# IMPROVING EMPLOYEE BEHAVIOR AND PATIENTS CARE BY ENHANCING MEDICAL IMAGERY TIMELINES RESULTS USING INFORMATION TECHNOLOGY

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**ABSTRACT:**

The meteoric rise of Information Technology Systems (ITS) has made humanity depended on technology. Many hospitals information systems are lacking behind and reaching their end of life (EOF) support. In today's technology advancement, it is expected that such development increases the care for patients while maintaining the quality and the safety of all stakeholders. In some countries, the hospitals experience budget constraints when they depend on the government agency to process the patients' payments Kornai (1979; 1986). This particular situation unable the hospitals to stick to the forecasted budget Maskin (1996). The author proposes a faster and a cost effective method of delivery of the medical imagery to the physicians.

**Keywords:** Information technology, Safety, Patient, healthcare, Radiology

## INTRODUCTION

Wilhem Conrad Röntgen, a German engineer discovered X-Rays in November 8, 1895. Since this invention, the successive development of imaging techniques has helped physicians to see the invisible and rely more on scientific based evidence to diagnose patients. The discovery stimulated the investigation of the electromagnetic wave with the human body which has led to two dimensional (2-D) and (3-D) images. In 1960, the technology started to have little impact on businesses. In 1970 the academicians focused on revenues and customer satisfaction had less importance. In 1980, the technology changed the businesses behaviors and became concerned about customer satisfaction. In 1990, the businesses started to use the world-wide-web to build relationships with the customers. In 2000, the communication across the globe grew exponentially and businesses reacted to change. In 2010, the technology became part of our daily lives. The information technology (IT) played a major role in different businesses since 1960 through 1980 except in the healthcare sector. The technology in hospitals failed behind other businesses in the industry due to ineffective information systems and shortage in resources. The challenge facing the healthcare industry today is disturbing because the cost of healthcare services

Roberson et al. (1998). The deployment of various IT equipment in the healthcare industry played a major role in increasing the cost of healthcare in particular the medical imaging equipment such as the radiology information systems (RIS) and the picture archiving and communications systems (PACS). The newly developed digital radiography imaging looks different from prior analog screen-film (SF) frame Bansal (2006). The screen-film radiology (SFR) system still have advantage over digital imaging. The physicians, the medical staff familiarity with the X-Ray, the simplicity and the information density of screen-film offers an advantage over the digital imaging Ritenour (1996). However, granting the physicians access to a digital image via a secure link to the patient' Dropbox or even forwarding a digital image via email or WhatsApp offers a faster service to patients in remote areas over a screen-film. In a hospital where budget is a constraint, the radiology technician can place the screen-film on the white light x-ray film viewer and use a digital camera in a dark room to capture x-ray image Szot et al. (2004). In turn, the tele-radiology is transferred to Dropbox and stored in a folder with the patient's name. The link to the folder is provided to the patient and to the referred physician. The hospital can follow this procedure to store patient's record such as laboratory test results and prescriptions on Dropbox. Sharing the patient's data in real time with multiple physicians in complex situation can save lives and improve the quality of care provided at the organization. The latest technologies discoveries enhanced communication tremendously and with some IT creativity the hospital can gain a competitive advantage over other hospitals in the region.

**Figure 1.** White Light X-Ray Screen-Film **Figure 2.** Captured Image Using Digital Camera

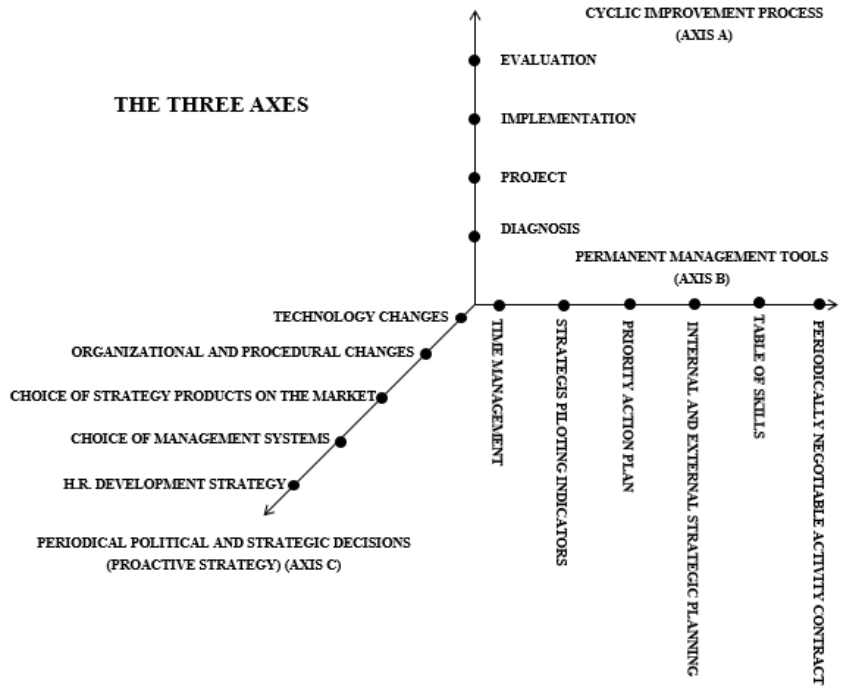
Adjusting the hospital procedure could save time and money on the patient, the physicians and the hospital staff without jeopordizing the quality and the safety of the patient. The radiology department does not need to provide a copy of the x-rayed image on a compact disc (CD) to the patient. In addition, the current practice of archiving medical images in house is adding a financial burden on the organization Chen et al. (2010). An alternative and a cost effective solution would be to use a cloud medical imaging services for archiving. The services provide appropriate confidentiality and simplifies the access of images from mobile devices. The cloud storage space can be increased on demand with few clicks. The information technology team does not have to deal with the storage upgrade, backup, ordering new hard drives and adding the drives to the

maintenance contract. In addition, the data on the cloud is protected, backedup and secured Kagadis et al. (2013).

## THEORETICAL MODEL

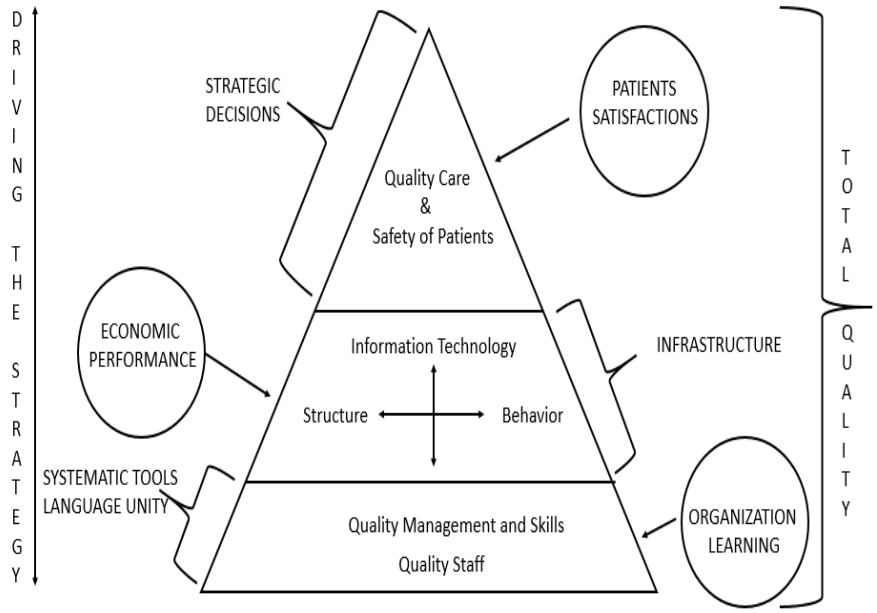
The theoretical research model of Henri Savall and his team have proven that each dysfunction is associated with five hidden costs indicators: absenteeism, injuries, turnover, product quality and quantity. A hidden cost is considered as an unrecorded cost in the organization financial accounting systems Savall et al. (2008). The triangular model aims to create a unified method of communication by deploying systematic tools throughout the entire organization. The method is built around three axes. The x- axis consists of training the chief executive officer and his team to follow a pre-defined set of communications method to insure quality and execution of pre-defined tools: priority action plan, periodically negotiable activity contract, internal and external strategic action plan, time management, strategic piloting indicators and table of skills. In turn, these tools are used horizontally and vertically throughout the entire organization. The y-axis aims to create a learning environment by forming a team of experts to conduct a participative action research to identify dysfunctions. The team is then trained to identify the associated hidden costs. The collaborative action research process and the repetitive test helps the creation of a generic knowledge to improve the quality of the processes Savall et al. (2008). The z-axis consists of training and helping the steering committee to take a decision to induce a change and drive the organization's strategy day-in-day-out by scientifically adjusting and eliminating useless procedures. It also provides upper management with scientific facts and reasoning to make a technology change to improve quality, safety and services in the organizations Cappelletti (2009).

**Figure 3.** The SEAM 3-Axes (© ISEOR 1997, 2009)




The theoretical model relies on leading authors in the field of scientific management like Frederick Taylor who worked on improving the skills of man's work using scientific method (Mark Bahnish, 2000), Henri Fayol who developed the business reporting structure (Daniel et al. 2002. P906-918), Maximilian Weber who enhanced the theory of ideal type of authority (Richard Kopelman et al., 2008, p255), Kurt Lewin organizational development, Ernest Lowe management control system,and Chris Argyris double loop learning. The approach is also based on lean management and total quality management described by Jim Womanck (Kollberg et al., 2006, p.7-24). Henri Savall follows the core values of organization development and management control systems but his model is unique in its methodology. The model bases its approach on empirical experiments results. The model aims to generate a generic knowledge. The research is longitudinal and requires a lot of back and forth approaches to construct a true knowledge.

**Figure 3.** Total Quality Driving the Strategy




The middle part of the triangular model encompasses: 1) forming the team effectiveness by building a functional organization structure molded together to meet strategic decisions of the company. 2) Defining the information technology equipment and systems required to guarantee quality of services.

The top part of the triangle consists of setting the strategic objectives, make them known to the entire staff in the organization and steer the team toward one common goal Conbere et al. (2011).

## RESEARCH METHODS

The research methodology is divided into two phases. The first phase of the research uses a semi-structured sample survey using a horizontal and a vertical approach to identify dysfunctions in the organization. The results, of the reflective survey analysis of the qualitative data variables, are grouped by theme, sub-theme and key-ideas to produce the mirror effect report. The dissection of the qualitative data reveals preliminary social and economic performances. The methodology uses Lewin (1947a) and Schein (1996, p.27) psychological approaches to destabilized the emotional state of the top management and put them into action to initiate projects to correct the dysfunctions based on the researcher expert opinion Burnes (2004). The second phase consists of using a participative action research methodology to create a generic knowledge. The investigation does not rely on the survey to from the knowledge because it is not a scientific approach. The research relies on the organization's team to correct the dysfunction and on the scientific observation to capture quality data. The empirical systematic research approach is longitudinal and requires ample amount of time to repeatedly test the proven method. The researcher uses a see-saw approach to collect, analyze and reproduce the concept to generate and replicate a generic knowledge Macintosh et al. (2007). The aim of the research is to transform the living knowledge into constructive learning theories. The ontological objective of the study is to determine the quality and safety of patients care and how they fit together with the effect of information technology on services. The research methodology uses the ontological and epistemological approaches and tools to capture a general knowledge. Since "the world we want to explore is a largely unknown entity" one research method is not comprehensive enough to generate pure knowledge Feyerabend (1975:20). The rational uses the qualitative inductive concept and the quantitative deductive approach to capture knowledge through an empirical observation and mathematical measurements to identify associated hidden costs and economic performances Keating et al. (2008).

**Figure 4.** Phase I & II of the Defined Methodology

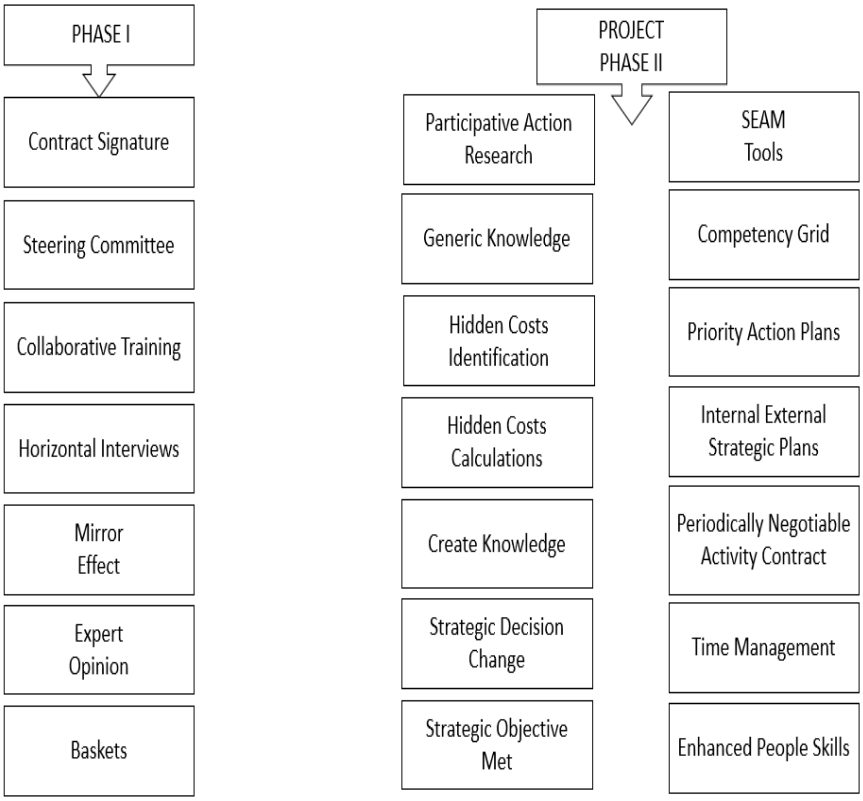
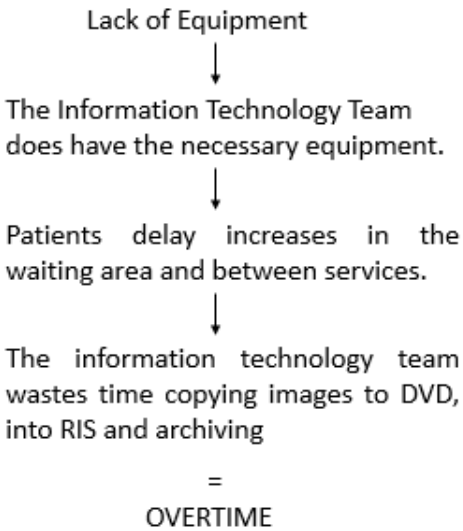
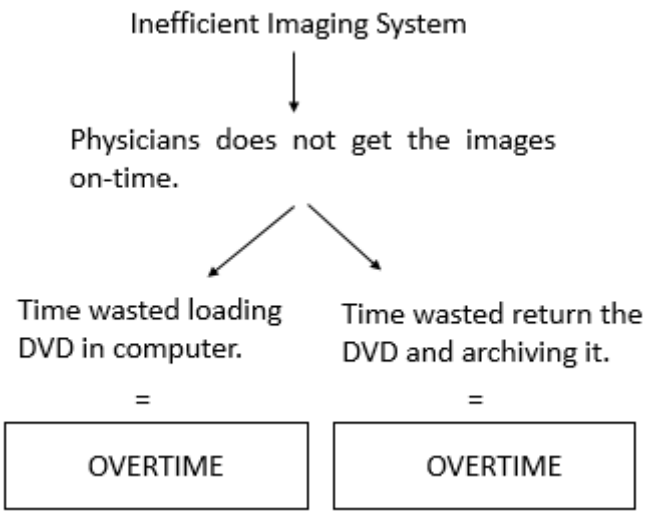



**Figure 5.** Evaluation of Hidden Cost – Direct Observation (Non-Quality 1)



The radiology information system is old and the patients have to wait on the information technology technician to manually burn the image on a DVD.

**Figure 6.** Evaluation of Hidden Costs – Direct Productivity Gaps




The systems in the hospitals are not inter-connected with each other which causes delay in delivering the image to the physician. It also takes about half a minute to load the DVD into the computer to view the image. At times, the physician experiences problems with the computer and will have to call the information technology team to rectify the problem with the DVD.

**Figure 7.** Evaluation of Hidden Cost – Direct Observation - Non-Quality (2)

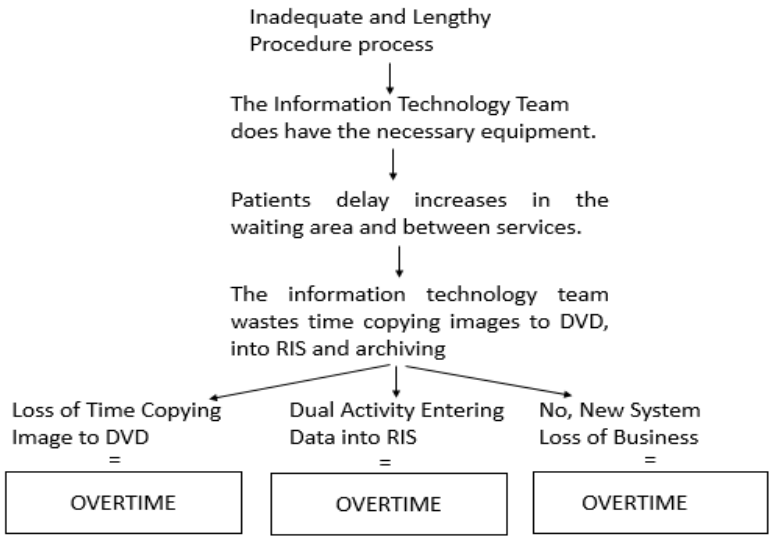


**Table 1.** Attributing Direct Labor to Fixed Expenditure (© ISEOR 1987)

| **Principle** | **Hospital – 400 employees** |
|---|---|
| Earnings | $24,468,925 |
| minus | |
| Variable expenditure based on aligned activity (personnel expenditures excluded) | -$6903600 |
| equals | |
| Gross margin on variable costs (MVC) | =$17,565,325 |

**Figure 8.** HCVAVC Calculations

| Hourly Contribution Value-Added Variable Cost (HCVAVC) | |
|---|---|
| Profit/Loss = | Sales – Variable Costs – Fixed Costs |
| CVAVC = | Sales – Variable Costs = $24,468,925 - $6,903,600 = $17,565,325 |
| HCVAVC = | CVAVC/Total Number of Hours Worked per Year |
| = | $17,565,325/1,048,800 = $16.774 |
| = | Rounding $17.00 |

Figure 8 represents the hourly contribution value-added variable cost calculation (HCVAVC). The total calculated value is used to calculate the hidden costs associated with the observed dysfunction. The finance officer provided the HCVAVC value off the hospital Profit and Loss Statement (P&L).

## ANALYSIS OF THE HIDDEN COSTS

Every dysfunctional activity is associated with monetary units of hidden cost Henri Savall (1974, p. 42). The individual semi-structured interviews confirm the direct observation of the data collection.

**Table 2.** Direct Observation Grid (© ISEOR 1974)

| Dysfunctions | Regulations | | Invoices + Observations |
|---|---|---|---|
| | Nature | Time | |
| Manual Labor<br>Absence of an effective information systems<br>Absence of a decentralized storage | 2 IT people waste 8 hours a day copying ECHO, RADIO, ERM, Mammogram and SCANNER into HIS. | 2920 hours/year | Daily duties and must keep images for five years per government contract. |
| Manual Labor<br>Absence of a decentralized storage | 1 IT person wastes 3 hours a day archiving returned DVD. | 730 hours/year | Daily duties and must keep images for five years per government contract. |
| Absence of a universal language | 2 people wastes 8 hours a week correcting tickets in helpdesk. | 416 hours/year | Poor System Indicator |
| Absence of a decentralized storage | 1 person wastes 1 hours a day looking for archived DVD | 365 hours/year | Lack of space and must keep data for 5 years per government contract |

**Table 3.** Evaluation of Hidden Costs (Diagnosis Name: Absenteeism)

| Cited Causes of Dysfunctions | Indicator | Economic Impact | | |
|---|---|---|---|---|
| | Frequency | Calculations | Over-Time | Total |
| Current equipment requires upgrade | 2 days | 2 employees are absent 2 days a year. (2PX$17X16HRS) | $544 | $544 |
| Current Digital Images are backed up to DVD | 2 days | 1 employee is absent 2 days a year. (1PX$17X16HRS) | $272 | $272 |
| Application lacks many fields | 2 days | 2 employees are absent 2 days a year. (2PX$17X16HRS) | $544 | $544 |

The evaluation of the hidden costs table shows the quality defects diagnosis of the dysfunctions, roots causes, frequency, and its economic impact.

**Table 4.** Synthesis of Hidden Cost Evaluation

| Indicator | Qualitative Results | Quantitative Results | Financial Results | Amount |
|---|---|---|---|---|
| Absenteeism | • Equipment requires update<br>• Backup daily images to DVD<br>• Free helpdesk applications lack fields | • 16 hours of absences<br>• 16 hours of absences<br>• 16 hours of absences | • Additional Hours<br>• Additional Hours<br>• Additional Hours | $272<br>$272<br>$272 |
| Quality Defects | • ECHO, RADIO, ERM, MAMMOGRAM and SCANNER are not included in HIS | • 6112 hours of manual labor | | $103,904 |
| | • Lack of Electronic Filings<br>• Inadequate Helpdesk System | • 730 hours of manual archiving<br>• 832 hours correcting tickets in helpdesk ticketing system | | $12,410 |
| | • Lack of Reading Skills | • 1825 hours spent reading tickets to illiterate technicians | | $14,144 |
| | | | | $31,025 |
| Direct Productivity Gaps | | | | $63784 |

The calculation of the hidden costs is based on absenteeism, quality defects, and direct productivity gaps.

**Table 5.** Evaluation of Hidden Costs (Diagnosis Name: Quality Defects)

| Elementary Dysfunctions | Cited Causes of Dysfunctions | Indicator | Economic Impact | | |
|---|---|---|---|---|---|
| | | Frequency | Calculation Details | Over-Time | Total |
| ECHO, RADIO, MAMMOGRAM and SCANNER are not included in the system | Current equipment requires upgrade | 12 months | 2 employees waste 8 hours a day copying ECHO, RADIO, ERM, MAMOGRAM AND SCANNER into the his. (2px$17x2920hrs) | $99,280 | $99,280 |
| Lack of electronic filings | Current digital images are backed up to DVD. | 12 months | 1 employee wastes 3 hours a day archiving returned DVD. (1px$17x730hrs) | $12,410 | $12,410 |
| Helpdesk software application | Application lacks many fields | 12 months | 2 employees waste 8 hours a week correcting and entering helpdesk tickets to generate weekly report. (2px$17x416) | $14,144 | $14,144 |
| Lack of reading skills | Lack of competency | 12 months | 5 employees cannot read the tickets and manager has to manually assign each ticket to technicians. (1px$17x365hrs) | $6,205 | $6,205 |

The direct productivity gaps diagnosis table summarizes the root causes, the frequency of the dysfunctions along with its economic impact.

**Table 6.** Evaluation of Hidden Costs (Diagnosis Name: Direct Productivity Gaps)

| Elementary Dysfunctions | Cited Causes of Dysfunctions | Indicator | Economic Impact | | |
|---|---|---|---|---|---|
| | | Frequency | Calculation Details | Over-Time | Total |
| ECHO, RADIO, MAMMOGRAM and SCANNER are not included in the system | Current equipment requires upgrade | 12 months | 1 employee wastes 3hours a day looking for a DVD due to insufficient place for archiving. (2px$17x1095hrs) | $37,230 | $37,230 |
| Lack of electronic filings | Current digital images are backed up to DVD. | 12 months | 1 employee wastes 1 hour a day archiving returned DVD. (1px$17x365hrs) | $6,205 | $6,205 |
| Helpdesk software application | Application lacks many fields | 12 months | 2 employees waste 8 hours a week away from duties. (2px$17x416) | $14,144 | $14,144 |
| Lack of reading skills | Lack of competency | 12 months | 5 employees cannot read the tickets and manager has to manually assign each ticket to technicians. (1px$17x365hrs) | $6,205 | $6,205 |

The table below demonstrates a breakdown of the main hidden costs indicators calculated based on Absenteeism, quality defects and direct productivity gaps.

**Table 7.** Overview of Hidden Costs by Indicator and Component

| | Over-Time | Total |
|---|---|---|
| Absenteeism | $1,360 | $1,360 |
| Quality Defects | $132,039 | $132,039 |
| Direct Productivity Gaps | $63,784 | $63,784 |
| Total | $197,183 | $197,183 |

| | |
|---|---|
| 3 People in the division, information technology | $65,727<br>Per person and per year on Average |

**Table 8.** Provisional Outcome of the Hospital Research Project (© ISEOR 1977)

| Costs | | | | | Benefits | |
|---|---|---|---|---|---|---|
| Cost Increase | | | | | Benefit Increase | $38,097 |
| Tangible Investments | | | | | Save a total of 2241 hours for searching for DVD for the proper patient with the proper images. | |
| Cloud storage services are accessed via desktop, tablet or smartphone | | | | | Increase physician efficiency and performance | |
| Service Type | Traffic | Hours | Total Yearly Cost | | Provide better healthcare attention to the patient by allowing other physicians to review the patients' cases remotely. | |
| Data Transfer | 30TB Outgoing | | $28,872 | $28,872 | The information technology team will not have to worry about the flood of data, | |
| VPN | | $744 | $311 | $311 | The data is encrypted to keep the health of the patient confidential. Each patient will have his/her own username and password. | |
| Internet | 5MB up/down | unlimited | $12,000 | $12,000 | | |
| Total | | | | $41,183 | | +$38,097 |
| Conversion of IT Hidden Costs into added-value | | | | $128,400 | | |
| | | | | ($128,400) | | ($38,097) |
| Overall Costs | | | | ($87,217) | | ($125,314) |

- Total Monthly Cost = $33.99/100GB Data Transfer Prices quoted by Microsoft Lebanon as of March 14, 2016 at 7:31pm Assuming 30TB
- Data Transfer Monthly Cost = $24,06 => (30,000GBX$8.02)/(100GBX12) = $28,872
- Yearly VPN Cost = 12X$25,97 = $311
- Total Internet Yearly Cost = 12X$1,000 = $12,000

## EMPIRICAL RESULTS AND AMBITIOUS PROJECTS

The participative action research resulted in an annual cost $65,727 loss per person per year in the information technology department. The calculation of the economic balance sheet reflected a benefit of $125, 314 if the proposed solution is implemented. The research also showed that the patients' quality and safety could be improved if the radiology image is delivered faster to the physicians for diagnosis. There is a need for literature to connect the dots between management control and information technology. The financial indicators show hidden costs related to old equipment and how it is affecting the quality and safety of the patients in a healthcare environment. The information technology manager needs to speak numbers with the finance officer to show the importance of upgrading the radiology information systems. He also needs to demonstrate how old equipment are actually causing delays in responding to the patients' needs. The demonstrated example is a first try and should be tested in other hospitals in the

future. The strategic outcome of the intervention minimized dysfunctions, improve behaviors, reduced hidden cost, cleaned nuisance tasks, and improved economic performance in the hospital. Most of the dysfunctions were caused by invisible external factors affecting the operation of the information technology department.

As far as the future ambitious projects go, we intend to investigate the root causes of patients delay in the hospital and its relationship to information technology and human behaviors. We will adopt the same research model to further confirm the validity of the scientific approach.

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