into three major things : labor, materials and overhead. However, ICT have a different nature in terms of defining it's cost. Organization usually breaks down the cost into three components : hardware assets, software assets, and data assets [26].

There are six components in ICT that are consider as part of hardware assets, all this components are tangible and therefore are easy to count the value of each one of it. These are:

1. Centrally managed large-scale computers, and technologies related to it such as servers and data storage
2. Small distributed computers, consisting of desktop and laptop computers
3. Additional technologies such as printers, scanners, solid state memory devices (data sticks), cameras, etc
4. Network equipment
5. Telecommunications equipment
6. Other fixed assets such as buildings, power generators, air conditioners, cabling etc

For software in ICT, they includes not just the systems software, but also middleware and application software. Software have been seen as an intangible asset and therefore are said to be more difficult to evaluate the value of it compare to hardware. This is especially true when the system is developed internally. There are various categories in software assets, one organization may have one type of the asset or multiple of it combining together. These are:

1. Purchased enterprise systems software

2. Purchase middleware
3. Internally written enterprise applications
4. Purchased enterprise packaged application software
5. Purchased enterprise custom built application software
6. Purchased personal computer application software
7. Software licensing agreements

Last one is data assets. Calculating the amount invested in data assets is even more difficult than calculating the software assets. It is also consider as an intangible asset which has a particular range of shelf life that is differ on each organization. Most organizations consider data assets as a form of goodwill, i.e. an intrinsic part of the value of the company like a brand or a reputation. Data assets may be categorized into two major parts. These are:

1. Centralized data resources (assets that are composed from the various databases inside the organization)
2. Data stored on personal computer and laptops (data that may contain items of strategic value)

2. Hospital Information Systems Evaluation

Evaluation seems to be a part of the human social behavior. People love to evaluate anything, from their football teams to governments and their policies. If general business investment

evaluation is challenging, then making an ICT evaluation, or in this term making a HIS evaluation can be consider as a super challenging task [26]. This is due to the nature of the HIS itself, that it is hard to estimate the cost of investment, moreover the benefit and the economic life of the investment.

Before jumping into HIS evaluation, we must first have an understanding that there are three fundamental economic issues that needs to be address in an organization, these are : “what to produce”, “how to produce”, and “for whom to produce” [27]. In healthcare setting, the “what to produce” means to choose among a wide varieties of services and technologies that will give an actual benefit to citizens; “how to produce” means giving the most suitable process for the services (i.e. short hospitalization, day surgery, outpatient clinic); while “for whom to produce” means deciding which citizens have the right for access and how (free of charge, or cost-sharing).

In almost all productive sectors, those three economic issues mentioned above are solved in the free market, through process of supply and demand. But this is impossible to be applied in healthcare sectors, because consumers or patients in this term usually do not know what they need and doctors will be the one addressing the appropriate diagnostics tools and treatments for them. Therefore the

alternative free market come up : governments decide what to produce, how to produce and for whom to produce through a planning process. Since it is first begin with a planning, an evaluation therefore is needed, such as the economic evaluation technique.

Economic evaluation refers to a comparative analysis, both in terms of costs and consequences, including alternative ways of action. This means that the main function of economic evaluation is to measure, identify, developed and compare each of costs and consequences of alternatives considered.

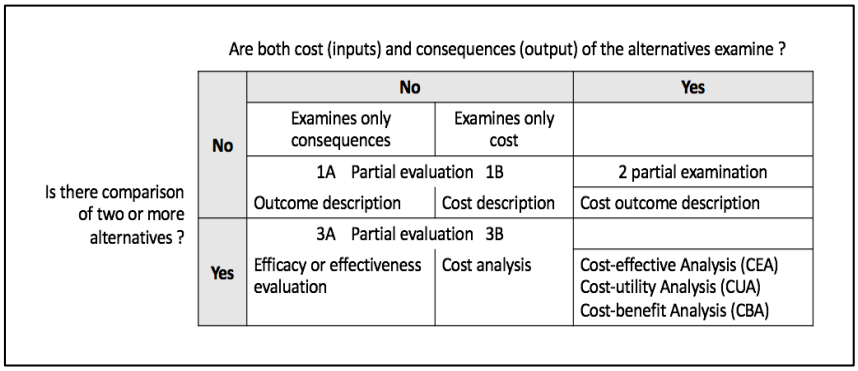

Figure 3. Classification of economic evaluation

By understanding the fundamental economic issues and the economic evaluation technique, we will be able to understand the ICT or HIS evaluation because this evaluation mainly rely themselves on financial analysis. One of the main reasons why financial-based evaluation have persisted is because it is easy to understand by

managers. It is also worth noted that the financial approached is the only one that has been available since 1950s [26].