RFID in Healthcare Industry: A Strategic Framework for Implementation

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ABESTRACT

The healthcare industry is revolutionizing its operations and utilizing ICT capabilities to improve services and attain competitive advantage. RFID technology has wide applications in the manufacturing and retail industry and started to be used in the healthcare sector. This paper tries to explore the potential of RFID in the healthcare industry and review its benefits and risks. Also, this study applies three conceptual tools to test the potential of the technology and its survival. This work utilizes Porter's five forces model to fit the firm within its environment; Venkatraman and Henderson alignment model to fit the technology within the firm's strategy; and finally, the TAM model to make sure that this technology is accepted by users and stakeholders. Conclusions and future work are stated at the end of the paper.

Keywords : RFID, RFID' Strategy, competitive advantage, technology acceptance

1. Introduction:

Radio Frequency Identification (RFID) technology has been around for more than 50 years, but only in the last ten years started to be one of the commercial tools that supported business objectives. RFID is considered a good replacement and enhancement for barcode technology. Wal-Mart and the US Department of Defense (DOD) have brought new business opportunities to many information technology companies, when they announced their intention to use RFID applications in 2003 [1].

Li, Visich and Khumawala, (2006) put forward that RFID technology promises numerous benefits in any industry. They assert that it will provide firms with improved speed, accuracy, efficiency, security of information sharing in the organization and real time communication. All of that is a result of the advantageous properties provided by such tool [10]. Knebel et al. emphasize few aspects that make RFID technology an important tool compared to barcode or other types of technologies. First, RFID provides unique identification, where RFID tag can contain an ID to identify product's type and individual items. Second, RFID can communicate dynamic information because of the read/write capability of the tag; this

property allows changing and updating the information that is stored on it. Third, the large storage capacity, compared to other types of technologies; the tag can store significant amount of data, more than the ID of a product. Fourth, there is no need for a line of sight; the tag can be read without direct line of sight, regardless of any cover or obstacle of sight. Finally, real-time information is utilized; with RFID tags, collection of real time data on objects, individual items, is becoming a reality, which was impossible with barcodes.

RFID technology is utilized by manufacturing and retail industry and they are considered the first home of the RFID technology [1]. RFID technology provides many benefits related to reduced material handling and inspection time, and increased data accuracy. Data accuracy is a major problem in the retail industry where RFID is considered a great solution to this problem by improving inventory records and reducing human errors in material handling. Finally, RFID could also increase the accuracy of shipment data, which leads to improved demand forecast and production planning and ultimately achieving lower inventory by improving inventory data and reducing stock-outs [11].

RFID technology is used in production tracking, where it enables tracking of raw material, work-in-process inventory, finished products, and even assembly status during production [11].

RFID technologies are being applied in telemedicine through wired and wireless communications to provide medical information and services. Also it is adopted to improve the quality of healthcare services, reduce medical errors, and reduce or eliminate shortages of qualified healthcare personnel. In 2003, Alexandra Hospital in Singapore, adopted an RFID tracking system during the severe respiratory syndrome (SARS) outbreak [4]. RFID systems can be used to manage medicine and hospital equipment, track critical care assets, and help doctors and nurses keep tabs on their patients frequently and remotely. Also, RFID tags were affixed to medicine bottles, teacups, and other objects regularly used in hospitals [4].

Tzeng et al. [1] suggest that IT is the most important enabler to the organization activities, operations, and management.

One of the critical tools that utilize any technology is business process reengineering (BPR), where a careful alignment is mapped between business values and objectives and IT capabilities. The RFID system makes objects more intelligent and processes more automatic. Such aspect can reduce the cost of collecting data and improve efficiency. It is necessary to implement BPR with an innovative spirit on the fundamental processes before implementing RFID to achieve greater synergy. RFID will require considerable process redesign at all stages in

the value chain where the technology is applied.

The growing importance of RFID technology makes it important to understand the reflections of such tool and how it would influence businesses and firms. RFID is changing how healthcare firms are operating, and influencing their core competencies, and thus changing their strategies. This conceptual paper will have two main objectives; the first is to understand RFID technology and its manifestation in the healthcare industry. This is done through the in-depth analysis of the literature and how RFID technology is revolutionalizing the operations in the healthcare industry. The second objective is to test this technology against three conceptual tools and models to contrast its potential against the literature. First, Porter's five forces model will be used to explore how this technology fits with the external environment of the firm [20]. Second, Venkatraman and Henderson (1991) alignment model will explore the fit of this technology within the business, its IT strategy and the firm's infrastructure. Finally, the Technology Acceptance Model TAM [23] will test the acceptance of users of such technology. Conclusions, limitations and future work will be stated at the end of this paper.

2. RFID Technology

RFID is a technology using radio waves for automatic identification of physical objects such as industrial containers, individual products, people or objects. The RFID system consists of three basic components: a tag, a reader, and a host system or connection to an enterprise system [11]. The tag contains unique identification information of the object in which it is embedded, the reader sends and receives radio waves to read the information stored in the tag, and the data-processing equipment (host system) processes all the collected data. This equipment could be simple like a personal computer, or complex like a networked system [3].

RFID tags may be active or passive depending on transmission reactivity. Active tags have high frequency (HF) and operate with battery power and a moderate sized antenna, and they can transmit signals over long distances, these tags are typically read/write devices. Passive tags have low frequency (LF) and operate without battery using a very small size antenna that can be used for items' tracking; these tags are generally read only [11]. Figure 1 depicts the RFID system components [15].
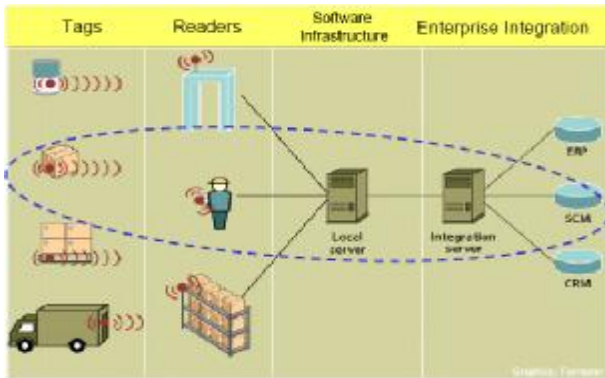
Figure1: RFID system components
 (adopted as is from Holmqvist & Stefansson , 2006).

The earliest use of RFID technology was by the US military, where they used RFID technology since the early 1990s with the first deployment in Bosnia in the mid 1990s. On the other hand, the United Kingdom Armed Forces adopted RFID in the year 2003 [11]. In order to remain competitive, organizations from different industrial sectors have started to evaluate RFID technology to improve supply chain visibility, asset management, information and product management flow, product visibility manufacturing, healthcare and pharmaceutical, and distribution and logistics [4] .

Some big firms, such as Wal-Mart, Target, and Gillette, have adopted RFID technology to achieve several purposes and goals such as reducing the labor cost of scanning items, reduction of out-of-stock items, reducing theft loss, providing proof of delivery, inventory reduction, and facilitating promotions at stores [2]. An RFID system also has been applied in telemedicine and healthcare (that will be explored more in the following section), which employs wired or wireless communications to provide medical information and services [4].

3. RFID in Healthcare industry

Many industries are facing key changes because of technological dependencies, and this is the case of healthcare industry. The high demand on healthcare delivery and responsiveness of services are deteriorating revenues. Healthcare firms are trying to utilize this new technology to avoid such problems. Adapting modern technologies, in the form of wireless computing and communication technology, to improve the outcomes of clinical services, enhance physicians and nurses productivity and operations efficiency is becoming a strategic choice [5].

Hospitals in general are complex institutions because of the nature of human interactions between the medical staff and patients. Physicians and nursing staff interact with thousands of patients to provide healthcare services to them, and to successfully provide these services to them physicians and nursing staff must correctly identify patients [6]. Recent studies indicated an increasing number of medical errors caused by adverse drug events, which are caused by incorrect patients' identification. These errors are recognized as a threat to patients' safety, so it is important for hospitals to prevent these medical errors from happening by adopting a

proper patient identification system that can improve safety procedures [6].

Healthcare industry, like other industries, started to utilize information technology especially wireless technology to solve their problems, improve business processes, improve operation efficiency and effectiveness, and gain competitive advantage. New technologies are used for several purposes like management of patients, personnel, and inventory. All of that promises to improve the efficiency and effectiveness of hospitals' operations [7]. The RFID technology is expected to add mobile capabilities and intelligence to healthcare industry by its identification, tracking and tracing nature, because it can collect and provide a large amount of information about the entities or objects physically embedded in. Healthcare industry is considered the future of RFID technology, behind manufacturing and retail [1]. In this sector huge investments are being placed in information technology (IT) to reduce the operating costs and improve patients' safety. RFID is expected to become critical to healthcare organizations for achieving these goals. Although it's not widely used, RFID technology has great potential to significantly reduce cost, improve patients' safety and medical services and ultimately reach competitive advantage [2].

4. Healthcare Industry Strategic Analysis

Porter describes strategy as "a broad based formula for how business is going to compete, what its goals should be, and what policies will be needed to carry out these goals" [19]. Realizing that an IT strategy should be aligned with the business strategy, this led Ahitu and Neumann (1986) to claim that a strategic information system is a system that supports the business strategy and its competitive objectives like customer/supplier support and improve productivity and product design.

A well thought and built healthcare strategy provides a clear direction for the future development of primary healthcare, and the industry's capabilities to adopt new technology. This strategy contains vision, objectives and long term goals, so any new technology that will be adopted by this industry should meet and be aligned with such goals. A strategy provides an outline on how to use RFID technology in alignment with the enterprise vision and goals. This strategy is applicable regardless of the size of the firm because of the ubiquity of RFID and its future potential. RFID strategy is not going to work if built in general terms, but on the contrary, businesses must create their own unique RFID strategy. In addition, any business has to determine how RFID can create value that is aligned with its strategic

directions are within the tolerable cost and risk ranges [14, pp. 57).

Koh, Kim & Kim [13] concluded that developing such a strategy requires well-defined strategic plan that contains a number of important factors that affect the new technology adoption process. The following are the main aspects of this plan:

1- Define the functions and services that RFID can bring to the healthcare business, also identifying where values can be added and the effect on patients satisfaction that will be influenced by RFID applications.

2- Define the perceived risks and challenges that will affect the industry when adopting the RFID system. The relationship between these factors is depicted in Figure 2 [13].
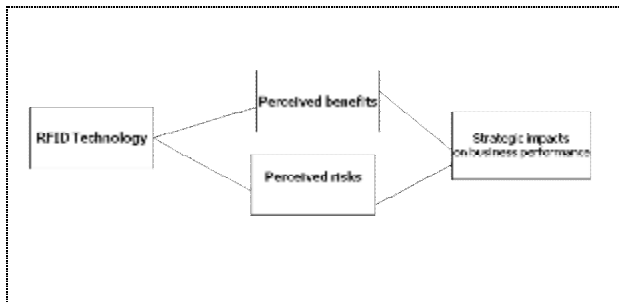

Figure 2: The impact of RFID technology on healthcare industry *(adopted from Koh, Kim & Kim 2006)*

4.1 Perceived Benefits From RFID Technology

4.1.1 Short Term Benefits

The following section will explore how RFID technology meets and is aligned with healthcare objectives. The following will focus only on short-term benefits (hard benefits):

Ensuring patients' safety and patients' satisfaction*:* RFID can improve patient treatment and safety by reducing medical errors, improving the security of medicine, and improving patient compliance [2]. RFID systems are suitable for emergency rooms, where it improves treatment quality by making patient safety the starting point, the risks of patients posed by incorrect treatment, incorrect diagnosis and delays in treatment were reduced [1].

Improve process effectiveness and efficiency: By ensuring that the right information continuously flows to the right people at the right time. The automation of the processes will reduce cost and improve efficiency, where objects can become more intelligent [1]. RFID has the potential to improve process efficiency and effectiveness, where in the case of barcode technology; the off-sight of objects avoids an object to be turned several times before the tag can be read. This results in less manual intervention on the object. On the other hand, the increased storage capacity allows more product data to be stored on the tag and the ability to add information during an object's life cycle [2].

In combination with sensors, additional up-to-date information can be collected about temperature, humidity or pressure in the object's environment. Accurate information

and identification increase process transparency, making processes more secure [10]. The case of improving efficiency and increasing asset utilization can be supported through the avoidance of losing expensive equipment each year and spending countless hours searching for patient-care assets, including medical devices (Examples of infusion pumps, portable X-ray machines and patient monitoring devices, as well as other mobile assets such as wheelchairs, stretchers and gurneys). The ability to find assets and improve their flow and usage through hospital processes saves staff time and reduces costs [1].

Real-time Management: environmental data can be monitored continuously, allowing real-time response reception from the emergency or healthcare staff. Collected information used to build a healthcare database that can be used for filling patient's history reports, also stored information can be utilized in future usage like diagnosing the same patient whenever he needs medical care [8].

Patient Identification: Many medical errors result from the misidentification of patients before or during medical treatment. Patient identification errors may lead to improper dosage of medication to patients. Also, inaccurate lab work and results reported for the wrong person will cause misdiagnoses and serious medication errors [9]. In order to eliminate or reduce these medical errors,

improve patients' identification, improve care and security, and improve productivity and patients' satisfaction, several RFID-based patients' identification and tracking systems have been initiated in several hospitals in the world. One of the examples is the Wan Fang Hospital in Taiwan, where all patients admitted to the hospital are given an RFID-based wristband with a passive RFID chip in it [1]. This chip stores unique patient ID number and other relevant medical information such as the patient's blood type, to speed up treatment, ensure patient privacy and avoid medical errors from happening [9].

Tracking equipment, patients, and staff: The characteristics of RFID make objects intelligent and processes automatic, and thus best suited for tracking applications. The technology enables automated and fast tracking of assets, equipments and patients, also RFID technology can provide more information about the object or patient's environment like temperature, humidity and other pieces of information [9].

Blood tracking: The success of blood transfusion service depends on every aspect of transfusion practice: identification and selection of blood donors, preparation of blood components, quality laboratory testing and ensuring the safest and appropriate use of blood components [16]. The objective is to ensure availability of sufficient high quality blood with maximum efficiency and

minimum risk to both donors and recipients. These objectives can easily be achieved using RFID technology where each bag of blood arriving at the hospital gets an RFID label, where unique identification number is stored and detailed information related to the blood. Identification numbers are also saved in a secure database containing details about blood origin, its particular purpose and, its recipient. During the preparation of blood transfusion, the nurse uses a reader-equipped PDA to read the data encoded on the blood bag and on the patient ID bracelet. The data from the patient and the bag must match before the blood can be used. With this solution the process of managing blood transfer is easer faster. Also the risk of patients receiving the wrong type of blood is eliminated or reduced [9].

Smart operating theatres: Surgical identification can lead to significant problems. Fuhrer and Guinard [9] declared that most of surgical errors involved are related to wrong body part or site, the wrong patient or the wrong surgical procedure. In smart hospitals patients get an RFID-tagged wristband containing all relevant information and a digital picture of them. This allows the clinical team to easily confirm that they have the right patient, and the electronic record ensures they perform the correct procedure. If the wrong patient enters the operating room, the medical staff would automatically

discover the mismatch. So that radio tagging makes the operating theatre safer and more efficient, also the risk of surgery mistakes are minimized and the costs they generate should be significantly reduced [9].

Gaining competitive advantages and enabling new services using RFID technology: Aspects of competitive advantage are achieved based on reducing the cost of business process, improving service quality, and focusing on the targeted market. All this can be achieved through the utilization of RFID technology. Long-term objectives of healthcare industry will be discussed later in this paper. Companies try to gain competitive advantage by being first-adopters; they use RFID to innovate their business and to gain strategic leverage.

New opportunity by RFID: When using RFID technology, equipped by wireless sensors network environment, constraints associated with location, space and time are meaningless. RFID technology is allowing for new services to be created or existing services to be customized in a new and innovative way. Using RFID systems will provide direct and continuous identification, and grant positioning and tracking of patients, drugs and assets at the right time all the time, and through the effective use of RFID in medical institutions, particularly for intensive data operations such as search, input, collation and confirmation [1]. The rapid pace of adoption

and advancement of RFID creates opportunities for new and innovative services provided through RFID system.

4.1.2 Long-Term Benefits

On the long run, RFID technology can benefit healthcare firms in the following aspects:

Being real-time enterprise*:* Being Real-Time Enterprise (RTE) is the vision of any organization in any industry, through the use of real-time information as a basis for business decisions. Managers need real-time information to make quicker, more informed business decisions to achieve their objectives. To do so, it is necessary to have a mapping of real-time events with events represented in systems connected to RFID systems. One technology that can automatically enable this mapping is the Radio Frequency Identification technology [10].

Build Intelligent digital healthcare network: Remote care is also available through the use of RFID technology. The healthcare industry has a future vision to move from e-and-m-healthcare (electronic and mobile healthcare model) to u-healthcare model (ubiquitous health care). U-Healthcare environment is derived from the four "Us" concept; ubiquitous collecting of data; unique healthcare planning for every patient; universal caring for patients in either hospitals or homes; and uniting between patients' protection from diseases and physical treatments. The RFID technology

can facilitate the building of the u-healthcare environment [1].

Prevent the outbreak of serious disease*:* Serious diseases are not a threat to patients' lives only, but they cause a threat to medical staff also. Using RFID technology to track any contact between patients with specific diseases in isolation areas through the identification of path of motion and location would serve as an efficient tool to control the spread of diseases. If the system detected any event that violates the disease isolation policy, an alarm signal would immediately trigger and a related standard operating procedure would be launched [1].

4.2 Risks Associated With RFID Technology

The previous section reviewed major benefits related to RFID technology in the healthcare sector. On the other hand, RFID technology still has some challenges and risks associated with it specifically in the healthcare sector. The following are some of these risks.

Customization*:* current RFID systems have not been designed in response to the particular needs of hospitals. Technology vendors have created standardized and inflexible RFID packages that are designed to be plug-and-play regardless of the settings and environment used in. Hospital administrators, physicians, and nurses expressed a need for customizable RFID systems to fit to the particular functions of

their hospital sites [7]. The authors proclaimed that in order to achieve this type of flexibility, some university hospitals are in the process of developing their own systems in house rather than purchasing "off-the-shelf" equipment from vendors.

Interoperability: Most RFID systems are not interoperable with existing hospital computer systems like medical records, electronic white boards, administrative systems, patient billing, and equipment rental. Interfacing with existing information systems will be a headache because of the many competing software companies already established within a hospital arena. This adds significant cost to hospitals, but more importantly for a sociological approach to technology, the presence of no interoperable information systems creates increased frustration for hospital staff, particularly nurses [6].

Medical regulation compliant*:* Another significant problem with the current RFID systems, from the perspective of hospital administrators, is that the RFID technology vendors have made systems that wouldn't have minimal compliance with current medical regulations [7].

Resources planning*:* Financial resources and the distribution of material should be evaluated and planned well in advance. Administrators and staff should assess the types of spatial resources required by the RFID systems and the potential physical constraints such systems might impose upon the storage capacity for inventory or the mobility of staff or patients [7]. It is also critically important that the design of RFID systems and interfaces are technically functional, easy to use, and as complementary as possible to established practices and processes of delivering care at the hospital. Additionally, the authors argue that hospitals should expect that these systems will require ongoing investment in staff positions and technical supplies (e.g., replacement of RFID tags and scanners) to keep them technically operational.

Privacy aspects of RFID*:* any technology implementation in healthcare must carefully deal with privacy issues. Using RFID technology presents unique concerns because of the possibility of unintended wireless transmission of healthcare-related information. Unethical individuals could snoop on people and collect data on them without their approval or without their knowledge, this could occur even after the completion of healthcare service. The threat to privacy through the use of information technology has its origins in the ability to permanently save and link information related to individuals [12].

Thiesse [12, pp. 216) confers that dimensions to data acquisition has developed through the spatial extension of data collection activities, the acquisition of new data types through

real-time monitoring, and the uncontrolled data access caused by extreme interconnectedness.

5. The Conceptual Model

The adoption process of RFID is influenced by several factors: environmental, organizational and internal factors. The conceptual model adapted by this study is illustrated in Figure 3.

Figure 3: The conceptual Model

The conceptual model introduced in the figure above represents the environment of the firm and illustrates two main factors, governmental and industry. Also, within any firm internal factors are important when considering any technology and its influence on competitiveness. Financial and human factors are important in this area, but the allignment between IT and business strategies and infrastructure is also important.

Environmental factors*:* The environment, where the organization exists and operates, has direct impact and influence on the organization's adoption of new innovative technology. Because the healthcare environment is generally complex, instable and uncertain, this makes the healthcare organizations pay more attention to new innovative technologies to be able to compete with its competitors and deal with dynamic customer requirements.

In addition, the governmental factors influence the organizational activities and the adoption process through its regulatory role that may support or restrict the technology adoption. Changes in the regulatory sector through relieving regulations, providing help in training human resources, and providing financial support [18].

Organizational factors*:* The main characteristics of the organization such as: the structure, culture, mission, strategies and the general climate of the organization; all of that have influence and drive the adoption of RFID technology. New technology must be aligned with the organizational strategies, goals, and objectives. Also there are several sub-organizational factors that also have influence like top management support and encouragement for new innovative technology adoption, availability of slack resources, and skills and communication between employees (Human Resource); so that when the organization have quality and highly trained employees, it will have more tendency to adopt new technology [18].

Internal factors*:* These factors are concerned with internal aspects of the organization such

as human resources, technical infrastructure and financial resources. Such factors have significant impact on the ability of the organization to adopt RFID technology or resist this new technology that may change the nature of work totally or partially. Top management should pay attention to employee resistance to such change because of the new competencies needed and the loss of jobs resulting from deploying RFID technology.

In this paper, we applied Porter's five forces model to analyze and examine the external environment influencing the healthcare industry when adopting RFID technology (mainly industry competitive factors). Appendix (A) shows a visual representation of this model and some analysis related to RFID. The following are the major parts of this model.

Bargaining Power of Buyer: The bargaining power of buyers is high, because the total cost of wireless technology is continuously dropping. So in the close future the market will grow and will have high adoption rate in hospitals, or residential home services, specially because the new healthcare vision of healthcare industry of moving from e-and-m- healthcare to u-healthcare.

Bargaining Power of supplier: the Barging Power of supplier of wireless technology and solutions to healthcare industry is attractive because the rapid growth of wireless technology adoption. So that the wireless

technology vendors continuously have the opportunity to find new market and identify new market niche.

Threat of substitutes: the threat of substitute technology is low, because of the real-time data and communication at anytime and anywhere. Such requirements are now a must in healthcare industry.

Threats of new entrant: Threats of new entrant may be medium, since there are some major constraints and barriers such as the high cost of this technology, perceived risks, and government's regulations.

Healthcare business strategy perspective:
On the internal side of the firm we utilized the diagram in Appendix (B), which describes the alignment model that we adopted to test how RFID strategy is aligned with healthcare strategy (The Strategic Alignment Model by Venkatraman, Henderson and Oldach, 2008; Venkatraman & Henderson, 1991):

Healthcare business strategy is the driver of both organizational infrastructure design and the IT infrastructure that is required to implement RFID system (line 1). Top Management participates in the design and implementation of RFID Strategy that is aligned with the whole healthcare strategy.

Technology perspective: This perspective also views the healthcare business strategy as the driver, it involves the formulation of an RFID strategy and (short term plan to implement this strategy) to support the

healthcare business strategy and the corresponding specification of the required IT infrastructure and processes (line 2).

Competitive perspectives*:* This alignment perspective is concerned with utilizing the emerging RFID capabilities to introduce new innovative products and services, influence and improve the key attributes of healthcare strategy. This perspective allows for some positive modifications of healthcare business strategy according to the emerging RFID capabilities. The success of this perspective depends on top management support (line 3)**.**

Service perspective*:* When the IT concept is the main driver of the strategy; RFID strategy will drive the IT infrastructure and thus driving business infrastructure and processes, the organization will be driven towards a strategy that RFID is its sole and serves the technology (line 4).

Risk and RFID technology acceptance:

Generally, introducing new technology in any industry may face some barriers; inside or outside the organization. One of the most important ones is the resistance of change by the users. Also, adopting the innovative RFID technology in healthcare faces problems based on several causes, first are the risks associated with RFID that include both the direct impact of electromagnetic radiation on health, also indirect economic results including the elimination of jobs of many employees by increasing automation. Second, privacy problems that are caused by misusing

of data generated and stored by RFID tags, resulting in an undesirable invasion of privacy. Privacy problem lead to trust risks that will lead to deteriorating customer retention and acquisition [12].

The TAM model [23]. is used to study how the RFID technology is accepted by users of this technology. The TAM is a model derived from the theory of reasoned action [22], and proposed to measure the intention of users to adopt a technology. TAM predicts that two main beliefs, perceived ease of use (PEOU) and perceived usefulness (PU), will determine user's acceptance of a technology.
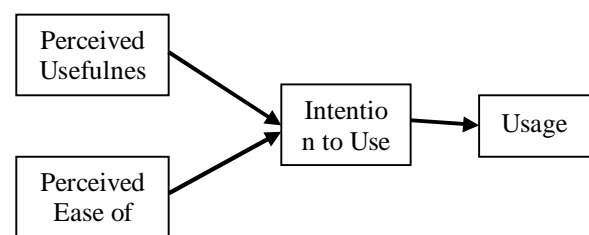

Figure 6: The TAM

The technology acceptance model has been tested many times in relation to trust issues. Gefen, Karahanna and Straub (2003) proposed an extension of the TAM that included trust mechanisms to increase the adoption and usage rate of customers. When testing online shopping, users were influenced by perceived usefulness and perceived ease of use and habit [24]. Trust was a major influencer of perceived ease of use, and online shoppers' level of trust was affected significantly by experience, repeated usage and the interaction with the systems. Suh and Han (2003) reported that trust in e-

commerce transactions was largely affected by perceptions of non-repudiation, privacy protection, and data integrity. In their study, trust had a significant impact on e-commerce' acceptance as it was a major predictor of intention. Pavlou (2003) explored the influence of trust and risk on technology acceptance in the context of e-commerce and found that trust and perceived risk are significant influencers of intention to transact based on the concept of uncertainty reduction. Research related to RFID and within the context of TAM indicated that trust has a positive effect on PU because part of the guarantee that consumers will sense the expected usefulness is based on the sellers behind the system. On the other hand, PEOU has positive influence on trust because PEOU can be argued to influence positively a person's favorable outcome expectation toward the acceptance of an innovative technology. Thiesse (2007), concentrated in his framework only on the factors that can be influenced by company's actions; he focused on the development of institutional trust and interpersonal trust. Also, he added technology trust to the model since the consumer's attitude toward RFID is at the centre of his framework.

6. Conclusions:

RFID is an emerging technology that is rapidly becoming a required standard for hospitals and continues to grow in healthcare industry to track inventory, positive patient identification, and manage personnel. Also, RFID systems are seen as valuable because of their ability to collect data in real-time and their great potential to reduce operating costs and errors. RFID like any technology in healthcare requires strong planning before adoption, since it requires some changes in the business process of hospitals; hospitals must be prepared to accept such change. RFID is reinventing today's hospitals to a new technology oriented ones. In addition to the technology itself, the physical environment, the interference with radio waves, business practices, domain knowledge, the behavioral side of the persons to be tagged, the movement of tagged objects and people, and cost/benefit considerations, all of this need to be considered. The success of RFID projects/systems depends on the strategy, the implementation process, the characteristics of the technology, the organizational context, and the attitudes of stakeholders, who certainly include physicians and nurses.

This paper proposed a conceptual model that depicts the environment needed to be considered when adopting a technology; in this case RFID. Also, proposed through the model using three models that are considered one of the leading models in their areas to test RFID and conclude to different aspects of applying RFID technology in the area.

Finally, RFID like any other technology is driving strategy and influencing competitiveness in the same weight that competitiveness requires technology to gain its sustainability.

Future work is recommended in testing the three models and rethinking the conceptual model proposed by this study. More tools need to be considered like: cost-benefit analysis in the area of financial infrastructure; and legal and ethical outcomes of adopting RFID.

The conceptual model proposed in this work is a framework for future research that utilized few tools. More empirical research is needed to test the tools and identify issues related. This work is a conceptual analysis of the reality of RFID in healthcare industry, where more empirical and case study research is needed to explore this emerging technology and fully utilize its influence.

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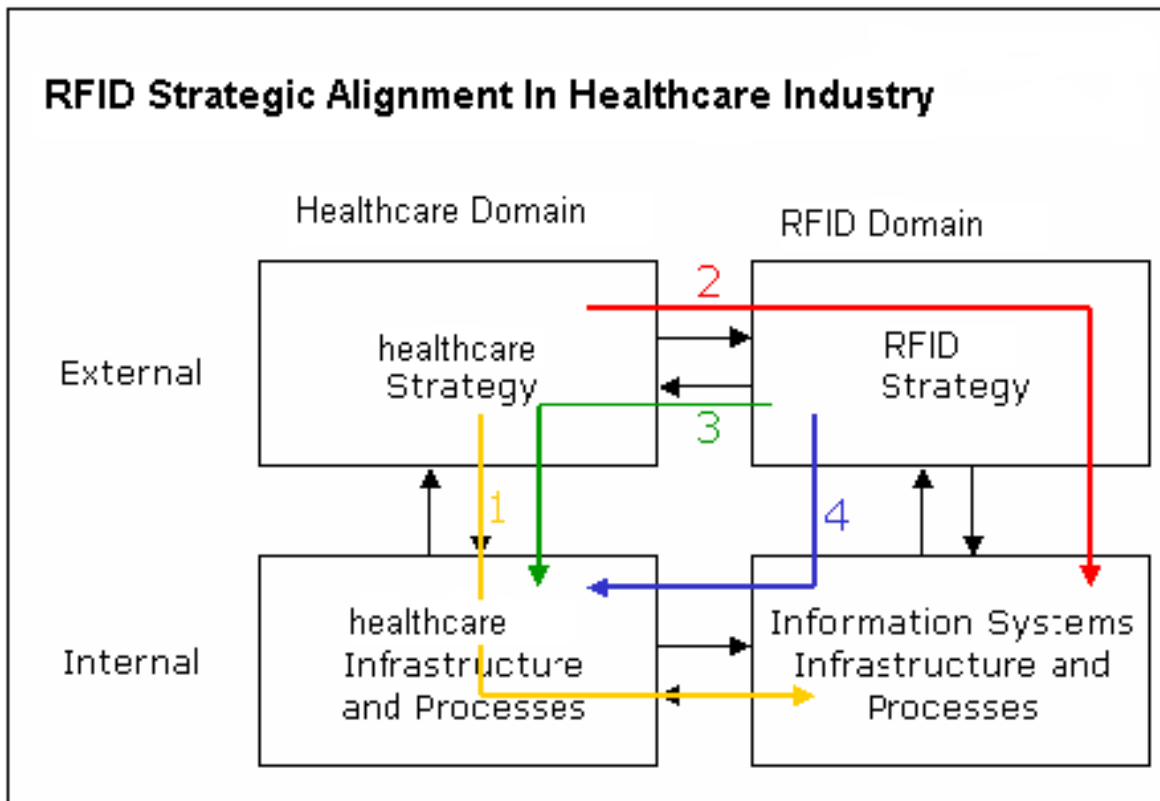
Appendix A:
Porter Five Forces Model and RFID analysis
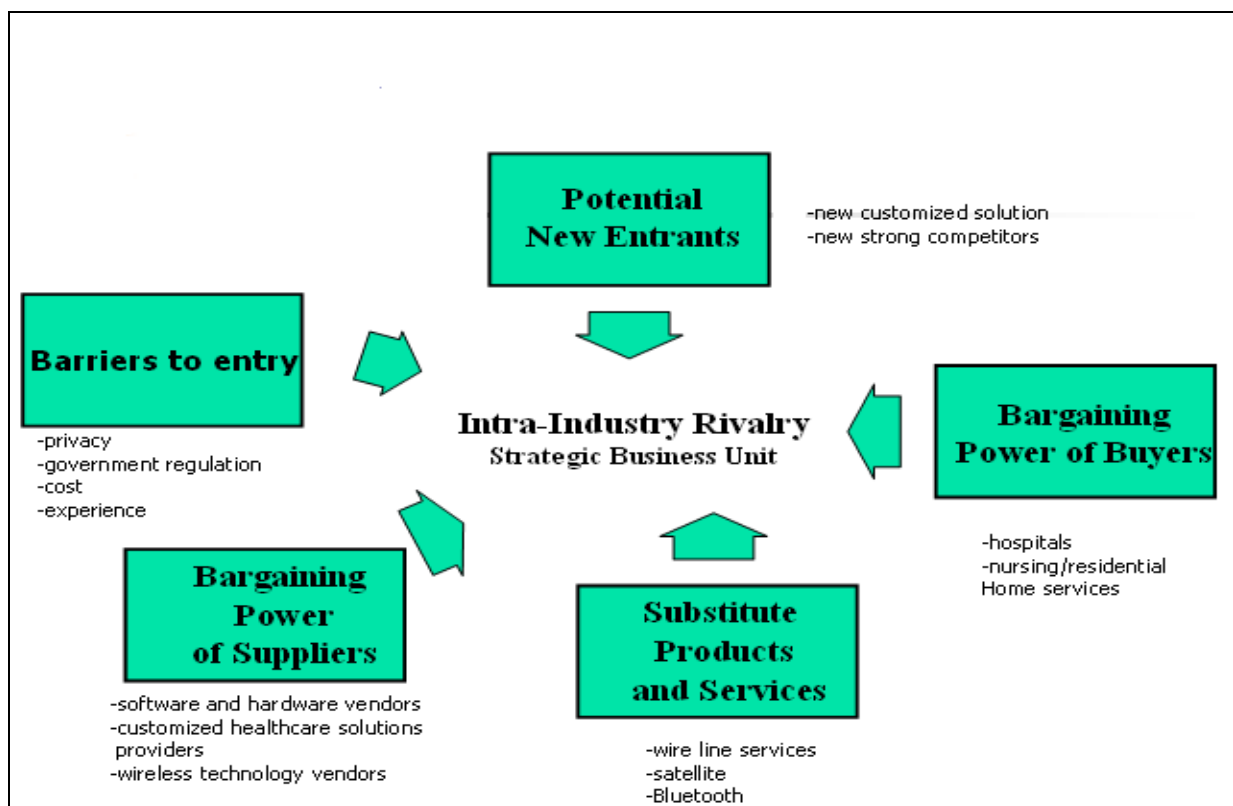
(adopted from Eyemaro, 2006).

Appendix B:

Alignment between healthcare strategy, IT Infrastructure and RFID strategy

(adopted from Venkatraman, Henderson and Oldach,2008)