

The Challenge of Implementing Health Information Systems - *a case study in Charlotte Maxeke Johannesburg Academic Hospital*

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Opsomming

Die tesis ondersoek die faktore wat Gesondheidstelsels (HIC) ingewikkeld maak. Die fokus is op a) doeltreffendheid, en b) bruikbaarheid (uit gebruikersoogpunt). 'n Gevallestudie word gemaak van 'n stelsel wat onlangs by Chalotte Maxeke Johannesburg Akademiese Hospitaal in gebruik geneem is. Die eerste doelwit van die ondersoek was om die ingewikkeldheidsgraad van sodanige stelsels te probeer bepaal, en tweedens om die situasie in die hospitaal self te evalueer.

In hoofstuk 1 word die agtergrond en aanleiding tot die ondersoek uiteengesit, soel as die metodologiese keuses wat gemaak is.

Hoofstuk 2 bied 'n oorsig oor relevante literatuur ten opsigte van HIC. Dit is duidelik stelselontwikkeling riskant, onnodig duur en koersloos is as dit sonder 'n duidelike metodologie geïmplementeer word. Verandering vind voortdurend plaas en die implementering van operasionele doeltreffendheid mag vernadering in besigheidstrategie, informasiesistelsels, kennisbestuur en prosesoriëntasie noodsaaklik maak.

In hoofstuk 3 word bruikbaarheid ondersoek. Verskeie mediese instellings het soortgelyke stelsels in gebruik geneem, maar die bruikbaarheid daarvan is steeds onseker. Vir die doeleindes van hierdie tesis is 'n eie evaluasie metode ontwikkel en 'n vraelys op grond daarvan opgestel.

Hoofstuk 4 rapporteer die gevallestudie in Charlotte Maxeke Johannesburg Akademiese Hospitaal hospital. Datakolleksie, navorsingsafbakening en – beperkinge, sowel as vraelysresultate word aangebied.

Hoofstuk 5 bespreek die implikasies en toepassings van HIC. Dit blyk dat die voordele van die stelsel slegs deur die pasiëntadministrasieafdeling geniet word. Alle ander afdeling gaan steeds voort met papiergebaseerde inligtingstelsels, aangevul deur ad hoc gebruik van Excel en woordprossering.

Die tesis kom tot die gevolgtrekking dat kliniese personeel avers is teen die gebruik van geoutomatiseerde informasiesistelsels.

Summary

This thesis investigates the complexities involved in Health Information Systems. The focus is on the factors of a) efficiency and b) usability. A case study is made of a recently implemented system in Charlotte Maxeke Johannesburg Academic hospital. The first objective of the research was to gain a deeper understanding of the complexities of Health Information Systems, and secondly to evaluate the situation at Charlotte Maxeke Johannesburg Academic Hospital.

In Chapter 1 a detailed introduction of the thesis is offered. This includes, explaining what triggered the research, the objective of the research and the methodology used to conduct the research.

In Chapter 2 the focus is on a literature review of Health Information Systems, system fundamentals and planning and implementation. It is clear that without a methodology, systems development becomes haphazard and subsequently a risky and expensive undertaking. While change is pervasive, introducing operational efficiencies sometimes may necessitate reviewing of information systems and business strategy, knowledge management and process orientation.

In Chapter 3 the issue of usability is investigated. Several healthcare institutions have implemented information systems but evaluations of the usability of these systems are still under debate. For purposes of this research an evaluation method for system usability and survey questionnaires were developed.

In Chapter 4 the case study of Charlotte Maxeke Johannesburg Academic Hospital is reported. The chapter also describes the data collection design, research limitations and delimitations, survey findings and interpretations.

In Chapter 5 the implications and applications of Health Information Systems are discussed. After analysis of the survey results, it appears that the impact and benefits of the new Health Information System are only positive or realized in the patient administration division. The rest of the health professionals continue to manually capture clinical notes and other management information on pieces of papers, spread sheets and word documents.

The thesis comes to the conclusion that despite widespread use of technology in other sectors, clinicians in hospitals do not use implemented automated systems. Implementation of systems is complex and problems associated with usability are not resolved and that traditional systems implementation methodologies may not apply.

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LIST OF ABBREVIATIONS

AHRQ	Agency for Health –care Research & Quality
BHAG	Big Hairy Audacious Goal
BI	Business Intelligence
CEO	Chief Executive Officer
CPU	Central Process Unit
DOI	Diffusion of Innovations
EHR	Electronic Health Record
EIS	Enterprise Information System
ERP	Enterprise Resource Planning
HISs	Health Information System
HISs	Health Information Systems
HIT	Health Information Technology
IOM	Institute of Medicine
IS	Information System
IT	Information Technology
KM	Knowledge Management
NIH	National Institute of Health
NIST	National Institute of Standards & Technology
PC	Personal Computer
SDLC	Systems Development Life Cycle

Chapter 1

Introduction

1.1 Health Information Systems

As the world's population increases, and as a significant proportion of living human beings live longer than ever in history, health issues are becoming more prominent in politics and economies. It is, therefore, no surprise that the world of information technology (IT) has linked up with the medical world and the field of health information systems (HISs) and has grown into a special focus area in the circles of Information and Knowledge Management.

Nowadays, it is generally accepted that information systems are more intricate than most people anticipated; they have a high rate of failure or under-performance. It is by no means certain that a newly installed system will bring a return on investment. HISs seem to be even more prone to being dysfunctional than conventional systems in business organisations.

This thesis focuses on the phenomenon of an HIS as a unique sub-set of information systems.

Interest in this topic was triggered by actual exposure to the implementation of a new HIS at the Charlotte Maxeke Johannesburg Academic Hospital. As will be described later, this new HIS did not deliver the results that were popularly (and maybe naively) expected. Of course, the question raised is why?

In 2001, the Gauteng Provincial Government in South Africa implemented an HIS, called Medicom that was developed in India and rolled out in various public health institutions at tertiary, secondary and primary levels. Since 2001, the Gauteng Provincial Government has been moving towards the centralization of hospital data; thus Medicom is a transversal system.¹ The Charlotte Maxeke Johannesburg Academic Hospital was one of the first

¹ A transversal system is one that is managed centrally, but implemented in different organizations.

academic hospitals to implement this system. To date, of the research for this thesis (2010), the Charlotte Maxeke Johannesburg Academic Hospital has still experienced problems in retrieval of patients' records, clinical notes were still manually captured, patient files/records could not be traced, at times patients could not be found in the hospital, and patients' statistics/reports were calculated manually for presentation to management for discussions. Clinical staff did not use the implemented system but preferred to continue with manual processes. The system was mostly used in patients' biographical data, appointments, and admission administration.

1.2 The Research Project: Assumptions and Objectives

It is quite clear that the situation at the Charlotte Maxeke Johannesburg Academic Hospital is another case of the HISs not delivering on their promises. As such, this provides fertile ground for a case study.

At present in South Africa, given the context of many government-run departments that are characterised by very sloppy management and low morale, it is tempting to ascribe the relative failure of the HIS in the Charlotte Maxeke Johannesburg Academic Hospital to work ethic, managerial or cultural factors. However, such an approach fails to appreciate that HISs fail also in other parts of the world where the work ethic, managerial and cultural factors are vastly different. Thus, the failure cannot be ascribed only to incompetence on the part of workers in the hospital. In fact, most of the staff are highly dedicated to their work and work for long hours under high levels of stress.

A proper analysis and interpretation of the case of the Charlotte Maxeke Johannesburg Academic Hospital has to take its point of departure in the assumption that work in a medical environment is inherently complex, which impacts on the HIS. In its own right, a system may be well structured and integrated, but that does not necessarily mean that it will be experienced as useful in relation to the work practices already established in the workplace where it is to be implemented.

When an HIS is chosen and implemented - even in the (unlikely) event of a work force and work practices being totally unmotivated and incompetent - the question remains: Does this particular HIS interface with the prevailing work practices, or does it, at least, promise to do so?

Framing the question in this way indicates the entry point of this thesis into the study. This thesis approaches the case from the perspective of the factor of *Usability*. The analysis of the

case at hand is done to determine the *usability level* of the Charlotte Maxeke Johannesburg Academic Hospital's HIS and, in the process, to identify those factors that impede the system's usability.

The entry point into the study of usability does not preclude attention to human factors [such as (in)competence] and technical factors [such as systems' (in)efficiency], but a usability approach weaves such factors into a more holistic understanding of the situation. The highest level of competence, coupled with the highest level of technical efficiency, may nevertheless not deliver a useful system.

In exploring the usability factor in the case of the Charlotte Maxeke Johannesburg Academic Hospital, it was borne in mind that, in essence, an information system is a technical structure. So, when a new information system is implemented, users may decide either to adopt or resist it based on the evaluation of change associated with the system. This suggests that a common theoretical basis is possible for explaining user acceptance and resistance.² Literature re technology acceptance was used in examining user resistance and system usability; so, this thesis gives shape to the notion of "usability." Research on technology acceptance has attracted several theoretical perspectives including the technology acceptance model, the theory of planned behaviour and, recently, the unified theory of the acceptance and use of technology.

In light of the foregoing:

- i. This thesis is a case study of HISs' usability (the case being that of the Charlotte Maxeke Johannesburg Academic Hospital).*
- ii. The case study attempts to profile the special characteristics that prevail in Charlotte Maxeke Johannesburg Academic in light of present HIS theory, and*
- iii. Attempts to draw conclusions from the particular case that might enrich general HIS theory and insight.*

1.3 Methodology and Research Design

Although information systems consist of combinations of hardware, software and "connection-ware," an information *system* is actually a conceptual construct. What makes it a system lies not in its visible dimension, but how the visible components are linked and used.

Therefore, a study of an information system necessarily comprises both a conceptual and an

² Kim & Kankanhalli. 2009. User resistance to IS implementation. *Journal of MIS Quarterly* (33)3, 567-582.

empirical dimension. In this thesis, this also is the case.

Using a wide scan of relevant HIS literature, an understanding of the complexities of an HIS was built up. As pointed out above, the focal point in the literature analysis is the notion of usability and technology acceptance. The purpose of the literature analysis was to establish a conceptual framework against which the realities of the Charlotte Maxeke Johannesburg Academic Hospital could be interpreted on the basis of empirical work.

The empirical part of the research took the form of a survey, which was constructed on the basis of the literature and theory analysis, with the specific context of the Charlotte Maxeke Johannesburg Academic Hospital in mind. In light of the results of the survey, several follow-up interviews were conducted with selected respondents.

To bring the empirical work into the realm of feasibility, the survey and follow-up interviews were conducted in only one section of the hospital.

1.4 Thesis Layout

The thesis is laid out as follows:

Chapter 2 presents the findings from the literature analysis of information systems in general, and in HISs in particular.

Chapter 3 zooms in specifically on the notion of usability, complexities around usability and operational efficiencies, and survey methods to assess the impacts of HISs.

Chapter 4 deals with methodological issues related to empirical dimensions of the case study, data collection design and findings.

Chapter 5 discusses implications and applications for both an HIS and the Charlotte Maxeke Johannesburg Academic Hospital.

Chapter 2

Health Information Systems – a Literature Analysis

2.1 Introduction

HISs are clinical support tools with the potential to reduce the strain on the clinicians' memory and cognition, while improving efficiency in workflow and effectiveness in the quality of care and coordination. The increased availability of patient information and decision support at the point of care has tremendous potential for the reduction of errors and improvement of the delivery of evidence-based care. The evolving role of an HIS can be organized around the following four primary functions:

- i. Memory aid: It reduces the need to rely on memory alone for information required to complete a task.
- ii. Computational aid: It reduces the need to group, compare, or analyse information mentally.
- iii. Decision support aid: It enhances the ability to integrate information from multiple sources to make evidence-based decisions.
- iv. Collaboration aid: It enhances the ability to communicate information and findings to other providers and patients.

HISs that support the process of health care, without being directly relevant to patient care, are less easily accepted. In particular, attempts to introduce health care information systems that require health care providers to enter data, have not always been successful.³ To determine success depends on the setting, the objectives, and the stakeholders; only a

³ Van der Meijden MJ, Tange J, Troost J & Hasman A. 2003. Determinants of success of inpatient clinical information systems. *Journal of the American Medical Informatics Association* 10(3), 235–243.

thorough evaluation study can show whether or not a specific system was successful in a specific setting.

If a hospital intends to use computer-based records systems to manage patient care across a continuum of care, then all those who provide direct patient care must accept these systems, but acceptance is not universal. Understanding acceptance⁴ of computer-based medical record systems will require the assessment of many different users' views in many different settings.

2.2 Planning, Design and Implementation of Health Information Systems

Planning for the implementation of HISs requires participation of, and input from, every area in an organization, whether or not it is immediately obvious that an area would be affected. To maximise operational success, medical and administrative leadership must espouse a culture of change. New systems necessitate new operational processes; thus, when implementing systems, a structured process needs to be followed.

Various life cycle models exist for a structured approach to systems development. Many different layouts of a systems development life cycle⁵ (SDLC) exist; however, they all accomplish the same thing from start to finish. Some have four steps while others have as many as twelve -depending on how the phases are expanded.

Without a methodology system, development becomes haphazard and, subsequently, a risky and expensive undertaking in terms of cost, schedule and quality. To mitigate this risk, the National Institute of Health (NIH) established the following enterprise principle for its architecture:⁶ “Developers and maintainers of enterprise applications will have a documented systems development life cycle (SDLC).”

Each organization establishes an SDLC methodology and assigns responsibility for each phase of the cycle, so that system design, development and maintenance may progress smoothly and accurately. The SDLC provides a structured and standardized process for all phases of any system development effort. These phases track the development of a system through several development stages: from feasibility analysis, system planning and concept development; to acquisition and requirements definition; design; development; integration

⁴ Drazen Erica. 1995. *Patient care information systems – Successful design and implementation*. ISBN 0387942556.

⁵ Carr Jonathan. 2006. Systems development life cycle framework. <<http://www.atlaseditorials.com/2008/04/01/the-systems-development-life-cycle-sdlc/>> Accessed 26 May 2008.

⁶ Mckay R. 2006. National Institutes of Health. Best community practice.

and testing; deployment and acceptance; through deployment and production; and finally to the system retirement.

Lifecycle management⁷ is a systematic, controlled concept to manage and develop systems and systems-related information. From the initial idea, it offers management and control of the system process (its development and marketing) as well as the order-delivery process and the control of system-related information throughout the system's lifecycle.

The traditional SDLC⁸ has project planning in phase 1, and moves to analysis and requirements gathering in phase 2. Once both technical and user requirements for a project are obtained, the design of the system is embarked upon in phase 3. When the design has been finalized in phase 4, implementation (i.e., programming) of the system is undertaken. Finally, in phase 5, the system will be in place and must be supported and maintained until it is eventually phased out, replaced, or modified by a new system that leads to a new cycle of development.

The most common means of acquiring the clinical information system's capability for the enterprise has been a "best-of-breed" or "plug-and-play" approach of individual or ancillary systems, inpatient and ambulatory electronic medical record functions tied to a common repository, with an online offering of active clinical decision support and report writing.

The belief that some clinical system components *must* be integrated with certain other ones, is gaining wide industrial acceptance and is, in fact, becoming more commonplace. Ultimately, the use of an enterprise HIS is now more than a mere transaction-based, real-time functioning system that tracks patients through a seamless care delivery continuum, i.e., pre-service, point of service and post service, with organizational support interventions as part of the value chain of care delivery. Its use in a wide array of purposes, as outlined below, is not exhaustive:

- i. Clinical decision support that generates case-specific advice;⁹
- ii. Managing clinical competency;
- iii. Maintaining cost control;
- iv. Monitoring medication orders, avoiding duplicate or unnecessary tests;

⁷ Saaksvouri Antti & Immonen Anselmi, 2002. *Product lifecycle management*. 2nd edition. ISBN 3-540-25731-4.

⁸ Anderson G James & Aydin E Carolyn. 2005. Evaluating impact of health-care information systems.

⁹ Wyatt J & Spiegelhalter DJ. 1991. Evaluating medical expert systems: What to test and how? *International Journal Medical Informatics* 15(3), 205-218.

- v. Support of patient safety;
- vi. Clinical research; and
- vii. Education of future caregivers.

Identifying the need for an EIS is a far simpler task than engaging it in the actual strategic planning, capital allocation, acquisition and implementation. Today, much of the driving clinical need centres around efforts at enhancing patient safety, patient satisfaction, throughput and the demand for quick and accurate access to clinical information, in order to provide not only quality patient care, but also to access real time information for crucial leadership decision making.

Health-care professionals expend an inordinate amount of time creating a safe environment in which clinicians can deliver quality care. Delays in treating a critically injured patient can be fatal. Consequently, clinicians expect immediate and accurate clinical information to assist them. Health-care providers recognize the inherent advantages of an integrated software approach, which an EIS provides in terms of the speed and accuracy of information.

Health-care organizations are complex structures, the peak performance of which is measured in their quality of patient care. Each new day requires the effective integration and coordination of professional, support, and administrative staff, sophisticated clinical and information technology, critical processes and inventories, and facility resources. Changes within the organization, such as growth, innovation, patient demographics and financial fluctuation, continually impact on the environment and place a strain on information management, decision making and quality management processes. Only with specialized direction and oversight of the systems and processes in place, can health-care organizations confidently optimize resource and capacity utilization, and thus ensure the effectiveness of the system(s) and process(es).

Although prior research suggests that ITs can enhance firms' operational and financial performance, the dynamics of their impacts are more complex than was initially expected.¹⁰ Recent research has utilized the theoretical lens of complementarities as a way of explaining how, and why, firms could utilize ITs in producing superior performances.¹¹ Many empirical studies have examined complementary effects of the integration of IT applications with

¹⁰ Barua, K & Mukhopadhyay T. 2000. Information technology and business performance: Past, present and future. In RW Zmud ed. *Framing the domains of information technology management*. OH: Pinnaflex Press.

¹¹ Sambamurthy V, Bharadwaj A & Grover V. 2003. Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *Journal of MIS Quarterly* 27(2) 237-263.

specific organizational processes.¹² Other researchers have studied complementarities at the level of the enterprise. However, complementarities could also be viewed in terms of the integration of information technologies within a cumulative set of business processes - referred to as “activity systems.” Most contemporary firms seek to digitize entire activity systems, spanning customer relationships, operations, financial as well as human resource management through a portfolio of ITs. Therefore, the performance effects of IT should also be evaluated, not just within specific business processes, but also in the context of entire activity systems.¹³

Researchers also acknowledge that the nature and level of the use of ITs play a key role in the extent to which their impacts on performance are captured.¹⁴ The “digitization of activity systems” refers to the level of ITs’ use within the activity system.

To design an HIS project¹⁵ so that it succeeds, means building the right team, selecting the right content for the system, detailing the site management process, putting the pre- and post-launch measurements in place to gauge effectiveness and user satisfaction, developing a system promotional plan, conducting training on the uses and abuses of the organization’s electronic space, and making a host of diverse other procedural and policy-related decisions.

2.2.1 Initiation

Project identification is the first phase of the SDLC. Projects are identified by both top-down and bottom-up initiatives. The formality of the process of identifying and selecting projects vary substantially across organizations.

The main objective of the initiation stage¹⁶ is to gather adequate information to define the problem to be solved. It should also provide sufficient economic, operational, and technical information to determine the project’s feasibility. Prior to committing funding and resources, the key output of this phase will be knowing exactly what the scope of the project is, including the project timetable with milestone dates and resource estimates, as well as a formalized approval/authorization, or disapproval of the project, based on the project’s

¹² Pavlou PA & El Sawy OA. 2006. From information technology leveraging competence to competitive advantage in turbulent environments: The case of new product development. *Journal of Information System Research* 17: 198-227.

¹³ Kalakota R & Robinson M. 2003. *Services blueprint: Roadmap for execution*: Addison-Wesley

¹⁴ Devaraj S & Kohli R. 2003. Performance impacts of information technology: Is actual usage the missing link? *Journal of Management Science* 49(3) 273-289.

¹⁵ Wolper F Lawrence. 2004. Health care administration – Planning, implementing and managing organized delivery systems.

¹⁶ Marcella J Albert Jr & Stucki Carol. 2001. Process development life cycle.

definition.

2.2.2 Analysis and Requirements

The system analysis is the stage of the cycle in which you determine how the current information system functions, and assess what users would like to have in a new system. There are three sub-phases in analysis, that is, determination of requirements, structuring and alternative generation of requirements, and choice.¹⁷ The analysis and requirement statement should provide a written description of the user's needs, any effect(s) upon business, and the value of expected benefits. The document should outline the business functions to be addressed, deficiencies in existing capabilities, new or changed program requirements, the organizations or departments to be impacted, opportunities for increased economy and efficiency, and interdependencies between the organizations/departments and other systems.

An important (but not only) result of system analysis and requirements, is the application software, that is, software designed to support a specific organizational function or process.

Those who work in the domain of a hospital's information systems, are quite amazed at the field's intrinsic complexity. A patient needs care at different levels around the clock, therefore, work shifts require their own communication needs. During the analysis, because of the high amount of existing cooperative work, designers need to understand the relationships and interdependencies among single activities. From an organizational perspective, they have to identify and understand joint cross-departmental tasks in a broad manner.

Another source of complexity lies in the heterogeneity of the involved user groups and their often competing requirements, while, at the same time, design an integrated system to connect the different groups. Designers must apply agreeable solutions together with representatives of the different units - this creates another guideline.¹⁸ Handle the complexity of competing requirements by initiating on-going negotiation processes.

2.2.3 System Development

The software development plan should define how the new/enhanced system will meet the users' needs. This plan should include a definition of the technology that will be utilized and the approach to be followed for different types of models to be created to help record and

¹⁷ Hoffer Jeffery A, George Joey F & Valacich Joseph S. 2002. *Modern systems analysis and design*. ISBN 0-13-033990-3.

¹⁸ Adi Armoni. 2000. Health-care information systems: Challenges of the new millennium.

communicate what is required. Then, two types of system models are developed. The requirement model (or a collection of models) is a logical model that shows, in great detail, what the system is required to do, without committing to any one technology. The physical model shows how the system will actually be implemented. A physical model of the output would include details about its format.

The difference between logical and physical models is a key concept that distinguishes between the analysis and design of systems. In general, systems analysis involves the creation of detailed logical models, and systems design involves detailed physical models.¹⁹

Systems requirements include all the capabilities and constraints that the new system must meet. Generally, analysts divide system requirements into two categories: functional and technical.

Functional requirements are the activities that the system must perform, that is, the business to which the system will be applied. They derive directly from the capabilities identified in the planning phase. Functional requirements are based on the procedures and rules that the organization uses to run its business. Technical requirements include all the operational objectives related to the organization's environment, hardware and software.

2.2.4 System Implementation

The implementation phase is the most labour intensive and critical in terms of flawless execution. During this phase, the organization must deliver infrastructural activities, such as data/wireless networking, desktop and point-of-care device deployment, and, potentially, data centre build-out. Concurrently, the organization will have to deliver application design, build, and deployment (if implementing a new HIS), or deployment of the inherited HIS.²⁰

The implementation of an HIS causes changes in the entire work's organization. Designers must initiate infrastructure for organizational development, together with appropriate techniques. These techniques should provide clear and comprehensive representations of the existing, as well as that of the future, work organization, along with step-by-step system introduction.

With the organization of quality assurance, the user validates that the functional requirements, as defined in the functional requirements document, satisfy the developed or

¹⁹ Satzinger W John, Jackson B Robert & Burd Stephen D. 2002. *Systems analysis and design – In a changing world*. 2nd Edition.

²⁰ Lynne A King *et al.* 2002. The digital hospital: Opportunities and challenges. *Journal of Health-care Information Management* (17)1, 37-45.

modified system. The system, or its modifications, are installed and made operational in a production environment. This phase is initiated after the user has tested and accepted the system, and continues until the system operates in production in accordance with the defined user requirements.

During this phase, the departmental staff needs to practice using the system and any difficulties experienced need to be ironed out. The education and training of user staff is an important element of this phase. Documentation, such as the operations and user manuals, will be produced and the live (real, rather than test) data will be collected and validated so that the master file can be set up. Once all this has been carried out, the system can be operated.²¹

Another significant challenge to any organization, regardless into which category they may fit, is how to manage this large amount of new work without reducing the current workload. Our experience is consistent in that this is virtually impossible without adding staff, at least for a period of time during the planning, design, and implementation process. What varies, depending upon the organization's category, is how much, and where, additional assistance will be needed in the process. For example, an organization that is building a replacement hospital, must maintain the existing HIS's operations and also support the planning and design process, and then turn operational and high-level HIS requirements into the overall HIS architecture.

The business operations in the hospital are interdependent and the fact that clinical professionals often work in compressed time frames compounds greater interdependence. Therefore, coordination among the digitized processes is vital. In other words, an extended digitization scope will be a more vital complement to experience in the case of clinical systems, compared with business systems. If a hospital develops digitization experience with a limited number of technology solutions, then the other processes within the clinical activity system, which are not well digitized, could impair the effectiveness of the digitized processes, because of the high levels of interdependence (Thompson 1967²²). For example, if laboratory and radiology processes are not well digitized and assimilated with the operating room, the effectiveness of digitizing the operating room could be impaired.

²¹ Avison DE & Fitzgerald G. 1988. *Information systems development*. ISBN 0-632-01645-0 (Pbk).

²² Thompson JD 1967. *Organizations in action*. McGraw Hill: NY.

2.2.5 System Maintenance

The system operation is on-going; it is monitored for continued performance in accordance with user requirements, and the needed system modifications are incorporated. Operations continue as long as the system can be effectively adapted to respond to an organization's needs. When modifications are necessary, the system may re-enter the planning phase, depending on the size and nature of the modification.

While system maintenance is on-going, an evaluation of the implemented system must be done. The next chapter will explain the evaluation methods.

2.3 Information Systems and Business Strategy

2.3.1 Introduction

In a world of new technologies, transforming economies, shifting demographics, reforming governments, fluctuating consumer preferences and dynamic competition, it is not a question of whether organizations should change, but of where, how, and in what direction they must change. For living organizations, change is a given. Organizations must constantly be aligned with their environments, either by reacting to external events, or by proactively shaping the business in which they operate.

While change is pervasive, not all change forms are strategic by nature. Much of the change witnessed is actually of the on-going operational kind. To remain efficient and effective, organizations constantly make "fine tuning" alterations, whereby existing procedures are upgraded, activities are improved and people are reassigned. Such operational changes are directed at improving the performance of the firm within the confines of the existing system – within the current basic setup used to align the firm with the environment. Strategic changes have an impact on the way an organization does business (its business system) and on the way the organization has been configured (its organizational system). In short, while operational changes are necessary to maintain the business and organizational systems, strategic changes are directed at renewing them.

For managers, the challenge is to implement strategic changes on time, to keep the organization in step with shifting opportunities and threats in the environment. Some parts of the organization's business and organizational system can be preserved, while others need to be transformed for the organization to remain up to date and competitive. This process of constantly enacting strategic changes to remain in harmony with external conditions is called "strategic renewal."

The health-care industry is in the process of transforming itself by using technology. These transforming efforts focus on moving from manual processes (often based on historical practices) to technology-enabled or even automated processes. The overall effort is involved in the creation of an absolute need for commitment to managing change.

The implementation of an HIS is compared to a tornado, in that it whips through an organization, turning its life upside down, throwing users into a world filled with new ways of doing things and seeking ways to recapture some sense of balance and control. The technology of an HIS disrupts the status quo and, along with the many opportunities that it promises, it also brings a whirlwind of seemingly never-ending changes, which can have an entirely different effect on different people.

While the implementation, despite being effectively managed, brings these challenges, poor implementation can be disastrous and will cost the organization much more time, energy, and money to get things back on track. The implementations of HISs don't have to be nightmarish for users, but there certainly will be obstacles and challenges along the way. The key is to help users through the road-blocks and enable them to experience a positive journey. This process is always easier when people know what they are getting into, feel supported, and are prepared for what lies ahead, both good and bad, which is the role of change management.

2.3.2 Re-engineering work: Don't automate, obliterate

Despite a decade or more of restrictions and downsizing, in the 1990s, many organizations were still unprepared to operate. In a time of rapidly changing technologies and ever shorter product life cycles, product development often proceeds at a glacial pace. In the age of the customer, order fulfilment has high error rates and customer inquiries go unanswered for weeks. In a period when asset utilization is critical, inventory levels exceed many months of demand.

The usual methods for boosting performance – process rationalization and automation – have not yielded the dramatic improvements that companies need. In particular, heavy investments in IT have delivered disappointing results – largely because companies tend to use technology to mechanize old ways of doing business.²³ They leave the existing processes intact and use computers simply to speed them up. But speeding up those processes cannot address deficiencies of the fundamental performance. Many of the job designs, work flows, control mechanisms and organizational structures came of age in a different competitive environment

²³ Hammer M. 1990 July/August. *Re-engineering work: Don't automate, obliterate*, Vol. 68.

before the advent of the computer. They are geared toward efficiency and control. Yet, the watch-words of the new decade are innovation and speed, service and quality.

It is time to stop paving the cow paths. Instead of embedding out-dated processes in silicon and software, we should obliterate them and start again. We should “re-engineer” our business: use the power of modern IT to redesign our business processes radically in order to achieve dramatic improvements in their performance.

Every organization operates according to a great many inarticulated rules: “Credit decisions are made by the credit department”; “Local inventory is needed for good customer service”; and “Forms must be filled in completely and in order.” Re-engineering strives to break away from the old rules about how we organize and conduct business. It involves recognizing and rejecting some, and then finding imaginative new ways to accomplish work. From the redesigned processes, new rules will emerge that fit the times. Only then, can we hope to achieve quantum leaps in performance.

Alignment must provide clear and highly supportive lines of communication between transformational leaders and the staff’s clinical/medical operational leaders at all levels of the organization. So, while health-care organizations continue to seek the best practice of organizational alignment for positive clinical transformation, the leadership of clinical transformation aligned with IT leadership could put the technology implementation goals at risk. It is imperative that the implementation of an HIS is championed by a senior medical and clinical leader working in complete alignment with the IT leader.

Re-engineering cannot be planned meticulously and accomplished in small cautious steps. It’s an all-or-nothing proposition with an uncertain result. Still, most companies have no choice but to muster the courage to implement it. For many, re-engineering provides the only hope for breaking away from the antiquated processes that threaten to drag these companies down. Fortunately, managers are not without help. Enough businesses have successfully re-engineered their processes to provide some rules of thumb for others.

The goal of becoming digital with the implementation of an HIS is not to “electrify paper.” If the same workflow is maintained with the HIS as currently exists with paper, then the true power and value of an HIS will not have been gained.²⁴ In the industry, the saying, “Don’t pave the cow paths,” is often used as an analogy, and essentially points out that “how it’s

²⁴ Davis Nicholas E. 2010 June 25. Journey to the EHR: The five “rights” to building the business case. Health-care Information Systems.

always been done” does not make it a smooth and efficient path. Once these new processes are implemented, training, followed by further continuous training, is essential to develop a new comfort zone for users to integrate this new way of doing business and practising medicine in their everyday routine.

The journey of implementation is truly never-ending. Objectives will be achieved; however, the most successful systems bring about a process of relentless discovery. As objectives are achieved, new benefits realize, and new goals are set, leading to additional efficiencies. This process will not be a smooth and flawless matter of “connecting the dots,” and will require the ability to absorb a few punches, duck to avoid a few others, and get up and keep going even after the wind has been knocked out of you.

Because technology investments are largely made up of things (i.e., hard- and software), it is easy to believe erroneously that a technology is being implemented once it has been bought and installed. In fact, nothing works without people; human issues are magnified in the process of redesigning work processes. Many work-process redesigning projects focus exclusively on technology and fail to address the human and organizational aspects of work. In these instances, organizations fail to explore nontechnical solutions to improve organizational processes, such as training or changes in structures, procedures, and management practices. Most often, technological strategy drives organizational change.

While the business strategy may be clear, it is often not reflected in a defined organizational strategy for change. Too many technically good applications have failed because of sabotage by users who like the old ways in which things were done. To manage natural resistance to change and help convert that resistance into commitment and enthusiasm, must be a planned process. New systems should enhance the quality of the life of work and increase responsibility, empowerment, and motivation.²⁵

Health Information Technology (HIT) is being sought as one of the key elements to streamline the process of providing health-care to improve the quality and harness the cost. It is hoped that HIT will lead to a more cost-efficient health-care system than the current one. Surprisingly, there is no agreed definition of HIT in academic literature or government documentation. However, consensus exists on the purpose of HIT being the use of devices for the management of information in order to ensure that it is available for the right person at

²⁵ Lorenzi NM & Riley RT. 2000. Managing change. *Journal of the American Medical Informatics Association* Volume (7)2, 116-124.

the right time and place. HIT is the basis for a more patient-centred and evidence-based medicine with the real-time availability of high-quality information. Despite the various interpretations of the scope of HIT, all health-care stakeholders agree that this is the premise on which the 21st century's health-care system must be based.²⁶

If the objective of the HIS is to improve health-care practice through the use of technology, then the health-care professionals' workflow must be established to guide the conditions for technological transformation and provide the appropriate constraints. From any environment, at a basic level, a workflow represents a sequence of activities. At a practical level, the workflow allows for an assessment of activity in context and a review of a sequence of work; such as, all of a nurse's activities related to patient care on a given day in a given unit. At a greater level of abstraction, the workflow is a pattern of processes for information processing.

In the 1990s, the emphasis on the organizational workflow was reignited by the Institute of Medicine's reports on the quality of health-care: *To err is human* and *Crossing the quality chasm*. This period, 1980 to 1990, experienced the emergence of Total Quality Management and Six Sigma, and witnessed the evolution of Business Process Re-engineering. The bright spot in the emphasis on quality was that the workflow again became the focus of management and researcher surveillance.²⁷

At the heart of re-engineering is the notion of discontinuous thinking – of recognizing and breaking away from the out-dated rules and fundamental assumptions that underlie operations. Unless we change these rules, we are merely “rearranging the deckchairs on the Titanic.” Breakthroughs in performance cannot be achieved by cutting fat or automating existing processes. Rather old assumptions must be challenged, and old rules that caused business to underperform in the first place, must be shed.

2.3.3 Strategic Change

2.3.3.1 Introduction

Organizations are complex systems that consist of many different elements, each of which can be changed. There are many actions that constitute a strategic change – a reorganization, a diversification move, a shift in core technology, a business process redesign and product portfolio reshuffle, to name but a few. Therefore, to gain more insight into the various areas

²⁶ MedPAC. Report to the Congress: New approaches in medicine. 2004. Accessed December 18, 2008, at http://www.medpac.gov/documents/June04_Entire_Report.pdf

²⁷ Whittenburg L. 2010. Workflow viewpoints: Analysis of nursing workflow documentation in the electronic health record. *Journal of Health-care Information Management* 24(3), 71–75.

of potential change, organizations need to be disassembled analytically into a number of components. The most fundamental distinction that can be made in the organization is between the business and organizational systems.²⁸

The term “business system” refers to how an organization conducts its business - in simpler terms, how an organization makes its money, which is a specific configuration of resources, value-adding activities and product/service offerings directed at creating value for customers.

The term “organizational system” refers to the way an organization moves its people to cooperate in carrying out its business. In simpler terms, it is how an organization is organized; how the individuals, who populate an organization, have been configured and relate to one another with the intention of facilitating the business system.

It’s important to understand why you should make an investment in the human side of the project. To bring in the best technology possible doesn’t mean a thing unless users are comfortable and proficient in its use. The truth is *just because you build it, doesn’t mean they will come to the party.*

2.3.3.2 Change Management

In the circles of change management, there is the saying: *When one door closes another one opens, but sometimes it’s hell in the hallway!* Change management deals mostly with a “hallway situation,” while facilitating the human transition from the present to the future. These days, change is on-going and requires focused leadership for it to be as fast and painless as possible.

*It is easy to change the things that nobody cares about. It becomes difficult when you start to change the things that people do care about, or when they start to care about the things that you are changing.*²⁹

A failure in technological projects is due primarily to a lack of use, not a failure of the software. The focus of change management is the people, and the objective is to change their behaviour. This is good for business, as it accelerates the process of change, so benefits are achieved faster. Change management is not about being nice, or placing an emphasis on feelings - it’s about performance improvement and results.

²⁸ De Wit B & Meyer R. 2001. *Strategy synthesis – Resolving strategy paradoxes to create competitive advantage*. London: Thomson Learning. ISBN: 1-86152-317-3 (pbk).

²⁹ Lorenzi NM, Riley RT, Blyth AJC, Southon G & Dixon BJ. 1997. Antecedents of the people and organizational aspects of medical informatics: Review of the literature. *Journal of American Medical Informatics Association* 4(2), 79–93.

A search in the literature reveals a variety of definitions of human-focused change management. They all cover similar concepts, sometimes using different terminology. The simplest explanation of change management is to say, “It’s all about the people!” But, for the purposes of this thesis, we expand on that concept and use the following definition of change management:

- i. It is a structured process designed to deal directly and intentionally with the human factors involved in not just planning and implementing an HIS but through *change of behaviour*, to achieve the anticipated benefits that justified the project in the first place.
- ii. Desired *behavioural change* is achieved by helping people to understand and internalize change, and by preparing them to be successful contributors in the future state. In the case of the implementation of HISs, effective change management produces users who are willing and able to use an HIS in a way that satisfies the requirements of the job, the needs of the patient, and the health of the organization.

The overarching purpose of change management is to *accelerate the speed at which people move successfully through the change process so that anticipated benefits are achieved faster*. And, there are additional benefits of change management. By optimizing the users’ efficiency and efficacy, an effective HIS change management program will also:

- a. improve organizational outcomes and performance (effective use of the system generates value to patients and the organization).
- b. enhance employee satisfaction, morale, and engagement (when people learn new skills, meet performance expectations, and contribute to a greater good, they feel pride in their accomplishments).
- c. improve service quality (users feel valued and supported by an organization that invests in them; which impacts positively on how they treat patients).
- d. help to achieve hoped-for benefits (which include HIS value realization, reduction of errors, return on the investment).
- e. create higher levels of openness, trust, involvement, and teamwork (i.e., develop an engaged workforce).
- f. build change capability and capacity in the organization, which results in improved ability to respond quickly and effectively to new situations (create organizational nimbleness through the knowledge, structure, and process of embedded change

management).

The adoption of technology, specifically IT, is one such area that involves the application of the principles of change management to the implementation of the IT. The focus of this document is the adoption of technology, and will mostly use this term instead of change management throughout the rest of this document.

2.3.3.3 Fostering Adoption

Professionals, who adopt effective technology, align themselves with the organization's operational/business side and tailor solutions that drive behavioural change and tangible outcomes. They participate in the implementation of HIS projects from the outset, drive the human side of change throughout, and continue to add value post-life, as the HIS becomes part of the organization's central nervous system.

What do end users want from a system? The answer, of course, depends to a large degree on the end user. Physicians have various needs, depending upon their role in health-care delivery, whether in an academic setting, private practice, or in training.

Nurses also have different roles and interactions within a system, depending on their location within the health-care organization, and whether this care is acute, critical, ambulatory, or otherwise. As an end user, the health-care organization has its needs, including easily supported and deployed software that is well accepted by its own customers, the clinical staff, and hospital employees.

All users want systems that are intuitive, easy to use, quick, and responsive to input. All would like some help in filling out required fields on forms or ordering medications, but the assistance shouldn't be too obtrusive. Just as "Microsoft Bob" met an early retirement, and "Jot," the paperclip in Microsoft Office, is now able to be silenced, any intrusion into the clinician's workflow should be upon request and welcomed, rather than an obtrusive incursion that all decry. Clinicians want vendors, hospitals, and consultants to focus on enhancing the user experience with the content and authors being cognizant of the degree of intrusion appropriate to the risks of harm to the patient or institution, thus also including financial risks. The combination of an easy-to-use system, supported by real intelligence, provides the value that users seek for improved patient outcomes, without sacrificing clinicians' productivity.

Most private physicians do not welcome massive intrusions into their daily workflow, particularly in their office administration. To take an extra minute for each of their 60 patients

is viewed as adding an hour of uncompensated time to their already busy schedules. Thus, the speed of any computerized product for medical records and the ease of delivering quality care should be so good that the physicians clamour to be able to use the system, rather than resist the concept of an HIS, whether in hospital or office administration.

Most physicians - those in private practice and certainly those who are academically based - believe that they provide high-quality patient care. To tout support for an advanced clinical decision in any way that results in physicians feeling that they are substandard, will decrease the likelihood they'll accept automation.³⁰

While the change that occurs is an external event, an HIS's implementation, reorganization, proposed outsourcing, promotion, etc. (i.e. the transition from the old to the new for those whose experience is impacted upon) is a psychological and emotional process. This transition is difficult, even if the change is self-imposed or considered to be positive.³¹

William Bridges, a key thought leader in management of transitions, says: "It isn't the changes that do you in, it's the transition after the change that does!" For an implementation team, part of the problem encountered during transition is that change is messy: people start where they are, not where the team wants them to be. And when considering the personnel in a typical hospital, people can vary in terms of comfort with computers, stage in life, commitment to the organization, fear of change, etc. In addition, the fact that for change to be successful, three things must occur:

- i. People must let go of their current reality; have an ending.
- ii. They experience a confused period in between (hell in the hallway).
- iii. Only then can they have a new beginning.

To take this a step further, while IT consultants want to install the system and make enhancements, ultimately, the *users* will determine how the system will be implemented; and the following human, not technical, factors affect the use:

- a. Different frames of reference, backgrounds, and experience with technology.
- b. Organizational history and experience of other large-scale projects that incur change.
- c. Levels of resistance, fear, and the ability to deal with ambiguity.

³⁰ McCoy Michael J. Advanced clinician order management - A superset of CPOE, *Journal of Health-care Information Management* (19) 4, 11-13.

³¹ McCarthy Claire & Eastman Douglas. 2010. Change management strategies for an effective EMR implementation.

- d. A degree of alignment with, “What’s in it for me?” by the various stakeholder groups.
- e. Inefficiencies are uncovered because the system creates transparency.
- f. Work-surroundings that quickly become entrenched.
- g. Pressure to get through the day can override doing what is right.
- h. Issues of user work/life balance come into play from the very beginning

.All of these factors create problems for implementation teams who just want to install technology! How do you address the human issues? Or is it easier to simply install the technology effectively and assume that the people will learn as they *have* to use it? Some on the implementation team may falsely assume that users of an HIS system will snap into place over time and do what is right for the organization. This thinking is a fool’s paradise.

But, implementation of the technology is just a first, and very necessary, step because in, and of, itself the technology does not generate value. The technology is necessary, but not sufficient for benefit realization to occur. To create value requires people, and this is why change management is so important. Too much of a focus on technology, even in the early stages, will create issues downstream. And even with the best technology, if not used efficiently, anticipated benefits will be tough to achieve.

With all due respect to the technical side of an HIS implementation, installing the technology is only half the battle. However, this does not degrade the importance of the technology. The fact that we spend much money on researching technology, acquiring it, configuring it, installing it, and supporting it, confirms its importance. If we did not implement an HIS, we wouldn’t even have a discussion about an HIS related change management!

An enormous demand for health-care workers exists. Yet, at the same time, there is a shrinking supply of qualified workers. In addition to a shortage of health professionals, a corresponding shortage of education programs and enrolment will compel hospitals to make better use of existing employees and to create new ways to attract, educate, retain, and use physicians, nurses, technologists, allied health workers and other assistant personnel.

Over the years, medical and nursing schools have produced a finite number of graduates. These trained professionals do not always remain involved in the direct delivery of patient care. Many life science companies are successfully competing for skilled health-care workers. It is no secret that the standard of living of a primary care physician or nurse can leave much to be desired. Professionals are finding the option of regular work hours, reduced

stress, avoidable expense for malpractice insurance and other benefits far more attractive than working in the current health-care environment, all of which contributes to the lack of available staff during specific times.

A considerable amount of time will be spent on re-engineering the health-care delivery process based on best outcomes; this process will include industrial standard practice and quality assurance monitoring. Re-engineering will help to reduce and control the cost. Ultimately, the hospital has to police these activities through the HIS, which can track outcomes and medical errors much more closely.

Because the scope of this clinical and cultural transformation is so profound and all-inclusive, organizations must create new governance and organizational structures that ensure collaboration across clinical and technical areas. To succeed, committees for structural organizational change should ensure:

- i. Leadership alignment at senior executive level, including board-level
- ii. The participation of multi-disciplinary end-user work teams
- iii. Sponsorship by clinical, operational and physician leaders, and
- iv. Facilitation by IT personnel.

In technology adoption, experienced professionals embrace a systems perspective when given an assignment to drive performance, manage perceptions, and increase the utilization of new and existing technology. A systems approach is the ability to see the big picture and address interrelationships among the variables within the fabric of the organization, and influence the combined impact that these variables have upon organizational effectiveness. As each variable has the power to influence the outcome of any intervention, behavioural change often is not sustainable, because variables tend to work against one another. Strategies for effective technology adoption account for this interrelationship/interdependency and aim to bring these variables into alignment as a means for driving sustainable results.

2.3.4 The Demand for Creative Thinking

2.3.4.1 Introduction

Since the potential benefits of HIT are so great, and the problems of the current state of information management are so challenging, it behoves us to become adept with the exigencies of rapid change.

When change is contemplated or promoted, there will always be conflict between those who support the status quo and those who advocate change. Among the latter, there may be

conflict as to the extent and the nature of change that is desired. Health care is an area in which change is characteristically slow. It has been estimated that new treatments or knowledge percolates into common use over a period of 15 years. Yet many of the changes we promote or advocate occur over time frames of a few months to a few years, cataclysmic by comparison! Thus the conflict and turmoil associated with change are emphasized in the arena of rapid change. In rapid change, the intensity of feeling perhaps gives a tactical advantage to those who oppose change. For example, despite well promoted advantages of HISs and other forms of electronic health information, failed or problematic implementations are commonplace - testimony to the challenges of rapid change.

Health care organizations often view issues in a very narrow, short-term way: problems are issues to be solved. These organizations assume that there is a clear solution and that the process is only a matter of finding that solution. The progression follows a linear process, namely deciding whether change is necessary and, if so, what change will be made.³²

However, in health care, as in many other endeavours, the approach often is not so clear cut. There may not be a single clear solution, or best choice. The group advocating for the status quo may be as large as that promoting change. Which current state issues need to be addressed may not even be clear.

The congruence of ideas and methods in the writings of authors, each nominally addressing different aspects of management, is really quite remarkable. In the absence of clear cut, simple answers, the cumulative lesson is that one needs to learn to succeed. Polarities and apparently irreconcilable paradoxes must be resolved by managing them and taking advantage of them. Overall, one must be creative and create an atmosphere that encourages others to be creative.

Parallels of paradox and polarity in health information technology are easily seen. First, an institution must make a decision as to whether it will go the route of some, or all, of an HIS. It will eventually choose a direction, incur substantial disagreement and perhaps fail because of strong opposition or poor planning. The administration may not have the knowledge to anticipate or respond to the innumerable potential conflicts. They may not understand that it probably is impossible to resolve the dichotomies, but they may have to live with them and

³² Johnson Barry. 1996. *Polarity management*. Human Resource Development Press, Amherst, MA.

manage them.³³ The idea that there has to be a resolution may be the doom of the process. The same conflict can accompany each step of the implementation – choosing a vendor or vendors, setting up a governance structure, committing to standardization, order sets, etc.

2.3.4.2 Creative Thinking is the Opposite of Logical Thinking

However, when creativity is applied, the thinker does not take valid steps, but takes a leap of imagination, without being able to support the validity of the mental jump. In creative thinking, a person abandons the rules that govern sound argumentation, and draws a conclusion that is not justified, based on previous arguments. In this way, the thinker generates a new understanding, but without objective proof that the new idea “makes sense.”

In recent years, literature has recorded numerous failures of biomedical systems’ implementations. However, the exact number of information system failures is unknown, as organizations and individuals are reluctant to publish these facts. With major computerization, failures are (and possibly create) threats to patients’ safety;³⁴ so, health care IT projects will, increasingly, be viewed in terms of the opportunity costs and risks associated with implementation. While large-scale failures of health care IT systems pose significant problems, smaller-scale failures, resulting from incomplete delivery on expectations, also are disquieting.

Additional problems are viewed in cost overruns and delays in project completion. A variety of reports have suggested causes for failures of implementation, including a lack of user involvement, poor communication, lack of attention to people and organizational issues, and poor project planning.³⁵

IT systems test resilience in the health-care environment in ways that are not well understood.³⁶ The development and dissemination of useful strategies and insights for safe, efficient, and productive implementation of health-care IT is an urgent national requirement that needs large-scale concerted action. *The one factor that distinguished successful efforts from unsuccessful ones was the use of ambitious, even outrageous, goals to motivate people and focus them toward concrete accomplishments.*

³³ Martin S Kohn M.D. 2007. *Rapid change in health-care organizations*. Copyright Health-care Information Management Society.

³⁴ Han YY, Carcillo JA, Venkataraman ST, Clark RS, Watson RS, Nguyen TC *et al.* 2005. Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Journal of Pediatrics* 116(6), 1506–12.

³⁵ Glaser J. 2004 October. Management’s role in information technology project failures. *Health-care Financial Management*.

³⁶ Cook RI. 2002. Safety technology: Solutions or experiments? *Journal of Nursing Economics* 20(2), 80–2.

The complexity of health care often makes it impossible to implement information systems simultaneously throughout an organization. Therefore, most information systems are implemented according to a specific strategy. There are multiple theories to describe technology adoption, but one that has been successfully followed is the Diffusion of Innovations (DOI) theory of Everett Rogers.³⁷ The most important aspect of DOI is that adoption is not a momentary, irrational act, but an on-going process that can be studied, facilitated and supported.³⁸

Rogers classifies adopters on the basis of their innovativeness. According to his theory, members of a population vary greatly in their willingness to adopt a particular innovation. People adopt in a time sequence, and they may be classified into adopter categories on the basis of when they first begin to use a new idea. Within a population, the distribution of innovativeness resembles a normal curve beginning with “innovators,” who lead in adopting an innovation, and comprise about 2.5% of a population. “Early adopters” comprise approximately 13.5% of a population and this group contains the majority of the opinion leaders.

While the application of Rogers’s original process-stage model of innovation to technology adoption can be useful, a more nuanced understanding of each group and the organizational context of implementation is needed. Based on personal experience, observations and discussions with information system implementers across the world about their experiences, the researcher believes that there are two major chasms in the Rogers DOI model. In researching the concept of chasms within this model, the only reference to chasms was located in the sales and marketing literature.³⁹

The first chasm is between the early adopter group and the early majority group. The second chasm is present at the end of the late majority and before the laggard group.

The first chasm in our model represents the challenge of moving beyond the initial, enthusiastic groups of adopters. Implementers often start with these groups because they promise early “successes,” essential to convince sceptics down the road that the technology is worth using. In clinical settings, these may be groups that have been on the vanguard of technology adoption in the past and may have characteristics that facilitate the infusion of

³⁷ Rogers EM. 2003. *Diffusion of innovations*, 5th edition. New York: The Free Press.

³⁸ Lorenzi NM. Clinical adoption. In Lehmann HP *et al.* 2006. *Aspects of electronic health record systems*, 2nd edition. New York: Springer: 378–97.

³⁹ Moore GA. 1999. *Crossing the chasm: Marketing and selling high tech products to mainstream customers*. New York: Harper Business.

technology into practice, such as minimal (relative) complexity of practice.

The second chasm comprises the challenges of bringing the final clinical groups on board with a new system. Some groups have such intractable issues with the fit of task-technology that the system may never meet their needs. Others do not adopt it because of complex ecological or political concerns.⁴⁰

Reports on IT failures are a valuable contribution to the collective wisdom related to the implementation. To move forward and improve the percentage of implementation successes, it is critical that we develop strategies and tactics to correct known problems. Another “block” holding the chasm open comprises operational organizational issues. As information systems continue to become more embedded and more essential in organizations, they also become the source of more operational frustrations which cause friction and diminish trust - an important social lubricant - between the operational areas and the IT department. The operational staff may feel that the IT people do not really understand their needs and that the IT area is disconnected or “out-of-sync” with the operational areas. In turn, the IT staff believes that they have the “answers” to the operational areas’ needs, but that the latter either will not listen, or they do not understand how difficult it is to complete the projects. This distrust can lead to indifferent or antagonistic responses to new and upgraded systems.

The implementation of information systems in health care continues to challenge people daily. A number of major issues lead to chasms in the implementation process. These issues start with a lack of understanding of what the users need, move to the creation or purchase of systems, the design of which will not support the users’ needs, then to the overall management of the process of implementation. These major blocks that hold the chasm open, are widened by issues with the organization and operational areas and the lack of attention to evidence that already exists regarding implementation.⁴¹ The financial and human cost of ineffective implementation is incalculable!

The American College of Medical Informatics proposes a Big Hairy Audacious Goal (BHAG) to create a scientific team for implementation that will produce new knowledge on how to deploy IT in ways that help health-care organizations to meet their performance objectives.

⁴⁰ Baba M. 1995. The cultural ecology of the corporation: Explaining diversity in work group responses to organizational transformation. *Journal of Applied Behavioural Science* 31(2), 202–33.

⁴¹ Lorenzi NM, Novak LL, Weiss JB, Gadd CS & Unertl KM. 2008 June / May. Crossing the implementation chasm: A proposal for bold action. *Journal of the American Medical Informatics Association* 15(3), 290-6.

Achieving this BHAG will not only save health care billions of dollars, but would also save other industries billions. Equally important, we would save the human “pain” of dealing with information systems that are perceived to be to the detriment of patients and the work environment.

When identifying and diagnosing strategic problems, creative thinking is often needed. Old cognitive maps usually have a very compelling logic, locking people into old patterns of thinking. These maps are usually tried and tested, and have become immune to external signals that they no longer fit. To think within the boundaries of a shared cognitive map is generally accepted and people tend to proceed rationally, that is, they try to avoid logical inconsistencies. However, to challenge a cognitive map’s fundamental assumptions cannot be done in a way that is logically consistent with the map itself. To contradict a paradigm is illogical from the point of view of those who accept it. Therefore, to change a rigid and subjective cognitive map that is rooted in a shared paradigm, requires strategists to imagine new ways of understanding the world that do not logically follow from their past beliefs. Strategic thinkers need to be willing and able to break with orthodoxy, and make leaps of imagination that are not logically justified, but are needed to generate novel ways of examining old problems.

2.3.5 Team Syntegrity - Building Alliances

To be successful, an informatics practice requires the NIS specialist to develop and foster alliances in several different areas to merge the various bodies of knowledge successfully and institute the necessary change management, development, implementation, or workflow redesign.

By the use of a team approach and incorporation of several members with different areas of expertise, such as a developer, product manager, database manager, clinician, and others, much of the work is accomplished. Team alliances among the members are critical for the success of the project, whether in a large implementation, an upgrade, or a new software product. Clear expectations of team members and project goals enhance relationships between them and foster success for everyone. Networking among professionals is significant in informatics practice. Technology and its application are changing rapidly, and regulations that affect health-care initiatives are constantly evolving. Strategies for implementation, change management, system selection, and vendor or product evaluation continue to evolve and are tested by others.

Networking, with sharing of experiences and ideas, can be applied to many groups and approaches. Administrative alliances are imperative at all levels, including those of project team leaders and system or product developers. These alliances ensure knowledge transfer and appreciation of strategic direction, budgeting issues, or sales opportunities. Without such information, the appropriate finances and resources may not be allocated to support projects and team efforts.

When developing alliances, it is important to recognize that communication and relationships can be formal or informal. Both are valuable in getting the job done - from the reservation of conference rooms and resolving a network issue, to attaining a broad understanding and buying-in on a product, project, or direction. Formal alliances require the HIS to ensure communication regarding work being done and to provide the necessary information to support the organization's expectations. Informal alliances serve to provide information and workflows that the relationship defines, as opposed to the organization's expectations. All this can be accomplished either through actual team participation, project work, or informal "hallway" discussions. Regardless of a reporting structure for the work that has to be accomplished, clear communication of expectations or the work to be done is necessary to ensure role's success. Whether the HIS's specialist is part of the project team or the organization's management, clear and consistent communication will support an understanding of the budget, system, training, and support requirements in getting the job done. Documented communication plans should be a part of any development or implementation team's effort, with minutes of meetings, memos, and other communications that support an understanding of informatics initiatives. It is important to pass information to the right people at the right time and in the right place so that they hear the right message.⁴²

Team synteegrity provides a theory and set of procedures (a "protocol") that support non-hierarchical, participative and effective decision-making regarding a topic that is interesting to a group of people who share some knowledge and experience relating to it. This is of obvious value in organizations that are already democratic, as well as multi-organizational settings where, of necessity, the commitment of a variety of stakeholders to action has to be obtained. In the post-industrial age, where democracy and decentralization are becoming more highly valued than hierarchy and centralization, team synteegrity to promote inclusiveness, flatter structures and self-management, even in otherwise conventional

⁴² Hassett Margaret (Mimi). 2001. Case study: Factors in defining the nurse informatics specialist role. *Journal of Health-care Information Management* 20(2), 30-35.

organizations, is likely to be increasingly needed.

A need exists for organizations to develop conversational tools that can handle their members' divergent, and often conflicting, viewpoints and facilitate the emergence of a shared social consciousness. In order to define and specify a resolution to most policy, control, co-ordination and monitoring issues, it is important to have proper communication mechanisms that can deal with the variety that the participants necessarily bring to their discussions. It is essential to promote rich productive debate at the point in an enterprise where information about its internal state coincides with information about the external environment.

This organizational model generates synergy out of perfect democracy and, simultaneously, demonstrates great strength and cohesion. Essentially, team synteegrity is a process that guides non-hierarchical group decision making for an Infoset of people who share an interest in addressing an issue of particular concern to them, and about which they will inevitably have different opinions.⁴³ These individuals must agree about a communication protocol, - a set of procedures designed to extract maximum advantage from the qualities of the group members. The protocol establishes how these individuals share information about the issue, develop discussions and reach conclusions. It places participants in roles of equal status so that every voice is heard and no individual is allowed to dominate. People are divided into groups, meetings are sequenced and information is distributed in such a way as to ensure a highly interactive and democratic event, which offers the best opportunities for balancing tension and synergy as the groups negotiate different viewpoints. It should be clear that the protocol simply specifies the form of the interactions and discussions. It puts no restrictions and makes no comment on the content of what was said. That is left to the judgement of individuals and the teams.

Today, the scope of clinical and cultural transformation in health care is profound and all-inclusive. It requires collaboration between all clinical and technical areas of health-care organization, necessitating new governance and organizational structures.

This transformation is multi-dimensional, taking on medical, and clinical cultural implications. On the medical and clinical sides, efforts focus on determining and implementing best-practice, evidence-based processes that support the adoption of clinical technologies. On the cultural side, the clinical groups of physicians, nurses, pharmacists,

⁴³ Jackson Michael C. 2003. *Systems thinking - Creative holism for managers*. ISBN: 0-470-84522-8.

ancillary care providers, and information systems' personnel challenge the way things are done today. The results of such collaboration are new care processes and practices, as well as data standards and integrity that better support a patient-centric approach to care. These developments will ensure patients' safety, quality of care, workflow efficiencies, care timelines and effectiveness, and overall caregiver productivity.

The overall effort creates a tremendous amount of disruption to all aspects of the organization, thus creating an absolute need for a commitment to manage change at every point along the way.

2.3.6 Knowledge Management and Process Orientation

2.3.6.1 Introduction

In order for organizations to survive in an ever-changing environment, it is important for them to be competitive and to develop routines for continuous improvement of their competitiveness. During the years, various approaches have emerged to support organizations in their striving, and one approach that currently receives much attention, is knowledge management (KM). A mere introduction of the KM concept in organizations will not increase the level of their competitiveness as such, but there is a need to apply the knowledge in an efficient and appropriate way to enable the activities of KM to succeed and to contribute to the organization's competitiveness. The importance of this matter is illustrated by a quotation from Claycomb *et al.*:

Knowledge has no value if it is not applied in some way. It is only in the application that it becomes valuable.

On the other hand, KM has been abstracted to: "The systematic process of making sure everyone knows what the best of us knows." The learning culture of an organization, coupled with IT strategy, means that all can know the *best* of what is known, not only in the organization, but anywhere. There is simply too much to be known. Health-care organizations must leverage their learning with tools to embed knowledge in their structures and processes, making it available and accessible at the precise points needed in order to support excellent clinical decisions.

The use of a structured encounter-flow technology is invaluable to facilitate the workflow's "best practices," while simultaneously collecting codified data. By the use of proven techniques, health-care organizations can manage and learn from codified data and

communicate it, at a high level back to clinical analysts, managers and planners.⁴⁴ At both strategic and operational levels, reusable and structured encounter pathways can be built to guide best practices and enable the collection and linkage of codified data to facilitate the effective use of information in the re-engineering of clinical processes.

The provider's knowledge-enabling workflow allows for opportunities to improve health-care delivery by analysing episodes of care, comparing clinical quality, predicting resource needs and examining temporal relationships between interventions and outcomes. Structured encounter documentation is emerging as an essential core competency for health-care delivery organizations. Without this approach, care cannot be delivered in a consistent fashion, nor can outcomes be measured fairly and compared.

One way to incorporate organizational goals at a departmental level is to develop a department-specific education plan that stresses the mastery of fundamental skills.⁴⁵ This plan should examine both top-down and bottom-up requirements; rank them in terms of importance, benefit, and payoff; then provide an implementation program for the next three to five years. The development of such a plan begins with a review of the health-care organization's objectives and goals that are often found in its corporate strategic plan. The department of information management should be familiar with these goals, because it plays an important role in the implementation of projects to support them. Education to support these goals is no less important. The objective is to leverage the training opportunity to reinforce and unify organizational goals with the specifics of the training, thus helping all to understand more clearly the links between the new materials and the institutional mission.

To be effective, an education plan must consider requirements from every organizational perspective. Both corporate goals and objectives and specific individual requirements should be considered in order to ensure that opportunities for improvement are not missed. This kind of information can be attained by means of a survey, interviewing process, or through a managerial review of departmental job descriptions. Another helpful tool, both in building the training curriculum and in delivering the training as such, is to create a summary that relates the training material to the functional aspects of each major position in the institution.

When recognizing that resources are scarce, the education plan should demonstrate the clear

⁴⁴ Hongsermeier T & Schmeling W. 2002. Knowledge management: The use of knowledge strategies to transform health care. The Health-care Information and Management Systems Society.

⁴⁵ Nussbaum GM. 2000. Evergreen staff: Building a tree of knowledge for continuous learning. *Journal of Health-care Information Management* 14(3), 83–96.

links between the proposed training and organizational priorities. It is important to prioritize the urgent needs (e.g., requirements for current projects) and areas with the greatest return (e.g., improving customer service), while also building necessary basic skills. A ranking process can help to organize educational projects according to their ability to meet departmental and organizational criteria, and ensure that they are completed in the order of importance.

The educational plan should draw clear relationships to specific projects and initiatives. Once a ranked set of projects is defined and time frames established, the educational planning team (being discussed later in this thesis) must begin to determine the resources that will be required to accomplish tasks, recommend the most cost-effective methods to deliver the necessary education, and prepare cost estimates. The final product will become the road map for educational efforts throughout the department and will supplement the overall educational plan for the health-care institution.

On-going communication with both departmental management and organizational executives is required. Reviewing and fine-tuning will ensure that educational efforts meet the organization's requirements and can be funded to completion.

KM is an emerging management approach aimed at solving business challenges to increase efficiency and efficacy of core business processes, while incorporating continuous innovation. Specifically, through the use of various tools, processes and techniques, KM combines germane organizational data, information and knowledge to create business value and enable an organization to capitalize on its intangible and human assets so that it can effectively achieve its primary business goals as well as maximize its core business competencies.⁴⁶

The need for KM is based on a paradigm shift in the business environment, where knowledge is central to organizational performance. Broadly speaking, KM involves four key steps: creating/generating knowledge, representing/storing knowledge; accessing/using/re-using knowledge, and disseminating/transferring knowledge.

KM is particularly important to ensure that relevant data, pertinent information and germane knowledge permeate systems at all times, and that the extant knowledge base continues to grow in a meaningful and useful fashion.⁴⁷

⁴⁶ Wickramasinghe N. 2006. Knowledge creation: A meta-framework. *International Journal of Innovation and Learning* 3(5), 558-573.

⁴⁷ Wickramasinghe N & Calman RA. 2007. Defining the landscape: Data warehouse and mining: intelligence continuum of health-care. Information and Management Systems Society.

2.3.6.2 Becoming Oriented

There are two aspects to the process approach: 1) facilitating the operational aspects of caring for each patient; 2) facilitating learning from the aggregated experience of caring for many patients.

The process approach is an essential component to survival in a competitive health-care marketplace. To collect codified data and use a special guideline called a 'Community Guideline' will help to illustrate the benefit of focusing on the process to improve efficiency. In contrast to other guidelines, the community guideline is machine-readable and executable. It presents the appropriate results and reports, such as laboratory or physical therapy to the provider for review, without the provider's explicit action, and also presents opportunities to document the issues that are specifically pertinent for the given situation, as well as to order interventions in a single, unified process.

As health care becomes increasingly complex, all would agree that the on-going education of hospital personnel is important so that they can become more efficient and productive. When it comes to information management, education enables staff members to fully understand and use all the capabilities of available technology. Learning must also encompass improvement of related skills, including time management, customer service, and enhancement of patient satisfaction.

There is much to learn, and many stumbling blocks impede the realization of ideal employee education. These issues fall into four main categories: time, money, resources, and competing interests.

2.3.6.3 Time

To separate employees from day-to-day responsibilities and commitments is often difficult in departments with heavy workloads. When staff members attend classes, they are frequently interrupted by pages and cellular telephone calls that require immediate response, and when studying is required after working hours, staff members must often, at the same time, deal with personal issues or commitments.

2.3.6.4 Budget

There are many reasons for the low adoption rate of HISs in health-care organizations. To cite a few, no incentive exists for health-care organizations to adopt HIS if the payers (e.g., insurance companies) reap the major part of the benefits. The initial cost of implementing an

information system is also persistently reported as a factor that prevents providers from acquiring such systems. On the consumer side, in addition to the concern for the privacy and security of different HISs, consumers also report the difficulties of initiating and maintaining an HIS, as well as its unproven benefits, as barriers to the adoption of such technologies.

In times of shrinking health-care budgets, it often is difficult to fund staff education. Including the costs of shift coverage, personnel in the training plan may also raise the spectre that training is extremely costly.

2.3.6.5 Resources

The unavailability of proper resources, such as appropriate classrooms and equipment, prepared instructors, and staff to support the classes, often inhibits the ideal delivery of education to staff members. Because these kinds of resources require a significant investment in time and money, the planning team will need to include these requirements in the work plan.

Health-care professionals, with training in both IT and information management, could tackle the task of promoting the adoption of an HIS. Many surveys have found the existence of a “digital divide” in the adoption of an HIS. In underserved areas, small offices of physicians and health-care organizations are struggling with the adoption of an HIS with their limited resources and experience. Consumers in underserved areas also are in a disadvantaged position when it comes to managing their health information electronically, because of the gap in information accessibility and health literacy. Health-care professionals, with sufficient training in HIS, should reach out to these disadvantaged areas to help them in adopting an HIS. This involvement could be in the form of consultations, providing student interns, collaboration, grant writing, negotiating with vendors, training, or simply acting as motivators. Without the majority of health-care organizations that are willing to adopt an HIS for their daily transactions, it will be impossible to build a national health information infrastructure.

2.3.6.6 Competing Interests

Unless education plans are justified in terms of their ability to support organizational goals and objectives, they can often take a backseat in the prioritized list of projects that an organization will back. A great deal of education must take place on an on-going basis for all employees. In addition to general skills and IT systems, there are a host of clinical training needs. One of the biggest challenges is to coordinate all the training needs properly, and not permit competing interests to hamper the provision of each type of training. Initially, it may

not be possible to have a single unified training plan for the organization, but this may be a longer-term goal that will result in harmonizing all training.

2.3.6.7 The Educational Planning Team

Most organizations form an educational planning team to address these issues, formulate the plan for education, and direct its implementation. The team must be creative in its plans for training to ensure that the new methods, technologies, and educational solutions will reduce the overall time and cost of the required commitments to deliver results. They must understand that, when standard solutions continue to be the most effective means of achieving results, projects must be properly justified and prioritized. They must find multiple functions for educational resources, including, but not limited to, classroom space and in-house instructors. They must promote communication among all players during the planning process, and constantly provide status reports and issue summaries to ensure that everyone's requirements are addressed as efficiently as possible.

However, even with the best of efforts, the education plan will not anticipate every issue or obstacle. The planning team must create a flexible plan that may be adapted to meet constraints as they arise. Their overriding objective is to produce a plan that, over the long run, addresses the most useful fundamental skills.

A number of vendors have implemented a number of algorithms. One method may be more appropriate than another, depending on the type of data and the goal of the project. Each algorithm has its own unique advantages and disadvantages, some of which are discussed later in more detail. One important consideration is the level of "noise" present in the data. There is no such thing as perfectly clean and accurate data. All data have some inherent level of error, or noise. Tool packages, available commercially, allow the end-user to specify acceptable limits for noise in the model.⁴⁸

2.3.6.8 Data

The capture of discrete data is essential to drive a clinical decision to support "knowledge engines" and performance measurement systems. All processes for delivering and measuring care can be mapped to the requisite data required for superior performance. The method for designing and deploying structured encounter-flow documentation is iterative.

⁴⁸ Groth R. 1997. *Data mining: A hands-on approach for business professionals*. Upper Saddle River, NJ: Prentice Hall.

Encounter documentation is done for a variety of purposes that drive the content's quality and quantity. Three major reasons for documentation are: 1) to remind the clinician of prior care to guide the current care; 2) to communicate with other caregivers; and 3) to account for reimbursable care. The major goals of process improvement and process efficiency are poorly served by these common, loosely structured methods. Structured encounter documentation is an emerging, alternative approach whereby clinicians receive a knowledge-embedded template to use as the starting point of their documentation. These templates are the core components of multi-encounter, multi-disciplinary community guidelines. An enormous volume of data is generated, but few tools exist in the health-care setting to analyse the data fully in order to determine the best practices and the most effective treatments.⁴⁹

In general, the health-care industry lags far behind other industries in terms of IT expenditures. So, our industry's IT infrastructure is underdeveloped in comparison. This lack of IT sophistication, together with some historical scepticism from clinicians, has hindered the ability to analyse data adequately. Typically, data are stored in legacy systems that were never designed as long-term storage solutions, let alone allow for real-time analyses. Historically, there has been some clinical resistance regarding the collection of data. Some clinicians believe that the collection of data methodologies is flawed and that the use of data will threaten their decision-making authority.

As health care continues to become more complex, the industry needs to find an effective means of evaluating its large volume of clinical, financial, demographic, and socio-economic data.

By means of knowledge discovery in databases, companies learn to understand the mechanisms that drive their businesses. Health care is not alone in its struggles with data. Other industries have faced similar problems, with volumes of data exceeding their ability to properly evaluate and analyse it. Just a few years ago, databases were rare and were the exclusive domain of the IT department. However, as technology advanced, databases became easier to use, and business analysts began to create their own databases. This ever-growing volume of data needed new techniques for their interpretation and analysis.

As defined by Fayyad, Piatetsky-Shapiro and Smyth, "Knowledge discovery in databases is the non-trivial process of identifying valid, novel, potentially useful, and ultimately under-

⁴⁹ Hawkins HH, Hankins RW & Johnson E. 1999. A computerized physician order entry system for the promotion of ordering compliance and appropriate test utilization. *Journal of Health-care Information Management* 13(3), 63-72.

standable patterns in data.”⁵⁰ A seasoned analyst may be able to find relationships between two or three major variables, but would not be able to find more subtle underlying relationships that may exist in multiple variables. Understanding the relationships is key to building a more successful business. Simply put, there is money to be found in data when it is properly leveraged.

A health-care organization that wishes to implement an HIS, needs a skilled employee who understands the organization’s data, the health-care industry, the selected HIS software, and modelling principles. Management engineers, business users with good analytical skills, and analysts of information systems are good candidates to implement HIS products. Implementation times vary considerably, depending on the chosen product and the cleanliness of the organization’s data.⁵¹

Due to the immense size of the sets of data, computerized techniques are essential to help physicians, as well as administrators, to understand relationships and associations between data elements. Data mining is closely associated with databases and shares some common ground with statistics, since both strive toward discovering structure for data. However, while statistical analysis starts with some kind of hypothesis about the data, data mining does not do so. Furthermore, data mining is much more suited to deal with heterogeneous databases, data sets and data fields - typical of data in medical databases that contain numerous types of text and graphical data sets. Data mining also draws heavily from many other disciplines, most notably machine learning, artificial intelligence, and database technology.

Thus, data mining is the non-trivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns from data. Clinicians accomplish these tasks daily in their care of patients while using their own “personal CPU.” However, the enormous amounts and divergent sources of information, coupled with time constraints, limit any clinician’s ability to examine all issues fully. Data mining algorithms are used on databases for model building, or for finding patterns in data. When these patterns are new, useful, and understandable, we call it “knowledge discovery.” How to manage such discovered knowledge and other organizational knowledge is in the realm of KM.

⁵⁰ Fayyad UM, Piatetsky-Shapiro G & Smyth S. 1996. From data mining to knowledge discovery: An overview. In UM Fayyad, G Piatetsky-Shapiro, P Smyth & R Uthurusamy (eds.), *Advances in knowledge discovery and data mining*. Menlo Park, Calif.: AAAI Press, 6.

⁵¹ Degruy KB. 2000. Health-care applications of knowledge discovery in databases. *Journal of Health-care Information Management* 14(2), 59-69. Health-care Information and Management Systems Society and Jossey-Bass Inc., Publishers.

Like data mining connected to knowledge creation, another technology-driven technique is the area of business intelligence and the now newer term of “business analytics” (BI). This term has become synonymous with an umbrella description for a wide range of decision-supportive tools, some of which target specific user audiences.⁵² At the bottom of the BI hierarchy are extraction and formatting tools that are also known as “data-extraction tools,” which collect data from existing databases for inclusion in data warehouses and data marts.

2.3.6.9 Management

The most common failure of many health-care transformation efforts is related to the failure of organizations to develop empowered, accountable leaders, or to the premature disengagement of leadership after the launching of initiatives for HISs. It is essential that executive leaders build organizational structures that clarify lines of accountability for clinical service excellence and efficiency, and also enhance communication and effectiveness among leaders and direct-care providers. In many enterprises, initiatives for performance improvement often have inadequate authority, sponsorship or methodology to succeed. Leadership is required to determine where centres of excellence would be developed, where standardized cross-system processes are preferable, and which elements of excellence in practice can be generalized.

Effective analysis of health-care information is a central component in formulating strategies for improvement initiatives. These initiatives involve the analysis of episodes of care, comparisons of quality measuring, resource utilization and investigation of temporal relationships between various factors and outcomes.

Health-care professionals must strengthen their roles in facilitating electronic exchange for the access and use of health information, while protecting the privacy and security of the information about patients’ health. The health-care professional’s evolving role, as a data steward, should be emphasized and expanded. A need exists for development and implementation of standards for data content, data mapping, and documentation across the health-care continuum. This need is changing and expanding a records custodian’s traditional role to a global focus on balancing access, privacy, and security. At the population level, health-care professionals need to advance privacy and security policies, principles, procedures, and protections of information access and use for the population’s health. The success of the information infrastructure at individual and population levels will enable a flow of

⁵² Kudyba S & Hoptroff R. 2001. *Data mining and business intelligence: A guide to productivity*. Idea Group Publishing, Hershey, Penn.

information between different stakeholders in health care in order to maximize the utility of the information. However, such established infrastructure will need much trust from the users of the infrastructure (e.g., doctors and patients).

Health-care professionals can adopt two strategies to overcome these challenges to the privacy and security of health information. Firstly, health-care professionals should ensure that the practice of health information management complies with the country's laws that cover the various relevant domains. Whenever they have a chance to participate in the design, development, or implementation of an information platform for managing and sharing health information, privacy and security should always have top priority. Without such a mind-set and persistence, privacy and security will be of secondary consideration during the process of design and development. On the other hand, to consumers, health-care professionals should act as educators by showing them the proper way to access their health information, while also maintaining the confidentiality of their records. Consumers need to recognize the advantages of information security from the perspectives of authentication, authorization, and auditing in a digitized environment, as compared to that of paper. They need to understand that a trade-off always exists between confidentiality and accessibility. The essential requirement is that the information be kept integrated and made available to the right person in a timely manner for the purpose of providing care.⁵³

2.4 Organisational Impacts of Health Care Information Systems

2.4.1 Decision Making

Kraemer and Danziger⁵⁴ define decision making as: "The capacity to formulate alternatives, estimate effects and make choices." Results of research in other settings indicate that, although computers provide workers with higher quality and more accessible information for decision and action, expert systems that actually make decisions or aid human decision makers, remain elusive. In health care, decision support systems may assist in diagnostic decision making, as well as interpret, alert, and make therapeutic suggestions. The amount of information available can affect the decision-making ability of health-care professionals. For example, radiologists emphasize the importance of knowing the physicians' reasons for

⁵³ Xiaoming Zeng. 2009. Redefining the roles of health information management professionals in health information technology: Perspectives in health information management 6. Allima Foundation Research in Education and HIM.

⁵⁴ Anderson G James & Aydin E Carolyn. 2005. Evaluating the organizational impact of health-care information systems.

requesting specific tests, to ensure that the appropriate test has actually been ordered, and to assist their interpretation of results.

2.4.2 Control

Kraemer and Danziger define several aspects of control that warrant consideration, including:

- i. control of the individual's work by others;
- ii. the individual's ability to alter the behaviour of others;
- iii. constraints that the job itself imposes, such as time pressures, and
- iv. an increased sense of mastery over one's own work.
- v. However, the control aspects of computerization need not be conceived as "zero sum," but can result in the increased control by all groups.

Research in settings outside of health care has shown that computing has had a minimal impact in control over people in the work situation, perhaps because few systems to monitor employees' work are actually implemented, and monitoring capabilities are seldom used. In the health-care arena, computer systems that have the ability to either monitor or control physicians' ordering patterns, indeed have the potential to shift more control to institution administrators. The use of computers also has the potential to shift the power relationships between physicians and patients.

2.4.3 Increased User Productivity and Efficiency

In general, results show that computers save nurses' time in performing clerical activities, such as filling out requisition slips and assembling charts. Computers that manage the flow of information between nursing and ancillary departments, save time for nurses, whereas systems that emphasize online charting, but not communications, may not save time. Computers also have the potential to increase the quality of information work by reducing errors. Loading data into the computer in a timely, accurate efficient manner also remains an overriding issue in the implementation of medical information systems, especially computerized medical records. Another essential measure of the productivity of today's hospitals is the patients' length of staying.

One of the most prevalent complaints about health IT in general and HISs specifically, is that technology impedes users' productivity. A number of reasons for this relates to usability. Users must search for pertinent information in disparate sections of the HIS and often across different information sources that may include paper. Institutions may have non-integrated HISs from different vendors for inpatient and outpatient care.

A design for IT application may not facilitate easy navigation, ease of learning or recalling, and users may need to remember the navigation for numerous systems as they practice in several settings. One of the most compelling factors related to impaired productivity, compared to other industries, is urgent time constraints in health settings, e.g., 15-minute outpatient visits, tasks in critical care, emergency departments, acute care units and peri-operative units.

The available data impacts on negative productivity due to health IT usability. Several reports have documented impacts of negative productivity due to the usability of a widely deployed outpatient system.⁵⁵ Cognitive walk-through and naturalistic observations in the Charlotte Maxeke Johannesburg Academic Hospital revealed that clinicians worked several hours more per day due to the design of an inadequate system that lacked workflow support for clinical specialties; and users had significant work-around for non-integrated systems. In a laboratory setting, a cognitive work analysis of the same system revealed a large number of average steps to complete common tasks, a high average execution time and a large percentage of mental operators. Incorporating usability principles and methods into the design of a system would help to alleviate major impacts like these on health IT users' productivity.⁵⁶

Poor usability on intranets means poor employee productivity. Nielsen Norman estimates that "...productivity gains from redesigning an intranet to improve usability are eight times larger than costs for a company with 1,000 employees; 20 times larger for a company with 10,000 employees; and 50 times larger for a company with 100,000 employees." The Website redesign of statistics for the 42 cases that Nielsen Norman collected, yielded an average increase in user productivity of 161%. After testing intranets for low and high usability, projects a savings of 48 hours per employee if intranets were redesigned for high usability. Souza cites usability research which shows that two-thirds of buyers failed in shopping attempts on well-known sites.⁵⁷

2.4.4 Decreased User Errors and Increased Safety

One of the major reasons for health IT to be installed is the reduction of errors in health

⁵⁵ Saitwal H, Feng X, Walji M, Patel V & Zhang J. 2010 July. Assessing performance of an electronic health record (EHR) using cognitive task analysis. *International Journal of Medical Informatics* 79(7), 501-506.

⁵⁶ Stagers N, Jennings BM & Lasome CE. 2010 July. A usability assessment of AHLTA in ambulatory clinics at a military medical center. *Military Medicine Journal* 175(7), 518-524.

⁵⁷ Souza R, Sonderegger P, Roshan S & Dorsey M. 2001. Get ROI from design. Available from: Forrester Research at: www.forrester.com

care.⁵⁸ While some classes of errors, such as adverse drug events, clearly can be reduced by means of health IT, technology can create unintended consequences and new errors due to usability; 22 to 24 usability methods, specifically targeted to health IT error reduction, are imperative for designing life-critical systems, decreasing user error and improving patient safety.

However, a report by the Agency for Health-care Research and Quality (AHRQ)⁵⁹ indicates that despite being deeply committed to creating usable products, vendors of HISs, do not yet commonly employ designs of user-entered techniques, nor have dedicated usability resources.

An example of how usability methods can reduce errors is in the area of radiation therapy. *The New York Times* published a series of articles that outlined devastating errors in radiation therapy treatment, including human factors and software usability issues. In Canada, 26 researchers completed an ethnographic field study and workflow analysis to identify issues in their radiation therapy workflow and the associated system's design. A user-centred process for design was implemented to redesign the user interface, which resulted in significantly reducing common errors⁶⁰. In another example, Kushniruk was able to identify how certain types of usability problems related to errors as physicians entered prescriptions into handheld devices.

2.4.5 Social Interaction

Kraemer and Danziger define social interaction as the “frequency and quality of interpersonal relationships among co-workers.” Research on computer impacts has documented increased interdependence and communication between individuals and work groups connected by computers. Individuals use electronic mail to send information that would not have been sent or received without electronic mail, and individuals who share common databases meet face to face as often as before computerization to discuss the shared system.

2.4.6 Job Enhancement

One of the early debates related to computerization concerned the question whether the use of

⁵⁸ Institute of Medicine (IOM). 2001. *Crossing the quality chasm: A new health system for the 21st century*. Washington, D.C.: National Academy of Sciences.

⁵⁹ McDonnell C, Werner K & Wendell L. 2010 May. *Electronic health record usability: Vendor practices and perspectives*. Agency for Health-care Research and Quality (AHRQ) Publication No. 9(10)-0091-3-EF Rockville, MD: Agency for Research and Health-care Quality.

⁶⁰ Chan AJ, Islam MK, Rosewall T, Jaffray DA, Easty AC & Cafazzo JA. Dec 2010. The use of human factors methods to identify and mitigate safety issues in radiation therapy. *Journal of Radiotherapy and Oncology*. 97(3), 596-600.

computers would reduce or expand the variety of tasks and skills associated with specific jobs. According to Kraemer and Danziger, most research indicates that, particularly for jobs that involve diverse skills, computing has enhanced workers' perceptions of their job domains. In the health-care arena, the emphasis on cost efficacy and the need to streamline work processes and retain highly trained employees resulted in renewed interest in issues regarding job design. Although an evaluation of computerization's impact on health-care workers' skills also had to consider the existing job content, neither study showed that computerization had an impact on the core job dimensions of the employees under study.

2.4.7 Work Environment

In general, research results indicate that computing may increase stress and time pressure for some workers. However, the results mostly show that computing has increased the workers' job satisfaction and interest in their work.

2.5 Conclusion

From the literature review, the design of information displays (i.e., user interfaces) is central to ensuring that HISs effectively and efficiently support clinical tasks such as those highlighted in the previous sections. However, as both the clinical tasks and supporting technologies evolve, it is necessary to develop a basic framework to evaluate HIS usability against set and proven standards and guidelines which enable high quality and efficient patient care. It is important to note that both functionality and usability are essential elements of success, as HISs must provide the correct elements of functionality necessary to support clinical tasks as well as providing functionality that adheres to proven design principles necessary for efficient and effective use.

Upon completion of system implementation and organizational changes educed, the next logical process is the review of the project and also measuring of its success. It is only through an evaluation study that will show whether or not a specific system was successful in a specific setting. Criteria which predicts success or failure is still unclear, but it is likely that no single criterion can account for the success or failure of an Information System.

Increased observation, measurement, and lessons learned are needed to improve the accuracy of user interaction with HISs and the computing devices they run on. The development of metrics to describe an HIS's impact on ergonomic workload, cognitive workload and data comprehension would all be very useful in the evaluation and comparison of current HIS

products. Measurements specifically focused on usability would provide insight into the ease with which clinicians are able to integrate HIS use into the care setting and patient encounter. While this thesis does not thoroughly address evaluation methodologies it does provide an initial framework of concepts to be considered in design and usability evaluation. The use cases and design principles described in the following sections provide a starting point for the framework necessary to evaluate HIS adherence to information design principles.

Evaluation of HIS offerings is a complex but necessary undertaking. Once practical metrics have been developed, high performing HISs (in terms of information design and usability) can be identified and direct comparisons can be made which would support end users in making more effective purchasing decisions. New entrants into the market can be effectively compared to existing programmes, increasing the ability for promising technologies to enter into clinician use. Performed correctly, usability evaluation will provide the vendor community with proven evidence of particular design considerations that would be valuable to product enhancement efforts. Over time, one would expect movement towards enhanced consistency in the design and display of HIS products.

Evaluation structure and methodologies could take many forms, and this thesis does not fully address the extent of options. They range from conducting structured observations of mature HIS offerings in use through government-supported efforts like Practice-Based Research Networks, to improving the ability to track and evaluate actual HIS use through expanded use of captured audit trail data and structured analysis of navigation patterns. Another structural approach will be the creation of a National HIS Usability.

Usability can be judged based on the adherence to a set of established design principles. General principles have been developed for the design of effective information displays. These principles serve as a basis for heuristic evaluation of any system regardless of function or purpose. Usability problems can be observed by evaluators and, with associated use cases, analysed for expected impact on end users and system performance. The use of these principles and evaluation methods for HIS displays is necessary in the identification and design of effective HIS user interfaces.

Existing efforts to evaluate Health Information Systems are insufficient for the broad identification of best practices in information design. Further, the recognition of usability as a critical issue varies across organizations responsible for setting standards and not enough objective evidence currently exists to inform specific design considerations. Developing

standards and guidelines for the design of HIS user interfaces is a necessary undertaking to ensure that the current investments in health IT deliver the expected returns in efficiency and quality. The consistent presentation of well- designed user interfaces by HIS offerings will improve the usability, effectiveness, and implementation of HISs throughout the country.

Divergent opinions exist as regarding the ideal method for ensuring that usability is evaluated and communicated across the industry and to customers. These divergent opinions exist even within companies, as well as across vendors. Regardless of this uncertainty, there is agreement that end users need to remain a central component within the development process, that innovation needs to be encouraged, and that usability needs to be a critical driver of efficient, effective, and safe HIS⁶¹.

Among health care professionals, new innovations are predominantly judged by their value for patient care. However, systems that support the process of health care without being directly relevant to patient care are less easily accepted. In particular, attempts to introduce Health Information Systems that require data entry by health care providers have consistently been unsuccessful⁶².

In HIS terms, what is successful? The complete refusal of users to use a system is certainly a failure, but often success remains undefined. Clearly the determinant of success depends on the setting, the objectives and the stakeholders. Only a thorough evaluation study can show whether or not a specific system was successful in a specific setting. Which criteria predict success or failure is unclear, but it is likely that no single criterion can account for success or failure of an Information System.

The value of Health Information System is often measured against the value of the familiar paper-based systems, with the paper based systems serving as the gold standard, despite its well-known limitations⁶³. Definitions of success also vary over time. A system that is successful today may be considered a failure in a decade due to technical limitations or altered demand expectations. To compensate for these factors, a good evaluation should include multiple, carefully selected periods of data collection and should include all stakeholders points of view.

⁶¹ Dan Armijo, Cheryl McDonnell, Kristen Werner. October 2009. Electronic Health Record Usability, Evaluation and Use Case Framework. Agency for Healthcare Research and Quality.

⁶² Van der Meijden, M.J. Tange, H.J. Troost J. Hasman A. 2003. Determinants of Success of Inpatient Clinical Information Systems: A Literature Review. *Journal of the American Informatics Association.*(10)3, 235-243

⁶³ Berg M. 2001. Implementing Information Systems in Health Care Organizations: Myths and Challenges. *International Journal of Medical Informatics* (64)1, 43-56

The next chapter details the principles of system usability and the metrics to be used when conducting evaluations of system usability. It focuses on pertinent and established categories of usability and design like, e.g. describing the design characteristics which directly support the user-system interaction. Most important to this category is the ability to provide necessary system information to the user when needed and ease of learning, as the system should be designed to reduce the cognitive load on users.

Usability can be judged by adherence to a set of established design principles. General principles have been developed for the design of effective information displays. These principles serve as a basis for heuristic evaluation of any system regardless of function or purpose. Usability problems can be observed by evaluators and, with associated use cases, analysed for expected impact on end users and system performance. Using these principles and evaluation methods for HIS displays is a necessary step in the identification and design of effective HIS user interfaces.

The use cases and evaluation considerations presented in this thesis serve only as a foundation for the development of a common framework for the evaluation of HIS design.

Chapter 3

Usability and the Construction of the Survey Instrument

3.1 Introduction

In spite of the seeming advantages that health IT offers to clinicians and hospitals, the proportion of those providers that actually use such systems is relatively small. Several factors may explain the low rate of adoption, including the challenges that arise during the implementation of the systems, the inability of providers to capture all the financial returns of the health IT systems that they purchase and, in the case of health insurance plans, the possibility that the efficiencies they garner by using health IT will benefit their competitors, and uncertainty about the value of the advantages to be gained from adopting a health IT system and the evolution of laws that affect its acquisition and financing.

Generally, in recent years, numerous failures of implementation of HISs have been recorded in relevant literature. However, the exact number of information system failures is unknown, as organizations and individuals are reluctant to make these problems known. While large-scale failures of health-care IT systems pose significant problems, smaller-scale failures, resulting from incomplete delivery on expectations, also are disconcerting.

Survey results regarding IT implementations across a wide range of industries from the Standish Group in the UK suggest that 18% of IT implementations are outright failures, while an additional 53% are challenged during implementation. Additional problems are seen in cost overruns and delays in project completion. A variety of reports have suggested reasons for the failures of implementation, including a lack of user involvement, poor communica-

tion, a lack of attention to human and organizational issues, and poor project planning.⁶⁴

Projects of information systems' implementation have historically been plagued by failures for which user resistance has consistently been identified as a salient reason. A survey of 375 organizations from around the world indicated that user resistance is the first-ranked challenge for the implementation of large-scale information systems (ISs). User resistance becomes particularly significant in such IS implementations, due to the multifarious changes in social as well as technical systems that result (Gibson 2003). In response to the changes, users may resist the new IS and cause delays in the project's duration, budget overruns, and underutilization of the new system. In particular, user resistance prior to IS implementation (i.e., when the system is first being deployed) is widespread and critical for the project's success. Despite the importance of understanding and managing user resistance for the success of an IS implementation, a few studies (e.g., Joshi 1991; Lapointe & Rivard 2005; Martinko *et al.* 1996) have proposed theoretical explanations of user resistance. Furthermore, with the dominance of case studies in this area, there is a lack of theoretically grounded approaches with quantitative empirical validation (e.g., through surveys). While losses and threats have been noted as causes of user resistance in previous studies, there are gaps in the understanding of the psychological and decision-making mechanisms underlying the resistance to the new IS.

However, adoption of an HIS remains limited. One major hurdle to effective implementation has been the inability of multiple systems to share information effectively. While lacking a standard format and vocabulary, systems do not always effectively and unequivocally communicate the necessary information among all participants in the transaction. This reduces the effectiveness and attractiveness of using an electronic system.⁶⁵

The incomplete adoption of an HIS, that is, if new workflow processes are not developed to optimize the use of the system, the practice of duplicate work (using both paper and electronic systems) fails to optimize the HIS, and a full return on its investment will not be enjoyed. Currently, most vendors of HISs are narrowly focused on updating the data entry component of the physician's examination with over-structured elements that don't meet the broader needs of the practice.

⁶⁴ Lorenzi *et al.*, June 2008. Crossing the implementation chasm: A proposal for bold action. *Journal of the American Medical Informatics Association* (15)3, 290-296.

⁶⁵ Papshev D & Peterson AM. 2001. Electronic prescribing in ambulatory practice: Promises, pitfalls, and potential solutions. *American Journal of Managed Care* 7(7), 725-36.

3.2 Complexities with Usability

The National Institute of Standards and Technology (NIST) defines usability as the “... effectiveness, efficiency and satisfaction with which the intended users can achieve their tasks in the intended context of product use.”⁶⁶ This concept is critically important in promoting both the widespread adoption and “meaningful use” of HISs. Usability has been cited as a major factor in both the acceptance and effectiveness of HISs in a clinical setting. Examples that describe potential negative impacts of HISs on efficiency, cognitive load, team collaboration, and medical errors can all be linked, at least in part, to issues directly related to usability and design.⁶⁷

While the broad issue of usability is often cited in the literature related to less than ideal results of the use of HIS, evidence exists that this issue is often poorly understood and that HIS developers and users alike do not adequately address it. Even the prevailing body for setting standards and certifying the use of HISs specifically excluded usability requirements in their original certifications, and have only recently formed a usability workgroup to address this issue.

There are many potential reasons for this lack of attention to the usability of HISs. Unlike the more straightforward identification of desired software features, functions, and interoperability goals, the HIS’s usability can be a more subjective and elusive concept. Effective usability measures involve observations of direct use in clinical settings, along with noting unexpected patterns of workarounds and errors that the design induces. The complexities of outpatient clinical environments are difficult to replicate in laboratory settings, and ethical and privacy concerns may prevent some types of usability evaluations in clinical settings. This is further complicated by the vendor community’s inability, or unwillingness, to invest heavily in user-acceptance testing constructed by usability, information design, and usability expert involvement in product development. The market’s inability, or unwillingness, to pay consistently for the level of implementation support required to appropriately incorporate technology into clinical practice (which can involve a level of process improvement beyond the capital for change available in many practices) has also limited the quality of the available usability “evidence.” It is uncommon for the implementation of HISs’ teams to include

⁶⁶ Armijo D, McDonnell C, & Werner K. 2009. *Electronic health usability: Interface design considerations*. Vol.9.

⁶⁷ Kopel R, Metlay JP, Cohen A *et al.* 2006. Role of computerized physician order entry systems in facilitating medication errors. *Journal of American Association of Medical Association* 293(10), 1197-203.

usability experts and HIS end users; so, critical for the evaluation of usability is the typical lack of the skills or training required to assist in designing for usability. These factors combine to create an environment where usability has not received the required level of attention and investment, despite the best intentions of both HIS vendors and users.⁶⁸

For years, experts have praised HISs for their potential to improve patient care, reduce medical errors and contain costs, nevertheless, implementation remains a challenge. Despite improvement in technology, the ability of public health institutions to manage and reuse vast arrays of data and information has not necessarily optimized the management of what they know would improve the delivery of essential public health services. The lack of understanding how an organization does business, how it collects data, and uses information for development impacts negatively on the implementation and use of KM systems.

It has become common knowledge that, in the near future, ISs will increasingly be used to ensure a high quality of patient care, will also increasingly be used to increase administrative and individual worker productivity, which may result in lower health costs. It also seems that consumer health informatics will be used increasingly to facilitate better, easier, and faster communication among patients, payers, and health care providers.⁶⁹ So, system usability will inevitably increase.

One of the most important contributions of IT and systems to business organizations is the reduction in the uncertainty of information and resulting improvement in decision making.⁷⁰ Over the last decade, IT has contributed directly to an improvement in the quality of information that flows to management and employee decision makers. However, ISs have not yet contributed to some important areas of management life, which will provide great opportunities for future systems' efforts.

Significant investments in IT have lifted the fog of uncertainty and replaced it with a much more precise, timely and accurate level of decision making that was unimaginable a few years ago. These trends towards more real-time information and decision making will accelerate as new wireless technologies for communication and mobile computing platforms extend their reach.

⁶⁸ Armijo D, McDonnell C & Werner K. 2009. Electronic health record usability – evaluation and use case framework. Agency for Health-care Research Quality.

⁶⁹ Mullner M Ross & Chung Kyusuk. 2006. Current issues in health care informatics. *Journal of Medical Systems* 30(1), 1-2.

⁷⁰ Laudon KC & Laudon JP. 2004. *Management of information systems – Managing the digital firm*. 8th edition. Upper Saddle River: Prentice Hall. ISBN: 0-13-120681-8.

Two countervailing arguments are evident about how the digitization scope could impact on performance. On one hand, classical arguments about the benefits of information technologies suggest that the exploration and adoption of a larger number of IT solutions will enhance performance, because of their positive impacts on the efficiency of transaction processing, decision-making speed and accuracy, and organizational intelligence.⁷¹ The ability of IT to enhance the reach and range of organizations' processes helps them to coordinate work across organizational boundaries at a much lower cost.⁷² Furthermore, ITs are associated with lower costs for internal and external coordination; hence, digitization should lead to overall lower costs of operations.⁷³ Within the clinical activity systems, a greater digitization scope implies that the hospital has adopted a larger number of clinical applications that cumulatively would enhance the ability to gather, store, and disseminate clinical information across doctors' and treatment facilities. In addition, the adoption of more clinical applications could also improve doctors' decision-making support (e.g., adverse medical interactions, prior treatment history, etc.). Within the business activity systems, a greater digitization scope implies the availability of technological solutions to support a wide administrative and patient relationship management activities (e.g., patient registration, billing, insurance claims). They would benefit improved efficiency and speed of the business activity systems.

However, the countervailing argument is that the digitization scope simply captures the initial adoption of a large number of IT solutions. Regardless of the potential benefits of the technological solutions, their benefits and impacts are not automatic. Prior research on the assimilation gap demonstrates that there is a significant time lag between the initial adoption and eventual use of ITs in organizational activities.⁷⁴ Thus, while organizations are likely to gain from the adoption of ITs, the mere adoption does not lead to realizing their superior capabilities. Due to its experimental nature, exploration is known to be uncertain, unless it is followed by an elongated period of exploitation. While emphasizing the opinion, March (1991) points out, "... returns from exploration are systematically less certain, more remote

⁷¹ Jasperson J, Carter PE & Zmud RW. 2005. A comprehensive conceptualization of postadoptive behaviors associated with information technology enabled work systems. *Journal of MIS Quarterly* 29(3) 525-557.

⁷² Keen PGW. 1991. *Shaping the future: Business design through information technology*: Harvard Business School Press.

⁷³ Gurbaxani V & Whang S. 1991. The impact of information systems on organizations and markets. *Journal of Communication Association of Computing Machinery* 54(1) 59-73.

⁷⁴ Cooper RB & Zmud RW. 1990. Information technology implementation research: A technological diffusion approach. *Journal of Management Science* 36(2) 123-139.

in time, and organizationally more distant from the locus of action and adaptation.”⁷⁵ In addition, the introduction of new innovations is often disruptive and changes the existing work practices. In the case of a failure to assimilate the innovation, the organization is usually worse off as it might lose its existing set of successful routines.⁷⁶ Previously, this was documented in the health-care organizations for the implementation of enterprise resource planning (ERP) systems⁷⁷ (Dryden, 1998). Therefore, greater experimentation and exploration with new ISs in health-care organizations may not be sufficient to warrant performance improvements.

While taking these arguments into account, it has become apparent that implementation of the scope of HISs within the business or clinical activity systems will not have a significant link with hospital performance.

The experience of digitization captures the amount of time that an organization has spent in using any IT solution in its activity systems. Prior research has demonstrated that at least three enabling factors are required in order to enhance the assimilation and use of any IT.

First, depending upon the nature of the technological solution, users must make sense of its features and how to apply them in the context of their work.⁷⁸ Users experience significant knowledge barriers in making sense of the technology, and learning how to apply it effectively. With time and experience, they are able to learn about the features and effective ways of implementing them.

Second, organizations should enable assimilation by providing resources in the form of training, management support, or rewards and incentives. Though these resources are vital, they do not guarantee high levels of assimilation and use.⁷⁹ In fact, they should motivate users to invest their time and attention toward making sense of the technology and discovering how to use it effectively.

Therefore, even in the presence of the enabling resources, users need time to develop the needed experience and competence with the technological solutions. Finally, the effective use

⁷⁵ March JG. 1991. Exploration and exploitation in organizational learning. *Journal of Organization Science* 2(1) 71-87.

⁷⁶ Mitchell W & Singh K. 1993. Death of the lethargic: Effects of expansion into new technical subfields on performance in a firm's base business. *Journal of Organization Science* 4 152-180.

⁷⁷ Dryden P. 1998. ERP failures exact high price. *Computerworld*.

⁷⁸ DeSanctis G & Poole MS. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Journal of Organization Science* 5(2), 121-147.

⁷⁹ Orlikowski WJ, Yates J, Okamura K & Fujimoto M. 1995. Shaping electronic communication: The metastructuring of technology in the context of use. *Journal of Organization Science* 6(4), 423-443.

of technology requires mutual adaptations to the technology's features and the work processes to which they are being applied.⁸⁰ Through a recursive process, organizations and users discover how to "fit" the technology's features to the "adapted" tasks and activities so that these features are used effectively. As more time elapses, there is a higher probability for the mutual adaptation to occur. Purvis, Sambamurthy and Zmud (1999) found that more time after the adoption of IT enhances its organizational assimilation and use.⁸¹ Devaraj and Kohli (2003) demonstrate that higher levels of assimilation and use are key to the performance impact of an IT.⁸²

Upon the initiation of a system's implementation, it becomes increasingly more difficult to attain full user participation in the project. A conflict or competition of priorities always exists, because the project must not affect the work's daily operations.

3.2.1 User Resistance

In many cases, the physicians' resistance is justified and lies within the decision of support systems as such, for example, a medication decision supports tools to be integrated into HISs, which are often little more than pharmacist-friendly systems that have been retrofitted for the physicians' use. These redesigns often fail to take into consideration the differences between how physicians prescribe, and how pharmacists fill, those prescriptions. One example is prescribing systems within the HIS that require physicians to select medications based on pre-set dosages, rather than allowing them to simply indicate the prescribed dosage. When the pre-set options do not match the desired dosage, physicians are forced to find ways to work around the limitations, which often means overriding alerts or simply not utilizing the HIS. Systems that require significant changes in prescribing practices also thwart the physicians' acceptance. Their frustration with such requirements is further compounded by the rapidly growing number of delivery methods resulting from advances in pharmaceutical development.⁸³

Other obstacles include systems that are simply too difficult to use or that have excessive

⁸⁰ Leonard-Barton D. 1995. *Wellsprings of knowledge*. Boston, MA.: Harvard Business School Press.

⁸¹ Purvis RL, Sambamurthy V & Zmud RW. 2001. The assimilation of knowledge platforms in organizations: An empirical study. *Journal of Organization Science* 12(2), 117-135.

⁸² Devaraj S & Kohli R. 2003. Performance impacts of information technology: Is actual usage the missing link? *Journal of Management Science* 49(3), 273-289.

⁸³ Basta N. 2010, April 30. Drug-delivery technologies for controlled release score with manufacturers. *Pharmaceutical Commerce*. retrieved June 27, 2010, from http://www.pharmaceuticalcommerce.com/frontEnd/1472-controlled_release_ODT_Erand_Elan_opioids_labopharm.html

nonessential, confusing or poorly constructed alerts and reminders. These cause workflow disruptions and declines in productivity - neither of which the typical physician can afford to tolerate.

However, there have been reports of poor implementation of an HIS, resulting in degradation of patient safety and quality. When implications of the workflow and human factor are not adequately accounted for, there could be significant unintended consequences. The physicians' adoption of the computer has also long been associated with a perceived increase in work of low value and the ever-present issues of change management. Limitations in technology can account for some of these, but many are a product of the poor accounting of workflow issues and resistance to change that are perceived as being of low value. However, according to a recent report, health-care providers indicate that electronic order sets have the greatest effect on their organization, followed by evidence-based alerts and reference content. Inevitably, issues arise during any implementation, and the occurrences of new kinds of errors are unavoidable. Additional time of clinicians is also required for the creation and optimization of clinical content.

3.2.2 Organizational Commitment

Managers and clinicians (physicians and nurses) in health-care delivery systems too often blame undesirable consequences and implementation failures on the performance of the newly introduced technology. Although technical flaws often cause problems, many harmful, or otherwise undesirable, outcomes of the implementation of HISs flow from socio-technical interactions, the interplay between a new HIS and the provider organization's existing social and technical systems, including their workflows, culture, social interactions, and technologies. These socio-technical interactions have been richly documented in literature on HIT's unintended consequences.

With their potential to minimize practice variation and improve patient care, HISs have begun to surface throughout the health-care industry. The widespread adoption of HISs depends on having the right organization and individual financial incentives in place. Although HISs and clinical IT in general are powerful tools that can be used to support the practice of medicine, they alone cannot redefine the workflow or process within the profession. Health-care managers who count on technology to restructure or monitor clinicians' work patterns, are likely to encounter substantial resistance to HISs, even those that generate valuable information. While the pace of implementing IT systems in health care has lagged behind that of other industries, many of the obstacles are gradually diminishing. However, several factors

continue to inhibit their widespread diffusion, including the organizational turmoil created by large numbers of mergers and acquisitions, and the lack of the standards of uniform data.

Adopting an HIS involves more than just deciding to spend money; it is a major organizational commitment that, for hospitals in particular, will probably last for several years. To take full advantage of such a system may require physicians to redesign substantially the way they practice medicine. HISs are only as helpful as the information that is fed into them. Some of that information is part of the system when it is purchased, but much of the technology's value materializes when physicians devote considerable time to training, to personalizing the system, and to adapting their work processes to achieve the maximum benefits.

Breaking through physicians' resistance to a decision for medication support requires addressing all these issues in a way that meets the needs of both the clinicians who enter the initial orders and the pharmacists who fill them. Doing so will not increase the physicians' adoption at the point of care, and accelerate the reduction of adverse drug events and medication errors.

On the system's side, the solution is to deliver the kind of intuitive, logical decision support and order entry options to which physicians can relate and which do not disrupt workflows or care processes.

The point here is that usability is important. Developers must make it easy for a clinician to "do the right thing." In the world of human factors, usability testing has had a tremendous impact on improving systems, and what appear to be nuances can make the difference between success and failure. While it should be obvious that clinical computing systems are no different, usability testing has not necessarily been a routine part of their design. We have had many experiences in which a minor change in how screens were designed had a major impact on the provider's actions.⁸⁴ For example, providing clinicians with a list of patient-appropriate dosing parameters for each medication is a simple and relatively unobtrusive way to reduce dosing variability and errors. Utilizing defaults to assist selection of the most appropriate initial dose can drive the same outcome.

Other suggestions include providing physicians with complete pre-written medication orders that include dosage, a dose form (when necessary), route of administration, frequency and a

⁸⁴ Bates DW, Kuperman GJ, Wang S, Gandhi T, Kittler A, Volk L *et al.* Ten commandments for effective clinical decision support: Making the practice of evidence-based medicine a reality. *Journal of the American Medical Informatics Association* 10(6), 523–530.

reason (if necessary).

Alternatively, the system may provide separate recommendations for dosage and frequency.⁸⁵ These enhancements can decrease errors caused by unintentional oversight, a misplaced decimal point, or incorrect dosing unit. As a result, they serve the dual purpose of reducing errors through dosage guidance and increasing physicians' acceptance by enhancing workflows.

Though potentially more intrusive, another possible resolution is to enable order reviews by algorithms that are invisible to end users and which run after obtaining the user's dosing parameters. In this case, clinicians would be alerted only when reasonable dosing parameters have been exceeded.⁸⁶

Finally, to enable human intervention in the form of reviews and evaluations in order to determine what is, and what is not, working can also have a significant impact. For example, to have respected clinician experts that screen all alert language and recommendations prior to deployment, helps eliminate controversy and increases the perceived value. To task pharmacists with regular reviews of ignored alerts can generate a better understanding of why the warning was overridden, and leads to modifications and refinements that ultimately advance acceptance.

3.2.3 Achieving Physician and Clinician Involvement

For a significant impact on removing obstacles to adoption, providers and vendors must cooperate to address the obstacles that prevent physicians from embracing these important tools at the point of care. When vendors of HISs design systems specifically for physicians' needs, rather than retrofitting systems designed for a pharmacy, and by finding ways to deliver intuitive guidance when it is needed as well as alerts that advance, rather than disrupt, the care process, the physicians' resistance can be overcome. As adoption and acceptance rates increase, medication errors and other adverse events will decrease.

The end result will be an HIS empowered by decision support, which will finally provide decision makers with tools that make it possible to achieve large gains in performance, narrow gaps between knowledge and practice, and improve safety.

⁸⁵ Kuperman GJ, Bobb A, Payne T, Avery AJ, Gandhi T, Burns G *et al.* Medication-related clinical decision support in computerized provider order entry systems: A review. *Journal of the American Medical Informatics Association* 14(1), 29–40.

⁸⁶ Oppenheim MI, Videll C, Velasco FT, Boyer AG, Cooper MR, Hayes JG *et al.* 2002. Impact of a computerized alert during physician order entry on medication dosing in patients with renal impairment. In IS Kohane (ed.), *AMIA Annual Symposium: 2002* (pp. 577–581). Philadelphia: Hanley & Belfus.

Health care remains a turbulent industry. *Healthcast tactics: Blueprint for the future* (May 2002, PricewaterhouseCoopers) previews health care's next five years. Health-care organizations that want to arrive at the future first, must begin manoeuvring today and focus on the right paths.

This research identifies multiple issues that face health-care organizations today, including the turnover of staff and increased demand with lower patient satisfaction. One potential solution that truly allows a health-care organization to leap over current constraints is the digital hospital. Designed and implemented by an interdisciplinary team, the digital hospital provides leadership with the opportunity to move past historical, inefficient processes and move to an environment where the facility's design adds to efficiency; information is available where, when, and how it is needed; and staff have full ownership of the design and delivery of patient care.

Health-care executives, who construct a new facility, have a one-time opportunity to deliver enterprise-wide, technology-enabled innovation in care delivery, operations, and administrative processes. An innovative approach to achieve optimal process design must be used. This approach must ensure new thinking, plus identification and consideration of emerging technologies, and results in an appropriate risk profile for the organization.

An organization's ability to apply technology to optimize care delivery, operational and administrative processes, will directly affect revenue growth and profitability due to dramatic improvements in quality of care, reductions in costs, market share growth, and physician and consumer preference. While considering the construction of a digital hospital, the leadership faces many issues. Many damaging risks must also be considered - how can costly mistakes be avoided? The leadership faces critical decisions that affect the long-range success of the digital hospital, including:

- i. Strategy and visioning
- ii. Facility design
- iii. Clinical and administrative workflow design.

Patient care is centred on the patient - the digital hospital's ultimate "end user." Physicians and other clinicians provide that care, and their involvement in everything - from the hospital's design to functional requirements - is critical. Involvement and the program's strong sponsorship of the physicians' leadership are crucial. To achieve full use of clinical systems, resulting in return on investment, physicians must have ownership in the decisions

made during design and implementation. Also key to the success of the program are skilled clinical facilitators involved in the design of the future state.

3.2.4 A Collaborative Approach

While tweaks to the systems themselves can go a long way toward overcoming the physicians' resistance, a comprehensive solution can only come from collaboration. Hospitals, HISs and pharmacy-system vendors and medication knowledge-base vendors "need to collaborate if we are to realize the benefits of Clinical Decision Support Systems and make medication use as safe and effective as possible." The importance of patient safety dictates that all parties should work expeditiously on these problems. All stakeholders must work to build consensus on what contra-indications to include in HISs. To facilitate a means by which the effectiveness of medication decision support usage can be monitored and the resultant data shared with vendors for consideration in future system- or knowledge-based enhancements, is also critical.

Vendors of HISs should focus on developing user interfaces that present information clearly and concisely, allowing clinicians to act on alerts directly from alert screens when possible, then returning them to their previous workflows. They should support development of more detailed and intuitive knowledge bases and encourage research to deliver an improved quality and breadth of currently available drug information databases.

Knowledge-base vendors should work with HISs and pharmacy-system vendors to implement KM tools that enable user control and allow provider organizations to customize purchased drug information, without damaging information integrity. Further, when possible, knowledge-base vendors should use established and emerging standards and should actively support the development of on-going standards.

Finally, "the area of clinical decision support is replete with opportunities for further research" in such areas as:

- i. The impact of alerts on clinician behaviour and care outcomes;
- ii. Optimal alert presentation;
- iii. Increasing clinicians' sense of satisfaction with alerts and decision support;
- iv. The best means for sharing alert knowledge;
- v. Whether physicians and pharmacists should see the same drug-related alerts.

3.2.5 Information Security

Decreased access to patient information, that is, for practices that do not successfully

implement (or optimize) an HIS, patient safety can suffer because of a diversion of resources and reduced access to critical information that often is in multiple places. Even with an HIS's software, staying on top of laboratories, orders and results, requires a significant amount of staff time. Without a closed-loop order and results-management system, the cost of managing and tracking documents can be prohibitive.

HITs may enhance the safety, quality, and patient-centredness of care, while helping to contain costs and increase efficiency. Unfortunately, there have been disturbing mixed reports on HITs' implementation and outcomes. A growing body of research and user reports reveal many unanticipated and undesired consequences of implementation (usually called "unintended consequences"), which often undermine practices for patient safety and occasionally harm patients. Unanticipated consequences with desirable results may be regarded as happy surprises, while anticipated undesirable outcomes present opportunities for decisions, clarification of values, and implementation trade-offs.⁸⁷

3.2.6 System Effectiveness

While there certainly have been on-going challenges in developing HISs, they actually have proven their reliability and accuracy on repeated occasions (Shortlife, 1987). Much of the difficulty experienced in introducing these systems has been associated with the poor way in which they have adapted to the clinical practice, either solving the problems that were not perceived to be an issue, or imposing changes to the way clinicians worked. What is now being realised is that, when they appropriately fill a role, HISs do indeed offer significant benefits. One of the most important tasks that now face developers of HISs is to characterise accurately those aspects of clinical practice that are best suited to the introduction of health care information systems.⁸⁸

Patient views, once there is a database rich in patient history, the availability of different slices through the history enhances the value of access to historical information. HISs can assist in finding evidence in support of clinical cases, can assist in formulating appropriate specific and accurate clinical questions, and can act as information filters. A system can help in the formulation of likely diagnoses based on patient data presented to it, and the system's understanding of illness stored in its knowledge base.⁸⁹

⁸⁷ Harrison *et al.* 2007. Unintended consequences of information technologies in health care - An interactive sociotechnical analysis. *Journal of the American Medical Informatics Association* (14)5, 524-549.

⁸⁸ Coiera Enrico. 2003. *Guide to health informatics*, 2nd edition, Volume 12.

⁸⁹ Coiera Enrico. 2005. *Guide to health informatics*, 2nd edition, Volume 12.

Concerns about the information explosion in regard to medical information have long been recognized.⁹⁰ The Internet and the World Wide Web have increased the need for quality filtering of information for both clinicians and patients, as more and more medical information is made accessible. HISs have been shown to improve patient safety and to reduce the cost of care. However, while these tools have the potential to improve the quality of health care, problems have begun to surface regarding their proper use. Studies have shown that, although information systems have the capability of sophisticated decision support, these capabilities are often not used. A major reason why these systems are not used optimally is that, while tools have been developed to provide alerts and suggestions based on the information, they have not been refined to the point where they provide advice that is more likely to be heeded.

Most HISs are sponsored by government agencies. Governments are investing in programs for HISs, because they believe such programs will help them to contain health-care costs, improve the quality of care and better manage access to care. The programs for HISs are an endeavour with high stakes, as a result of their highly public nature, the large investment required, and the potential substantial benefits.

It is significant to note that a digital hospital should not be viewed mainly as an HIS project; it is a clinical, multidisciplinary project where the focus is upon information to support clinical decision making and knowledge-based care. Historically, health-care organizations were designed around financial systems and a master plan to design facilities. Clinical needs and operations are then “fitted” into that design.

The implementation of ISs within health care continues to challenge people daily. There are a number of major issues that lead to chasms in the implementation process. These issues start with the lack of understanding of what the users need, move to the creation or purchase of systems the design of which will not support the user’s needs, then to the overall management of the process of implementation. Issues with the organization and operational areas and the lack of attention to already existing evidence regarding implementation widen these major blocks that hold the chasm open. The financial and human costs of ineffective implementation are incalculable.

Throughout the world, IT has revolutionized the way people think and act in many spheres of

⁹⁰ Berner Moss. 2005. Informatics challenges for the impending patient information explosion. *Journal of the American Medical Informatics Association* (12)6, 614-617.

their lives. However, although few would deny the value of information for planning, the implementation and monitoring of health systems and the introduction of computers has made a hesitant start in the field of health care.⁹¹ The greatest progress has been made in the introduction of administrative systems, where the need for accurate utilization of data for budget setting has provided the stimulus. The balance between the costs and benefits of computerized clinical information remains unclear. The adoption of HIT is limited and is likely to remain slow unless significant financial resources are made available and policies are changed, such as financial incentives to clinicians to use HIT.⁹²

The introduction of IT into clinical medicine is not a new problem. However, in spite of numerous projects that the researchers, who carry them out, have deemed more or less successful, a look at HISs today reveals that not many are being used to manage clinical data, which is so important for the treatment and cure of patients.⁹³ The root of this discrepancy could lie in the criteria that are used to assess and evaluate the outcomes of these interventions, and the contention that evaluation in general is value bound; thus conditioned by the views of those who conduct the research and the original premises on which it is based. Methods to evaluate outputs and outcomes of the use of HISs are still a challenge to decision makers, as well as for those who want to measure the effects on IT in health-care settings.⁹⁴

3.3 Survey of Methods of Assessing the Impacts of Health Information Systems

3.3.1 Introduction

The rapid movement of ITs into health-care organizations has raised managerial concern regarding the capability of today's institutions to manage their introduction satisfactorily. Indeed, several health-care institutions have consumed large sums of money and have frustrated countless people in wasted efforts to implement information systems. Unfortunately, there are no easy answers as to why so many projects of health informatics are not more

⁹¹ Herbst K, Littlejohns P, Rawlinson J, Collinson M & Wyatt Jeremy C. 1999. Evaluating computerized health information systems: Hardware, software and human ware: Experiences from the Northern Province, South Africa. *Journal of Public Health Medicine* (21)3, 305-310.

⁹² Poon EG, Jha AK *et al.* 2006. Assessing the level of health-care information technology adoption in the United States: A snapshot. *BioMed Central Medical Informatics and Decision Making*.

⁹³ Sánchez Antonio. 2004. A chronic wound healing information technology system: Design, testing and evaluating in clinic. *Journal of Information Systems Evaluation* (7)1, 57-66.

⁹⁴ Bahlol Rahimi & Vimarlund Vivian. 2007. Methods to evaluate health information systems in health-care settings: A literature review. *Journal of Medical Systems* 31, 397-432.

successful.⁹⁵

Potential methods to measure (in other words, evaluate) the success of HISs, are being debated.⁹⁶ While a single measure of HIS success or effectiveness would certainly be desirable, it seems unlikely that such a measure can be found. In general, the success of an IS can be evaluated by means of:⁹⁷

- i. The quality of information provided to the users;
- ii. The impact of an HIS on users' thinking, decisions or actions; and
- iii. The impact of an HIS on the level of an organization's costs and benefits. The evaluation of the effectiveness of an information system constitutes one of the key issues in the research on ISs.

Although IT-based applications in health care have existed for more than three decades, methods to evaluate outputs and outcomes of the use of IT-based systems in medical informatics is still a challenge to decision makers, as well as to those who want to measure the effects of IT in health-care settings.⁹⁸ With the increased need for the implementation of IT in all health-care domains - such as primary health care and clinical settings, or home health-care environments - for the purpose of providing the optimal use of resource investment, its use is expected to rise. Therefore, the evaluation of such IT applications to help decision makers to acquire knowledge about the impact of IT-based systems becomes a key issue to all organizations that aim to implement any new application.

In any setting, the impacts of a system's computing go beyond the efficiency or cost effectiveness of the ways in which technology interacts with the organization's on-going routine policies and practices. The emphasis on cost efficacy, quality improvement and patient safety has increased the demand for computer systems to improve patients' safety, reduce costs and provide new and better information to administrators and health-care providers. New computer technology has the potential to change the experience and process

⁹⁵ Guy Part 1, Elam Joyce J 2, & Gillon C. Ward 3 Gillon C, Joyce J *et al.* 1997. Implementation of a patient charting system – Challenges encountered and tactics adopted in a burn center. *Journal of Medical Systems* 21(1), 49-66.

⁹⁶ Bourret Christian & Salzano Gabriella. 2006. Data for decision making in networked health. *Data Science Journal* 5, 64-78.

⁹⁷ Salmela Hannu & Turunen Pekka. Evaluation of information systems in health care.

⁹⁸ Bahlol Rahimi & Vimarlund Vivian, 2007. Methods to evaluate health information systems in health-care settings. *Journal of Medical Systems* 31, 397-432.

of work, as well as the structure and delivery of medical care.⁹⁹

According to this measure, no matter what quality a developed IS has, it would not help if those who will use it do not accept it. In the same manner, a developed IS has to have a certain quality to be a success, even if its acceptance is ever so high.

The objective of this research is to determine what dimensions in the health management IS at the Charlotte Maxeke Johannesburg Academic Hospital are inadequate and what interventions may best improve the system. A survey will help one to formulate strategic options for implementing systems in public hospitals.

3.3.2 Survey Research

A survey, or questionnaire, is the primary method for data collection in survey research. The use of a standard measure with established validity and reliability allows comparison of scores with other settings, and spares the investigator the time-consuming process of developing a new measure. Validity may be defined as the extent to which the measure actually captures the concept it purports to measure, whereas reliability refers to the extent to which it is free from measurement error. Measurement strategies are for:

- i. Users' reaction to information systems and the implementation process
- ii. Users' characteristics that may influence their attitudes toward the system and its implementation, and
- iii. Assessments of computers' social impacts are organized in the following six dimensions: decision making, productivity, social interaction, job enhancement and work environment.

3.4 How do you evaluate health information systems?

The implementation of HISs is often mentioned in order to make health care more effective and/or efficient.¹⁰⁰ To disprove, or prove, this hypothesis, an evaluation of HISs is essential. Another factor that induces organizations to evaluate its systems is the general lack of a permanent approach to systems, which refers to structured and rational methods for making

⁹⁹ Lundeberg Marts, Goldkuhl Goran & Nilsson Anders. 1981. *Information systems development: A systematic approach*. ISBN 0-13-464677-0.

¹⁰⁰ De Keizer Nicolette & Ammenwerth Elske. 2005. The effects and quality of medical information technology evaluation studies: Trends in 1982–2002. Department of Medical Informatics, Academic Medical Center, University of Amsterdam.

decisions about investments in systems on a portfolio-wide basis.¹⁰¹

How do you evaluate HISs? Answers are not easy to find, as very limited methodologically sound evaluative research has taken place. A wide range of evaluation questions exist, ranging from technical characteristics of specific systems to their effects on people and organizations.

For the purposes of this research, the survey was done through a list of questionnaires on system usability while testing the following categories: system simplicity, efficiency, effectiveness, ease of learning and general user satisfaction of the system. The categories are explained and the list of questionnaires is in Appendix B.

3.5 System Usability

3.5.1 Introduction

HISs are clinical support tools with the potential to reduce strain on the clinicians' memory and cognition, while improving efficiency in workflow and effectiveness in the quality and coordination of care.¹⁰² The safe, efficient, effective, patient-centred, equitable, and timely delivery of health-care services requires tools that organize and display information that places patients' data in context, synthesizes that information with available medical evidence, and supports the clinicians' decision-making process.

The usability of a product is considered as a precondition for the usefulness of an application.¹⁰³ In respect of the extent to which specific goals can use the product, its aim is defined as identifying strengths and weaknesses of an application and giving hints for improving its usability.

Usability is the effectiveness, efficiency and satisfaction with which specific users can achieve a specific set of tasks in a particular environment.¹⁰⁴ All these components of usability can be evaluated and measured (either formally or informally). In essence, a system with good usability is easy to use and effective. It is intuitive, forgives mistakes, and allows one to perform necessary tasks rapidly, efficiently and with a minimum of mental effort.

¹⁰¹ Simon D, Fischbach K & Schoder D. 2010. Application portfolio management – An integrated framework and a software tool evaluation approach. *Communications of the Association for Information Systems* (26)3, 35-56.

¹⁰² Armijo D, McDonnell C & Werner K. 2009. Electronic health record usability – evaluation and use case framework. Agency for Health-care Research Quality.

¹⁰³ Hamborf Kai-Christoph, Vehse Brigitte & Bludau Hans-Bernd. 2004. Questionnaire based usability evaluation of hospital information systems. *Electronic Journal of Information Systems Evaluation* (7)1, 21-30.

¹⁰⁴ Schoefel R. 2003. The concept of product usability.

Tasks that the software (such as data retrieval, organization, summary, cross-checking, calculating, etc.) can perform, are done in the background, improving accuracy and freeing the user's cognitive resources for other tasks. Usability evaluation is far broader than the simple process of measuring user satisfaction. Equally important, usability metrics include measures of efficiency, effectiveness, cognitive load and ease of learning. Usability emerges from understanding the users' needs, using established methods of iterative design, and performing appropriate user testing when needed.

A wide range of design and evaluation methodologies, both subjective and objective, exists, and is continually growing in sophistication. Built-in webcams on modern laptop personal computers (PCs), robust wireless networking, remote testing software, and compact, inexpensive video recorders increasingly facilitate "testing" in live clinical settings.

The following characteristics were compiled based on established design heuristics (e.g., those of Nielsen, Shneiderman, Tognazzini, Tufte, and Wheeler Atkinson).¹⁰⁵

i. **Ease of data entry**

When a patient presents for an acute episode, vitals and basic patient information must be quickly entered into the HIS to allow for effective coordination and subsequent decision making.

ii. **Effective use of default information**

The provision of default information can support the data entry; however, caution must be exercised in this area to reduce the occurrence of pseudo data in the HIS.

iii. **Proximity of items required for a single step**

Ensuring that commonly needed information and functions exist on a single screen improves provider efficiency and software usability. Functions or information that is repeatedly used in sequence should be reflected in the display.

iv. **Consistency in the system's terminology, structures, look and feel**

In many instances, procedures for patient intake are repetitive and similar events. Consistency across screens and between the providers' views enhances system navigation and team coordination. A standardized clinical design and display of the terminology's vocabulary that supports the needs of clinicians and software designers may be needed. Existing vocabularies of terminology may not have sufficient compatibility, and clinicians may have unmet needs for describing workflow steps and clinical preferences. An improved standard in this area

¹⁰⁵ Armijo Dan, McDonnell Cheryl & Werner Kristen. 2009 October. Agency for health-care research and quality.

would also serve other aspects of the clinicians' flow of information.

Without a standardized clinical design and display of the terminology's vocabulary, many aspects of information exchange related to describing the use of an HIS in clinical settings might be difficult, and may negatively affect communication, data use, and patients' health.

3.5.2 Purpose of the Questionnaires

The main objective of the questionnaires is to answer the **research question**, that is, to determine: a) the efficiency, and b) the usability of the new system. The main focus is on usability.

Many of the challenges in public-health organizations are the result of an increasingly demanding and complex public-health environment, characterized by limited resources, such as funding, staff, problems in attracting and retaining staff with the range of information and public health skills needed. Clear vision and leadership skills are needed to address the coordination and cross-cutting activities that support KM, and to sustain this effort over time. To create the right strategies and culture that cultivates the sharing of information, and to procure technology that meets business requirements will lead to increasing KM and a desire for improvement.

Technology supports the core provision of patient-care processes. The Medicom system is the primary source of patient-care information. This system is used in real time to manage patients' historical and current information and also, proactively, to manage data for the improvement of patient care and operational efficiencies.

Primarily, the focus will be on how the HIS, Medicom, supports patient care and clinical processes. Although traditional functions of practice management may exist in a system apart from the clinical system, the HIS works in conjunction with practice management functions, such as patients' identification and registration, the scheduling of patients and staff, billing and accounting functions, and the exchange of patient-centric information between systems.

Despite the improvements in technology, the ability of public health institutions to manage and reuse vast arrays of data and information has not necessarily optimized the management of what they know to improve the delivery of essential public health services. The lack of understanding how an organization does its business, how it collects data and uses information for development impacts negatively on the implementation and use of KM systems. HISs are implemented in Gauteng's academic hospitals, but, to do their work, health professionals are unable to access data quickly and transform it into information and knowledge.

While health IT systems are expected to reduce medication errors significantly, recent studies have found that, in health IT systems, information fragmentation (i.e., a lack of all pertinent information on the same screen) can actually facilitate errors. HIS technology is aimed at supporting the core processes required in the provision of care for patients. The supported processes include obtaining and trending a health/medical history, making clinical observations/assessments and physical examinations, supporting evidence-based clinical decision making, defining and diagnosing health problems/personal health management goals, prescribing medications, tracking immunizations, coordinating treatment plans, completing and communicating results, reporting, documenting visits and coding appropriate medical record procedures and diagnoses.

In summary, the following examples of patient-care information and processes should, optimally, be coordinated and supported with HIS technology:¹⁰⁶

- i. Integration of the core medical records with other disciplines, such as behavioural or dental health, to maintain a patient-centric record.
- ii. Support of chronic disease management and population-based care management processes.
- iii. Medication coordination, from clinical decision support for the prescribing process through patient education, dispensing, and compliance/outcomes measurement.
- iv. Management of laboratory processes, such as trending of historical laboratory results, requesting new laboratory tests, specimen collection, labelling and processing, providers' prioritization/review of results, and communication of results and associated recommendations to patients.
- v. Immunization management and coordination, including determining the need for immunizations, exchanging immunization data with local or state registries, managing schools' physical/entrance information, inventory controls, etc.
- vi. Communication with patients using technologies, such as 'phone systems, cell 'phones and the Internet.

3.5.3 Evaluation Metrics

Usability evaluation methods are often described as being primarily “formative” or “summative” by nature. Formative evaluation is applied to inform and improve the product's design during the development process. Summative usability testing is a validation exercise

¹⁰⁶ Davis Nicholas E. 2011. Application guidelines, community health organizations.

to evaluate a product at the end of the development process. Usability is the result of careful design and evaluation throughout the product's development. Summative usability activities include, but are not limited to:

- i. Expert reviews
- ii. Performance testing
- iii. Risk assessment
- iv. One-on-one usability testing.

3.5.3.1 Evaluating Simplicity

Simplicity in design refers to everything, from a lack of visual clutter and the concise display of information to the inclusion of only the functionality that is needed to accomplish tasks effectively. A “less is more” philosophy is appropriate, with the emphasis placed on the information needed for decision making.¹⁰⁷ The more complex an application, the more important this principle becomes. Clinical systems are complex, as well as dense with information; for efficiency, as well as for patients' safety, it is essential that displays are easy to read, that important information is prominent, and that options for functions are straightforward. As a principle, simplicity should not be interpreted as “simple.” A clear, clean screen design requires substantially more effort than a cluttered display; it also may mean that some complexity has been removed from the surface and moved “under the hood.” Simplicity applies to any design regardless of the target user's level of experience.

The lack of interoperable standards is widely cited as a major impediment to achieving the many proposed benefits of HIT. But, the very need for standards of interoperability points to the reality that there are systems that currently operate differently, not least among these paper-based manual systems. These systems operate within the context of human organizations that operate in a different way, and individuals within an organization even operate them differently.¹⁰⁸

The HIT industry has long promoted clinical systems as being flexible and configurable to adapt to clinicians' preferences. Much of the cost of implementation is the configuration of system tables to mimic the current organizational forms, processes and idiosyncrasies and then to train users to accept residual inflexibility. It is good to imagine systems that could transform free text forms into standardized data, much as systems can provide different views

¹⁰⁷ Nielson J. 1999. *Designing web usability: The practice of simplicity*. Indianapolis: New Riders Publishing.

¹⁰⁸ Health-care Information and Management Systems Society. 2005. An analysis of health information standards development initiatives.

of the same data, but we are nowhere near such natural language processing, or trusting that machines can add meaning and precision to that which was not the clinicians' original input. While many in executive leadership positions are willing to concede that hospitals and physicians' offices are much more similar than different, this is not yet the prevalent sales and implementation paradigm.

As an aside, in the on-going debate within the larger IT space, it is noted whether the IT is a public utility or strategic asset. According to Nicholas Carr's article in the *Harvard Business Review* (May 2003), "IT doesn't matter," points to a much different IT landscape than what many leading vendors promote. HIT is still positioned to provide a strategic, competitive value and return on investment for large provider organizations. Thus, the implementation of systems to accommodate organizational differentiation and preferences is 180° contrary to inter-system interoperability. An important exception is emerging in the critically important small segment of the physician's practice. The realization is that HISs must be delivered as a utility with as little complexity in operation, training and support as possible. The system must be simple and "inflexible."

Health care is a complex domain, further layered with specializations organized as a cottage industry paid for by piecework.

One of the key factors that drive the adoption and appropriate utilization of HISs is their usability,¹⁰⁹ the issues of which, usually, are not simple, one-function problems, but tend to be pervasive throughout the HISs. So, while small-scale issues are often reported and corrected after deployment, the identified issue may not be the primary determinant of a product's usability. The EHR's usability is determined chiefly within the main displays of information that are omnipresent, such as menu listings, the use of pop-up boxes, and interaction between screens.

Existing efforts to evaluate HISs are insufficient for the broad identification of best practices in information design. Furthermore, the recognition of usability as a critical issue varies across organizations responsible for setting standards, and not enough objective evidence exists currently to be considered for specific design. The development of standards and guidelines for the design of HIS user interfaces is a necessary undertaking to ensure that current investments in health IT deliver the expected returns in efficiency and quality. HISs' consistent presentation of offers of well-designed user interfaces will improve the usability,

¹⁰⁹ http://www.himss.org/content/files/HIMSS_DefiningandTestingEMRUsability.pdf Accessed June 2009

effectiveness, and implementation of HISs throughout the country.

The framework for evaluation of an HIS's design must incorporate important lessons learned from previous attempts in this and other countries to induce clinicians to use IT effectively in clinical practice.¹¹⁰ Through clinicians' collaborative effort, vendors of HISs, and usability experts, this framework should be further refined to inform and foster a practical and fair process of HISs' usability evaluation. As these concepts mature and a process is better defined, the Certification Commission for Health Information Technology could then choose the extent to which incorporation of usability considerations should be part of the HIS certification process. This process could be organized around a case structure of use, and incorporate a National Usability Laboratory coupled with a library of guidance documents (based on evidence captured through the research recommendations put forth in our companion document) to promote improvements actively in the design of HISs. Cases of use, testing algorithms (to evaluate the audit trail data of HIS use in practice settings), and observation methodologies to validate that products actually meet evolving usability requirements, are all approaches to a process in need of further refinement. HISs' products, designed to reflect more closely on the needs and desired work patterns of physicians and other clinical staff, would reduce the HIS's implementation difficulties and improve the long-term efficiency and effectiveness of the application of technology to clinical practice.

In order for all the events included in the cases of use to be realized, a significant increase in the use of health IT is necessary. Adoption of health IT, combined with the conversion and storage of paper-based to electronic information, and the establishment of shared critical clinical information will facilitate the ability to leverage the data and technology to streamline and enhance these processes.

Adoption of the necessary health IT functionality to support these cases of use is still very low. According to a study that the Office of the National Coordinator for Health Information Technology sponsored in partnership with the George Washington University and Massachusetts General Hospital/Harvard Institute for Health Policy, the current state of health IT adoption is far short of the tipping point necessary to drive the full functionality of these cases of use - see table below:¹¹¹

¹¹⁰ Walsh SH. 2004 May 15. The clinician's perspective on electronic health records and how they can affect patient care. *British Medical Journal* 328(7449), 1184-7.

¹¹¹ Jha AK, DesRoches CM, Campbell EG *et al.* 2009. Use of electronic health records in U.S. hospitals. *New England Journal of Medicine* 360(16), 1628-38.

Setting	2006	2007	2008
Physicians' offices (basic)	11%	13%	17%
Physicians' offices (full)	3%	4%	4%
Hospitals (basic)	N/A	N/A	8%
Hospitals (full)	N/A	N/A	2%

Minimizing the learning curve, associated with system use, is essential to ensure continued and efficient use of software functions. As users spend minimal time in training or consulting manuals, much of the system's burden of usability focuses on the display and embedded software support. Also, a software system should be designed to reduce the cognitive load that users experience. In alignment with tasks that the user attempts to accomplish, appropriate information should be displayed, graphics and visualizations used effectively, and clutter should be reduced or eliminated. The effective use of software's functions and features is more likely when users feel in control of the system, and have appropriate flexibility available to tailor the system to meet their needs. In supporting both the novice and expert user, the system should respond effectively to users' actions, and customization and shortcuts should be supported.

3.5.3.2 Evaluating Efficiency

Efficiency, as a test metric, is the speed with which a user can successfully accomplish the task at hand. Research activities aimed at evaluating efficiency includes expert review and efficiency studies. A number of variants exist on one-on-one usability tests aimed at evaluating efficiency. The most common measures of efficiency are:¹¹²¹¹³

- i. Time to perform a particular task.
- ii. The number of key presses or interactions to achieve a task.
- iii. The number of screens visited to complete a specific workflow scenario.
- iv. The number of back button uses.
- v. The time to execute a particular set of instructions.

¹¹² Mayhew DJ. 2005. Keystroke level modelling as a cost justification tool.

¹¹³ Bias RG, Mayhew DJ (eds.). 2005. *Cost-justifying usability, an update for the Internet age*. San Francisco, CA: Morgan Kaufmann.

It has been found that the speed of an information system is the parameter that users value most.¹¹⁴ If the decision support is excellent, but takes too long to appear, it will be useless. When infrastructural problems slow the speed of an application, user satisfaction declines markedly. Sub-second “screen flips” (the time it takes in transition from one screen to the next) appear anecdotally, as the threshold that is important to the users.

While this may be a difficult standard to achieve, it should be a primary goal. Evidence supporting this comes, in part, from user surveys regarding a computerized physicians’ order entry. In one such survey, we found that the primary determinant of user satisfaction was speed and that it rated much higher than aspects of quality improvement. In fact, users perceived a physician order entry primarily as a technology for efficiency, even though, in a formal time-motion study, we found that it took users significantly longer to write orders using the computer than on paper, in part, because many screens were involved. Others had similar results.¹¹⁵ Thus, while the hospital administration and clinical leadership’s highest priorities are likely to be costs and quality, users’ top priority will be the speed of the information system.

When considering the options of an HIS, health-care organizations are left with little choice. As providers make a sizable investment in an HIS, they want to receive all the possible benefits. By adding a mobility solution upfront, providers can immediately begin to see even a greater increased efficiency and return on investment. To tap into the government incentives and avoid the loss of Medicare benefits are just the beginning of what health-care IT has to offer providers and patients, while implementing a mobility solution and moving providers on a much faster road towards the success of an HIT.

Fundamentally, transformation to significant health-care delivery is impossible without a meaningful, system-wide adoption of an HIS and health information exchange. Without the health IT incentive funding program, providers and hospitals across the country - including many small health-care practices and rural health-care facilities - would find it difficult to make the transitions necessary to support such changes to their systems. In addition, any reversal of the current program would send a negative signal to health IT investment. This would reverberate far beyond an HIS implementation, and hinder or reverse plans for a broad

¹¹⁴ Lee F, Teich JM, Spurr CD & Bates DW. 1996. Implementation of physician order entry: user satisfaction and usage patterns. *Journal of American Medical Informatics Association* 3: 42–55.

¹¹⁵ Overhage JM, Perkins S, Tierney WM & McDonald CJ. 2001. Controlled trial of direct physician order entry: Effects on physicians’ time utilization in ambulatory primary care internal medicine practices. *Journal of American Medical Informatics Association* 8: 361–71.

range of health IT investments and the associated job growth. This program has already been set in motion, reflecting statute-based, multi-year commitments of the federal government. Many health-care providers and hospitals across the country have already mobilized and made substantial investments and hiring decisions, based on the anticipation of receiving the incentives. Any scaling back of the HIS incentive funding program, as a result of on-going budget deliberations, would be a sharp and lasting setback to the progress already made in HIT, thus creating dangerous uncertainty within the health-care system.

HISs have the potential to improve quality greatly, yet little is known about their cost and benefits.¹¹⁶ Health organizations face some of the greatest challenges in the successful use of HISs, which in part explains their slow pace of adopting HIT. Yet, the literature on cost/benefits in health care organizational practices is scant, and policymakers have had to rely on estimates that are based on “expert opinion,” rather than on evidence.¹¹⁷

Better cost and benefit data on HISs in solo and small group practices can help policymakers to formulate financial and nonfinancial incentives designed to achieve an acceptable rate of HIS adoption, together with higher levels of benefits at the lowest possible cost. How quickly physicians can recoup their investments in HIS, and to what extent they can improve quality using an HIS, will help to determine the health plans that employers need to pay for HIS adoption and use.

In 2001, the Institute of Medicine (IOM) issued a landmark report that states, “To improve quality in health care, health-care professionals needed to interact effectively and efficiently with the health IT systems.”¹¹⁸ Unfortunately, most health-care professionals do not use available health IT systems because those systems fail to offer value. A recent National Academy of Science study concluded that the current health IT efforts may set back the vision of 21st century health care.¹¹⁹

3.5.3.3 Evaluating Effectiveness

Effectiveness is the accuracy and completeness with which users can achieve their goal's

¹¹⁶ American Medical Association, *Physician Socioeconomic Statistics*, 2000-2002 edition (Chicago: AMA, 2001).

¹¹⁷ Wang SJ *et al.* 2003. A cost-benefit analysis of electronic medical records in primary care. *American Journal of Medicine* 114, 5, 397-403.

¹¹⁸ Institute of Medicine. 2001. *Crossing the quality chasm: A new health system for the 21st century*. National Academy Press, Washington, D.C.

¹¹⁹ Stead W & Linn H. 2009. *Computational technology for effective health care: Immediate steps and strategic directions*. National Academies Press: Washington, D.C.

task. A usability rating process can be developed by adapting risk assessment methodologies to evaluate objectively the potential for user error. Certain design factors can lead to user errors which would have implications for patients' safety. Studies of effectiveness are a class of one-on-one usability tests that involve collecting measures of effectiveness when users complete specific key tasks with the application.

During the past several years, much of the sustained enthusiasm and support for HIT stems from landmark reports in the 1990s that demonstrate the ability of such technology to prevent errors, reduce adverse events, and improve the quality of care. In almost all of these landmark studies, the gains came directly from the application of HISs' interventions (reminders, alerts, constrained choices, tailored forms, just-in-time references, and more) to common medical processes. New studies that demonstrate the positive impact of an HIS continue to appear in the literature, however, to date, its impact on a national scale has been muted, with a resulting delay in some of those expected major improvements.

The implementation of HISs in hospitals, practices, home care, and other settings, proceeds slowly with great difficulty, and with more than a few bumps in the road.¹²⁰ Without a common framework from which to work, each organization must discover for itself the key steps needed to gather the right stakeholders together, to find interventions for HISs that are acceptable and effective, to manage their testing and implementation, and to demonstrate their positive impact.

Recent reports about health-care IT's "unintended consequences" further highlight the urgent need to implement an HIS correctly the first time, and every time. Yet, despite the growing popularity of HISs and the positive impact it can have on the rates of medication error, adverse drug events continue to vex the hospitals. One primary reason for this is the physicians' resistance, caused largely by their belief that HISs create more work and that the traditional paper-based ordering is faster. In some cases, hospitals found that this resistance was so significant an obstacle that they "abandoned implementation plans, fearing that physician resistance could escalate to a point of 'physician rebellion.'"¹²¹ However, the reality is that medication decision support within an HIS can accelerate workflow and increase the quality and safety of care.

¹²⁰ Health-care Information and Management Systems Society. 2005. Improving outcomes with clinical decision support: An implementer's guide.

¹²¹ Poon EG, Blumenthal D, Tonushree J, Honour MM, Bates DW & Kaushal R. (2004). Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. *Journal of Health Affairs* 23(4), 184–190.

Point-of-care medication decision support is effective, because it overcomes the most common causes of errors. In particular, because errors in most preventable adverse events happen when drugs are ordered, “increasingly sophisticated clinical computer systems have been seen as a major opportunity to prevent inappropriate prescribing.”¹²² Within an HIS, medication decision support eliminates the problem of both illegible handwriting and transcription errors, which are responsible for as much as 61% of medication errors in hospitals. It also reduces the risks associated with drugs that bear similar names.¹²³ In doing so, medication decision support has had a measurable impact on safety.

In the USA, hospitals have realized a 66% drop in prescription errors after switching to HISs. In Massachusetts alone, one study projected that full implementation of an HIS at all the state’s hospitals would result in the prevention of 55,000 adverse drug events each year and a saving of \$170 million.¹²⁴ Furthermore, an HIS has been linked to a 40% decline in the rate of medication errors only among paediatric inpatients.¹²⁵ Yet, despite these findings, medication error continues to be a significant problem. Studies have estimated that 2.4 to 3.6% of all hospital admissions are caused by adverse drug events, of which up to 69% are deemed preventable. In addition, nearly 25% of all hospital patients experience medication errors - a 5% increase since 1992. Of these prescription errors, 60% involve wrong doses or improper administration frequencies.¹²⁶ While there are numerous reasons why errors continue to occur, within an HIS, the physicians’ resistance to medication decision support is a leading contributor.

3.5.3.4 Evaluating Ease of Learning

The introduction of an electronic health-record information system into a practice presents great operational challenges, as well as opportunities, for the improvement of patient care.

¹²² OSchedlbauer A, Prashad V, Mulvaney C, Phasalkar S, Stanton W, Bates DW *et al.* 2009. What evidence supports the use of computerized alerts and prompts to improve clinicians’ prescribing behavior? *Journal of the American Medical Informatics Association* 16(4), 531–558.

¹²³ Center for the Advancement of Health. 2007, June 7. Computerized doctors’ orders reduce medication errors. *Science Daily*. Retrieved June 27, 2010, from <http://www.sciencedaily.com/releases/2007/06/070627084702.htm>

¹²⁴ Adams M, Bates D, Coffman G & Everett W. 2008 February. Saving lives, saving money: The imperative for computerized physician order entry in Massachusetts hospitals. The Massachusetts Technology Collaborative and New England Health-care Institute.

¹²⁵ King JW, Paice N, Rangrej J, Forestell G & Swartz R. 2003. The effect of computerized physician order entry on medication errors and adverse drug events in pediatric inpatients. *Journal of Pediatrics* 112(3), 506–509.

¹²⁶ Bobb A, Gleason K, Husch M, Feinglass J, Yarnold PF & Noskin GA. 2004. Epidemiology of prescribing errors: Potential impact of computerized prescribing. *Archives of Internal Medicine* 164(7), 785–792.

The improvement of usability has been shown to improve ease of learning or the ability to learn. The more a user applies prior experience to a new system and the greater the internal consistency (use of consistency concepts, behaviours, layout, etc.), the lower the learning curve. When a system is forgiving of mistakes and allows discovery through exploration, it fosters faster learning by reducing the user's fear of unintended consequences. Errors, paths taken to complete tasks, and requests for help all correlate with how familiar a user is with the system. Ease of learning can be evaluated in terms of the time a user takes to reach a specified level of proficiency, and in terms of the time it takes a user, who has never seen the system's interface, to accomplish basic tasks successfully.

Stead and Lin¹²⁷ evaluated premier HISs in the United States and conclude that even these systems did not provide the required cognitive support for clinicians (i.e., tools for considering and solving health problems). Cognitive support may include designs to provide an overview or summary of the patient, information "at a glance," intuitive designs and tailored support for clinicians in specific contexts. Improved cognitive support can also impact on user efficiency and error reduction.

3.5.3.5 Evaluating User Satisfaction

The definition of usability typically includes reference to user satisfaction – i.e., people's subjective response to their interaction with a system. When evaluating usability, satisfaction can be addressed in several ways. A common approach uses Likert scale questionnaires that ask users to rate their satisfaction with various aspects of the product (e.g., on a scale of 1 to 10). Typically, this is done immediately after hands-on usability task performance and at the end of a usability test session. What is weak about this approach is that this method has not been developed under scientific scrutiny.¹²⁸

The researcher agrees that user satisfaction is one component of usability. However, because of the subjective nature of evaluating user satisfaction, he will not provide recommendations concerning the measurement of user satisfaction as part of a usability rating program.

3.5.3.6 The Star Usability Rating System

The five star rating system is readily recognized, since it is a common scheme used with

¹²⁷ Stead W & Linn H. 2009. *Computational technology for effective health care: Immediate steps and strategic directions*. Washington, D.C.: National Academies Press.

¹²⁸ Bangor A, Kortum PT & Miller JA. 2008. An empirical evaluation of the system usability scale. *International Journal of Human Computer Interaction* (24)6, 574-594.

consumer products in many commercial Web sites. Development work is needed to define a usability rating system (e.g., 5-star=excellent, 4-star=good, etc.) that can be used to communicate the results of a usability rating program to HISs. The most important aspect of developing a star rating system is the definition of the benchmark metrics for each measure.

3.5.3.7 Test Task and Scenario Survey Questionnaires

The task and scenario questionnaires reflect entire workflows consisting of a number of associated component test tasks. These scenarios are sufficiently complex to represent the hospital's workflow worthy of testing, and they occur frequently in the setting of a hospital. The questions were not meant to be exhaustive, but to serve as a starting point for types of scenarios and tasks that might be part of usability testing.

On systems' usability, the respondents had to tick the appropriate answer where a rating was used (1=strongly agree, 2=disagree, 3=agree, 4=strongly agree and 5=don't know) In total there were 21 questionnaires. Four general questions were about background information and self-assessment on computation.

Questions were categorized into Efficiency, Effectiveness, Ease of Learning and, lastly, User Satisfaction. Four questions were on simplicity, five on efficiency, five on effectiveness, four on ease of learning and, lastly, two on user satisfaction.

The list of questionnaires is in Appendix B.

3.6 Conclusion

Although, in their initiatives for meaningful use, more health systems involve physicians, health insurers, and patients they seem less confident about achieving full adoption within the time frame, as government has specified. The next chapter will focus on HIS in the Charlotte Maxeke Johannesburg Academic Hospital.

Chapter 4

A Case Study in Charlotte Maxeke Johannesburg Academic Hospital

4.1 The Charlotte Maxeke Johannesburg Academic Hospital

One of the key factors that drives the adoption and appropriate utilization of HISs, is their usability.¹²⁹ This research will focus mainly on the implemented HIS of the Charlotte Maxeke Johannesburg Academic Hospital, as it is an academic hospital with a high patient turnover. The standard processes of running the hospital can safely be assumed to be almost similar elsewhere in the world. The next section is a high level description of the hospital. The context is about the investigation of systems in the Charlotte Maxeke Johannesburg Academic Hospital, and not the hospital's medical professionals.

The case study is about the implemented Charlotte Maxeke Johannesburg Academic Hospital's HIS and will mainly focus on evaluating the usability in the following categories of staff: Personnel in Patient Administration, Nursing, Medical Practitioners (Clinicians) and Allied Staff, i.e. Physiotherapy, Occupational Therapy and Dietetics.

Health-care managers are being forced to examine costs associated with health care and are under increasing pressure to find approaches that would help carry out activities better, faster and cheaper (Davis & Klein, 2000; Latimore, 1999). Workflow and associated Internet technologies are viewed as instruments to cut administrative expenses. The implementation

¹²⁹ McDonnell Cheryl, Werner Kristen & Wendel Lauren. 2010 May. Electronic health record usability. Retrieved June 2009, from http://www.himss.org/content/files/HIMSS_DefiningandTestingEMRUsability.pdf.

specially designed ITs, such as workflow tools, are being used to automate the electronic paper flow in a managed-care operation, thereby cutting administrative expenses (Latamore, 1999), hence the implementation of Medicom.

The Charlotte Maxeke Johannesburg Academic Hospital, a public and tertiary hospital, is a case study. Public health¹³⁰ consists of organized efforts to improve the communities' health. In public health, efforts are organized and directed to communities rather than individuals. The public health practice does not rely on a specific body of knowledge and expertise, but rather on a combination of scientific and social approaches.

Information is central to each of these core functions. For example, the essence of community health assessment is the collection of data and information. Thus, each of these core functions accentuates the importance of public health as an information broker, which directly underscores the need for public health officials to be effective planners, developers, and users of HISs. At all levels of public health, the staff must build strong community collaboration, solicit and respond to the public's concerns, and present public health programs to elected officials. Public health professionals adopt this challenging work despite liabilities, lack of academic preparation in public health, obstacles to on-going training, and low pay.

Public health professionals are challenged to execute their broad responsibilities with limited electronic communication capacity, data systems, and other informatic tools. The staff recognizes that integrated, computerized information systems, and the World Wide Web are critical tools; traditionally, new appropriations have not funded these key components of the public health infrastructure. Thus, the personnel is required to use distinct, incompatible applications to enter and analyse data; across time or geographic areas persons cannot easily exchange, link, merge, or use different programs to evaluate problems.

The Chief Executive Officer (CEO), who has a board with no executive powers, heads the hospital management. The CEO reports to both the board and the political provincial head. Like other hospitals in some parts of the world, many of the challenges in public health organizations are the result of an increasing demanding and complex public health environment, characterized by limited resources, such as funding, staff, and problems in attracting and retaining staff that have the necessary range of information and public health skills. Clear vision and leadership skills are needed to address the co-ordination and cross-

¹³⁰ Novick Lloyd F, Morrow Cynthia B & Mays Glen P. 2008. Public health administration – Principles for population-based management.

cutting activities that support KM, and to sustain this effort over time.¹³¹ The creation of the correct strategies, and a culture that cultivates information sharing and procuring technology to meet business requirements, will lead to increasing KM and the desire to improve it.

Prior to the year 2001, this hospital used mainframes for a large part of its information-processing activities. The migration from mainframe to client-server architecture started in 2001. At the heart of these changes was a challenge to develop more efficient and effective means of integrating human and computer components to meet data-handling and needs for knowledge processing.

Across the country, health-care managers, including those in the Charlotte Maxeke Johannesburg Academic Hospital, are being forced to examine costs associated with health care and suffer increasing pressure to discover approaches that will help them to carry out activities better, faster and cheaper (Davis & Klein, 2000; Latimore, 1999). One of the most challenging issues in health care relates to the transformation of raw clinical data into contextually relevant information. Advances in IT and telecommunications should enable health-care institutions to face the challenge of transforming large amounts of medical data into relevant information (Dwivedi, Bali, James, & Naguib, 2001b).¹³²

The change, led by technology, opens up opportunities for new working methods in three main ways, namely by allowing existing activities to be carried out more rapidly, with more consistency, and at a lower cost than could be achieved previously.¹³³ Despite this hospital's creation of a technological infrastructure for sharing medical information, it experiences problems in managing information.

4.1.1 Flows in the Hospital's Process

The high level overview of the hospital's patient administration processes is described using a flow chart in Appendix A.

4.1.2 The Charlotte Maxeke Johannesburg Academic Hospital's Health Information System

HISs have helped to standardize protocols for diagnosis and treatment, and have established databases of medical information research and the planning of outcomes.

¹³¹ Association of State Territorial Health Officials, 2005. Knowledge management for public health professionals.

¹³² Bali Rajeev K. 2005. Clinical knowledge management – Opportunities and challenges.

¹³³ Bali Rajeev K & Dwivedi Ashish N. 2007. Health-care knowledge management – Issues advances and success.

The Medicom system has been used for years at the Charlotte Maxeke Johannesburg Academic Hospital, and the usability of this system should be evaluated. To what extent is the system being used, is the general hospital benefiting from the use thereof, and what interventions may improve the system best? The evaluation was done through a questionnaire survey to get a snapshot of the extent to which the system was being used. After receiving permission from the hospital's CEO, the printed list of questionnaires was distributed to the selected units of professionals, i.e., those in Patient Administration, Nurses, Medical Practitioners (Clinicians) and Medical Allied Practitioners in Dietics, Physiotherapy, and Occupational Therapy.

An HIS¹³⁴ can be defined as a hospital-wide system, or network of systems, designed to support the flow of information between departments. Common names in use today include: the "hospital information system," "order entry system," "patient care system," "medical information system," "patient management system," and "patient control system." Medicom has these modules built into the system. Typically, the system has information about a patient's current medical problems and conditions, current medications and allergies, and advance directives, as well as electronic documentation from clinical encounters or patient-care contacts.¹³⁵

The HISs form a significant part of the field of clinical KM technologies by means of their capacity to support the clinical process and use of knowledge - from diagnosis and investigation, through treatment and long-term care. Automated ISs¹³⁶ assist health-care personnel and health-care organizations to manage a number of care processes. These areas of support for clinical process management include the acquisition and maintenance of patients' demographic information, patients' appointment management and the generation and tracking of requests for the laboratory, pharmacy, diagnostic and supply services.

The health-care industry uses computer-based information systems¹³⁷ for traditional data processing operations, such as patient billing, accounting, inventory control, calculation of health-care statistics, and maintenance of patient histories. In addition, information systems are used to schedule the laboratory and operating theatre's use, automate nurse stations,

¹³⁴ Sneider Richard M, Snider and Associates, limited. 1987. Management guide to health care information system.

¹³⁵ Demetriades E James, Kolodner M Robert & Chriatopherson A Gary. 2005. Person-centered health records – Towards health-e-people health informatics.

¹³⁶ Price Basset Koch. 1998. Health care resource management, present and future challenges.

¹³⁷ Smith Jack. 2000. Health management information systems – A handbook of decision makers.

monitor intensive-care patients, and to provide preliminary diagnoses. In addition to assistance with record-keeping and administration in pharmacies, surgeries, hospitals, and community health centres, the combination of knowledge and technology enables a wide range of health professionals to carry out activities such as the following:

- i. To test for, and diagnose, diseases and illnesses faster and more accurately,
- ii. To design prosthesis and reconstruction models,
- iii. To build and use devices to monitor vital signs and bodily functions,
- iv. To design and test pharmaceuticals,
- v. To offer choices in lifestyle and job selection to people who are physically challenged.

The aforesaid characterise the Medicom system.

The implementation included hardware and software development, that is, the building of a local area network, and the installation of new computers, printers, servers, and software deployment. The entire cost amounted to R28 million. The hospital employs a staff of close to 2000 and operates with a total budget of R700 million.

4.2 Data Collection Design

Because of the hospital's size, a representative sector of the health-care professionals was targeted for the surveys. This sector consisted of: Clinicians (Medical Practitioners), Nursing Staff, Allied Staff (i.e., Physiotherapy, Occupational Therapy and Dietics) and Patient Administration Staff. Over a period of six weeks, a total of 121 individuals participated in the survey, of whom 31 respondents were from Medical Practitioners, 43 from Patient Administration Staff, 14 from the Nursing Staff, and 33 were from the Allied Staff.

The survey was constructed on the premise that a widespread adoption of an HIS holds the promise of a transformed change in the way that an improved quality of health care is delivered, safety is enhanced, and costs are reduced. The increased availability of patient information and decision support at the point of care have tremendous potential for reducing errors and increasing evidence-based care delivery. While much attention is paid to the financial and technical reasons for the limited use of the HIS, the usability of these systems and their ability to integrate effectively with clinical decision making and workflow have not been adequately explored to date. Information design, the art and science of preparing information so that human beings can use this system efficiently and effectively, is central to its usability and

success of implementation.¹³⁸

In evaluating the usability of the system, the method implemented was that of a list of developed questionnaires (printed on paper) that was distributed to staff and, thereafter, interviews with a selected few. Appendix B provides this questionnaire as well as the clause of confidentiality on the research results.

The research was done by:

- i. Seeking permission from the hospital management to conduct a survey
- ii. Scheduling convenient appointments and sending the list of questions to be discussed well ahead of time
- iii. Conducting interviews about the impacts of the HIS with staff from the entry level to senior management where the system had been implemented in their respective units
- iv. Investigating the documented processes/methodologies that were followed, which led to implementation of the systems
- v. Following up on processes post implementation.

The printed list of questionnaires was distributed to staff, irrespective of hierarchy, then the responses were returned. Due to the hospital's large size, but also to attain a fair understanding of the systems at hand, the survey, with its list of questionnaires, distribution was limited among only the Clinicians (Medical Practitioners), Nursing Staff, Allied Staff (i.e., Physiotherapy, Occupational Therapy and Dietics) and Patient Administration Staff. The health allied workers, generally, are health professionals distinct from medicine, dentistry, and nursing.

The total of 21 questions were based only on the system's usability and categorized into five design principles, as explained in Chapter 3. The categories were Simplicity, Efficiency, Effectiveness, Ease of Learning and, lastly, User Satisfaction. Four questions were on simplicity, five on efficiency, five on effectiveness, four on ease of learning and the last two on user satisfaction. The questionnaires appear on Appendix B.

The respondents had to tick only the appropriate answer by rating, for which a scale of 1 to 5 was applied, where 1=Strongly Agree, 2=Disagree, 3=Agree, 4=Strongly Agree and 5=Don't Know. In total, 21 questions were asked, including four general questions about background

¹³⁸ Armijo D, McDonnell C & Werner K. 2009. *Electronic health usability: interface design considerations*. Vol.9.

information and self-assessment on computation.

The implementation of technology to reduce medical errors and to promote patients' safety continues to be a top priority, both now and in future. This is being driven by a focus on quality of care and patients' satisfaction, which were identified most frequently as the health-care business drivers with the most impact. The improvement of the quality of care and the satisfaction of patients (customers) are among the top business issues that will have the greatest impact on health care.

The state of the research on HISs is mixed. Conflicting evidence exists about the effectiveness of these systems, computerized alerts and clinical reminders,¹³⁹ computerized provider order entry, and bar-coded medication administration systems. The latest research assessment of HISs shows that adoption rates are low,¹⁴⁰ quality of care has not improved with their use, and costs have not been reduced. Sometimes, health IT systems do not achieve their full potential due to health IT's lack of integration into the clinical workflow¹⁴¹ in a way that supports the workflow among organizations (e.g., between a clinic and community pharmacy), in both a clinic and a visit. For health IT to be effective, it needs to be integrated into the multiple levels of workflow that exist in health-care delivery. Results of empirical research also emphasize that an HIS does not consist of mere technical content or technical design; it also involves a workflow. So, the same system can have different results, depending on its impact on the workflow in a particular setting.¹⁴² Therefore, one cannot extrapolate the success of one HIS in another context (e.g., hospital care vs. ambulatory care), user (a primary care physician vs. a specialist), organization (solo-clinic or large health maintenance organization), or set of features, as all might accommodate the workflow differently.

As defined earlier, digitization is the level of IT's use within the activity system. The two dimensions of digitization are: the scope of digitization and experience. The "scope of digitization" refers to the exploration and adoption of a variety of IT solutions for processes within an activity system, and they vary according to the on-going organizational actions in

¹³⁹ Kho AN, Dexter PR, Warvel JS *et al.* 2008. An effective computerized reminder for contact isolation of patients colonized or infected with resistant organisms. *International Journal of Medical Informatics* 77, 194-198.

¹⁴⁰ DesRoches CM, Campbell EG, Rao SR *et al.* 2008. Electronica health records in ambulatory care – National survey of physicians. *The New England Journal of Medicine* 359(1), 50-60.

¹⁴¹ Himmelstein DU, Wright A & Woolhandler S. 2010. *American Journal of Medicine* 123(1), 40-46.

¹⁴² Berlin A & Sorani M. 2006. A taxonomic description of computer-based clinical decision support systems. *Journal of Biomedical Informatics* 39(6), 656- 667.

exploring the type of IT solutions that might be appropriate for digitizing activity systems, examining their potential relevance and value, and adopting them for use within the activity systems. Both the information systems departments, as well as vendors, develop IT solutions. As health-care organizations want ITs to enhance their performance, a wide range of IT solutions are becoming available for digitizing specific processes and activity systems. The scope of digitization is the number of IT solutions adopted in an activity system.

The second dimension of digitization is the experience of digitization. Prior research established that the mere adoption of information systems is not enough¹⁴³ (Fichman & Kemerer, 1999). The adopting organizations must muster knowledge about which specific features of the technological solution are appropriate (DeSanctis & Poole, 1994), how, mutually, to adapt the technological solution and the activity system (Leonard-Barton, 1995), and how to trigger the needed institutional efforts to routinize the use of the technological solution within the activity system (Jasperson, Carter & Zmud, 2005). All of these organizational efforts to exploit the technological solution's capabilities require time and experience. Therefore, experience of digitization is defined as the amount of experience after the adoption of technology solutions within the activity system.

Unfortunately, little is known about the workflow for care and administrative processes that can be implemented to guide decisions about where and how to integrate health IT.¹⁴⁴

The developed and distributed questionnaires were categorised as per evaluation metrics explained in Chapter 3. The metrics include evaluation on the system's simplicity, efficiency, effectiveness, ease of learning and general user satisfaction.

4.2.1 Delimitations

Evaluation is a post factor, thus problems might exist in finding some documentation - some of the staff might have resigned, or they might be reluctant to provide information freely, either in interviews or as proof of supporting documentation of staff who honour scheduled appointments and their availability.

In addition, the innate organizational resistance to evaluation has been identified as a barrier

¹⁴³ Fichman RG & Kemerer CF. 1999. The illusory diffusion of innovation: An examination of assimilation gaps. *Journal of Information System Research* 10(3) 255-275.

¹⁴⁴ Shiffman RN, Michel G, Essaihi A *et al.* 2004. Bridging the guideline implementation gap: A systematic, document-centered approach to guideline implementation. *The Journal of American Medical Association*. 11(5), 418-426.

to doing evaluation studies.¹⁴⁵ The reasons include the reluctance to find and publicize “failures” or “mistakes,” and concerns about encouraging damage-seeking litigation. Other reasons include the following:

- i. Insufficient available methods of evaluation, guidelines and toolkits to cope with the complexity of health-care information systems that originates from a combination of technical as well as organizational and social issues.
- ii. The scant support of methods and guidelines for constructive (formative) evaluation in an implementation or installation project, since many studies focus on summative aspects.
- iii. Limited value of evaluation reports to others, as these lack sufficient information to enable others to adopt the approach, or to judge the validity of the conclusions given.

To counterbalance this, better publicity of evaluation approaches but, above all, of the proven benefits of evaluation and adoption of lessons learned, are needed.

However, evaluations of the impact of health IT on quality and safety reveal mixed results. The main reasons seems to be a lack of integration of health IT into clinical workflow in a way that supports the cognitive work of the clinician and the workflows among organizations (e.g., between a clinic and community pharmacy) within a clinic and in a visit. It is clear that if health IT is to provide optimum performance, it must be designed to fit the specific context in which it will be used, specifically in the practice and patient types.¹⁴⁶

4.2.2 Limitations

This research was conducted before the advancement of mobile connectivity and cloud computing, which was to provide the context of the progression of times and improvements in technology.

It may be challenging for the researcher to attain access to clinician users for feedback or testing. Clinicians have other significant constraints that complicate evaluations of usability, such as concerns for confidentiality in all their encounters, the need for testing in the actual work environment, and frequent interruptions in their workflow.

Clinicians are often mobile, and move from one room to the next, from the hospital to the

¹⁴⁵ Ammenwertha Elske, Brenderb Jytte, Nykänenc Pirkko *et al.* 2004. Visions and strategies to improve evaluation of health information systems. *International Journal of Medical Informatics* 73, 479-491.

¹⁴⁶ Adams J, Culp L & Byron J. 2005. Workflow assessment and redesign: implementing an electronic health record system, pp. 36-9.

clinic. They seldom pay full attention to the software. Their primary focus is on the patient, and clinicians often talk, listen or think while using pen and paper or software. They often have an agenda that frequently changes during a single patient workflow, and interruptions are common.

4.2.3 Evaluation Research

Evaluation research differs from that of scientific inquiry.¹⁴⁷ Scientific studies focus primarily on meeting specific research standards. Although scientific rigour is important in evaluation studies, evaluation research must also recognize the interests of organizational stakeholders and be conducted in a way that is most useful to decision makers. Evaluation research's primary purpose is to provide information to organizational stakeholders and decision makers.

Evaluation is a post-implementation process, so the evaluation criteria focus on ascertaining the extent to which the hypothesized benefits of the introduced system have been met.

Evaluation of the impact of computer-based information systems requires not only an understanding of computer technology, but also an understanding of the social and behavioural processes that affect, and are affected by, the technology's introduction into the setting of the practice. Social and behavioural sciences can provide an important perspective to guide the establishment of research agendas and the conduct of policy-relevant investigations. For example, research and the evaluation of information systems may involve any or all of the following categories:

- (1) the external environment of the organization,
- (2) the internal environment of the organization,
- (3) the information system users,
- (4) the systems development and staff,
- (5) the management and operational environment of the system,
- (6) the nature of the system including the information processed,
- (7) patterns of utilization,
- (8) organizational impacts, and
- (9) social impacts.

Technologies do not succeed merely because they are inherently better at tackling a problem; their progress, rather, is the outcome of a number of factors that may, or may not, produce success. The core of technology evaluation is both a hierarchy of knowledge that reflects the "strength" of the evidence for the technology's effectiveness and a formalized pathway for

¹⁴⁷ Anderson G James & Aydin E Carolyn. 2005. Evaluating impact of health-care information systems.

assessment.¹⁴⁸

Even a superficial search for literature sources that discuss evaluation in general, reveals a large number of publications as well as the complexity of the problem.¹⁴⁹ It leaves one with a clear impression that evaluation is a difficult, and often confusing, research activity, as “there can be no single solution to the problem of evaluation.” Instead, there is an interdisciplinary field of evaluation with extensive methodological literature. Based on the reviewed literature, evaluation can be considered as a general research activity that is used in many fields of study. Issues related to the general aspects of evaluation continue to be the focus of many publications.

4.3 Survey Distribution

Due to the large size of the hospital, but also for a fair understanding of the systems at hand, the survey, with a list of questionnaires, was limited to distribution among only the Clinicians (Medical Practitioners), Nursing staff, Allied Staff (i.e., Physiotherapy, Occupational Therapy and Dietics) and Staff in Patient Administration. The Health Allied Workers, in general, are health professionals, distinct from medicine, dentistry, and nursing.

The list of questionnaires was distributed among stakeholder communities, that is, clinicians, clinical support staff and management. The clinicians are persons (stakeholders) responsible for the delivery of health-care services, and include primary care professionals, specialists and nurses. “Clinical support staff” refers to administrative staff in the practice and at any data office.

4.4 Survey Results

The results of the survey and follow up interviews are presented here in two waves.

Firstly the results are given for each category (as indicated above) and for each separate graphs detailing the 5 factors of simplicity, efficiency, effectiveness, ease of learning and user satisfaction are then presented.

After dealing with each group in isolation, a comparison between the groups for the various factors are presented.

¹⁴⁸ Webster Andrew & Wyatt Sally. 2006. New technology in health care – challenge, change and innovation.

¹⁴⁹ Kagolovsky Yuri & Moechr Jochen. 2003. Current status of the evaluation of information retrieval. *Journal of Medical Systems* 27(5), 409-424.

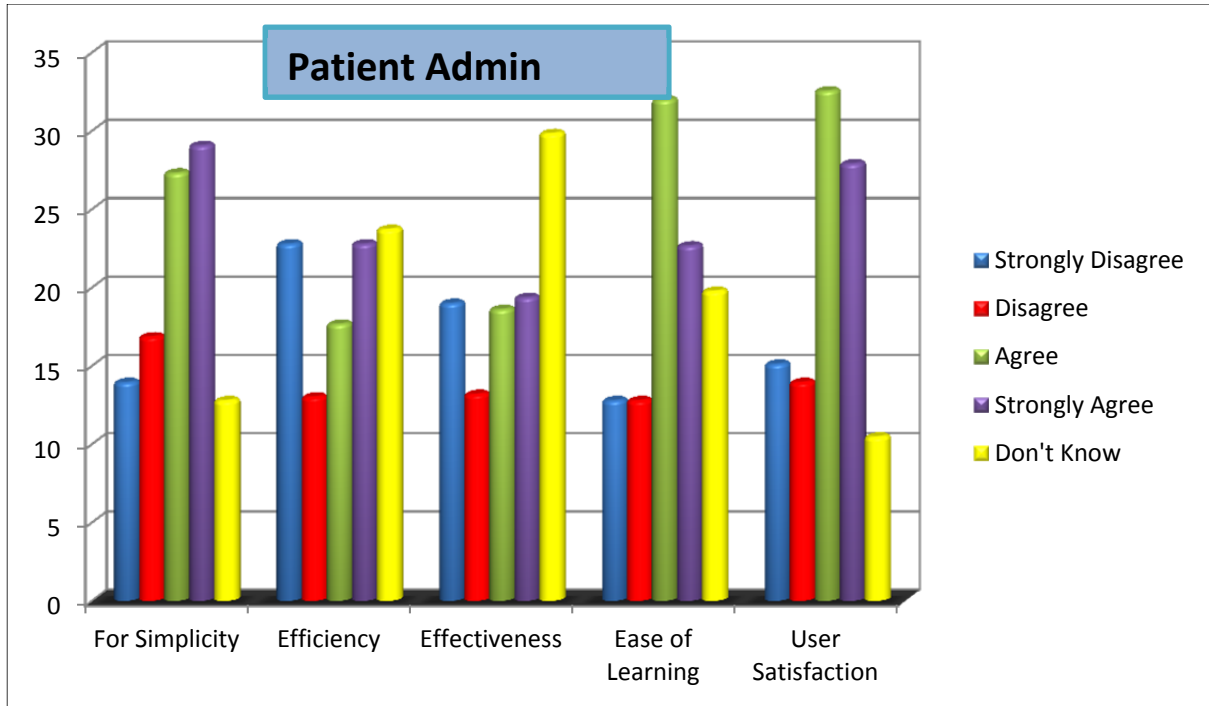
4.4.1 Patient Administration

In the Patient Administration profile, only 23.26% were respondents who have been in their current profession/job for 20 years or more, 32.56% have been in their current position between 10 and 20 years, 9.3% have between six to ten years' experience in their current position, while 27.91% have one to five years' experience.

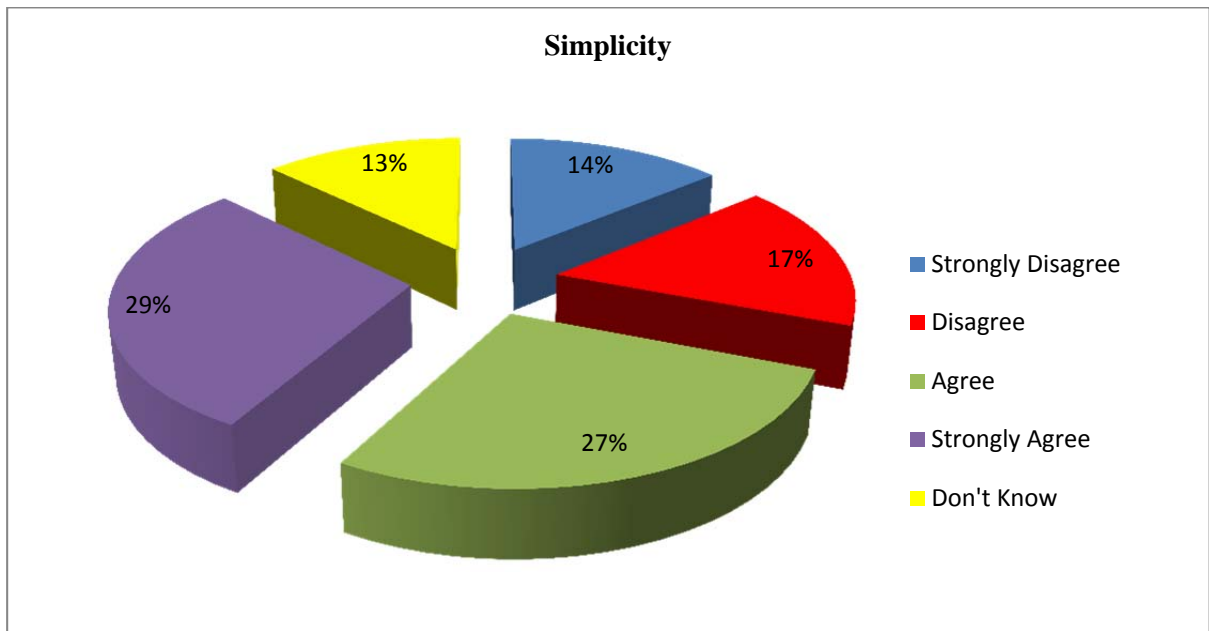
Over 72% indicated that they use computers very well, that is, they are very positive about the use of computers, while 18% are positive only about the use of computers. Over 79% like to use (i.e., they are very positive about liking to use) computers in the office.

The key findings of the survey in Patient Administration, in percentages, are the following:

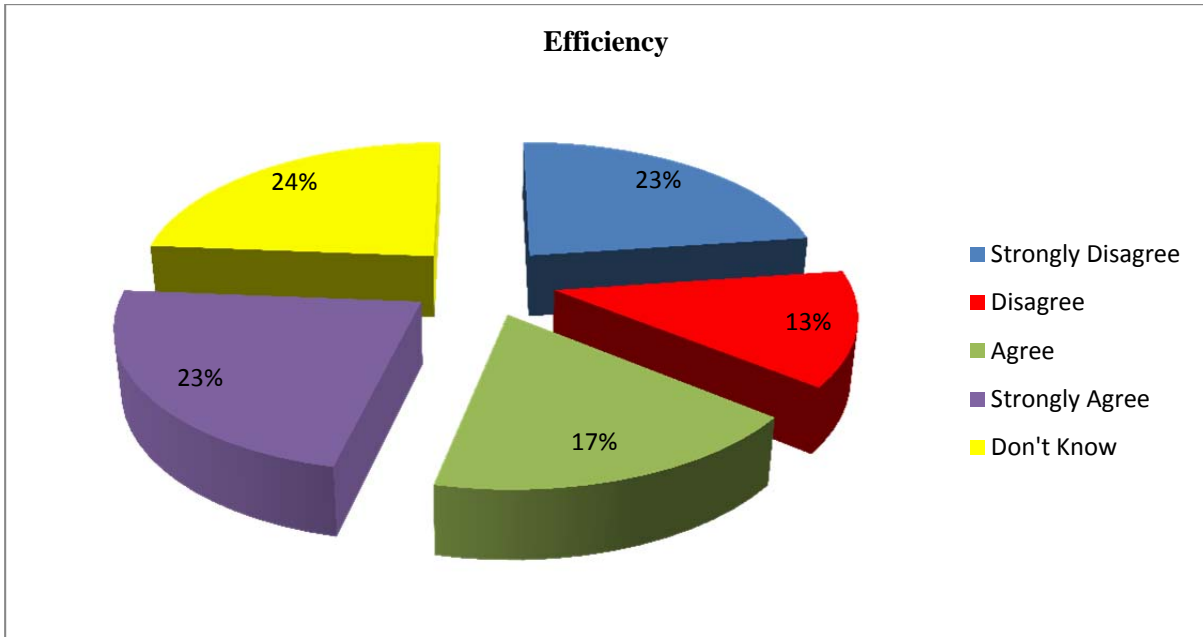
Patient Admin	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
For Simplicity	13.96	16.86	27.32	29.07	12.79
Efficiency	22.79	13.02	17.67	22.79	23.73
Effectiveness	19	13.19	18.61	19.37	29.84
Ease of Learning	12.79	12.79	31.98	22.67	19.77
User Satisfaction	15.12	13.95	32.56	27.91	10.47



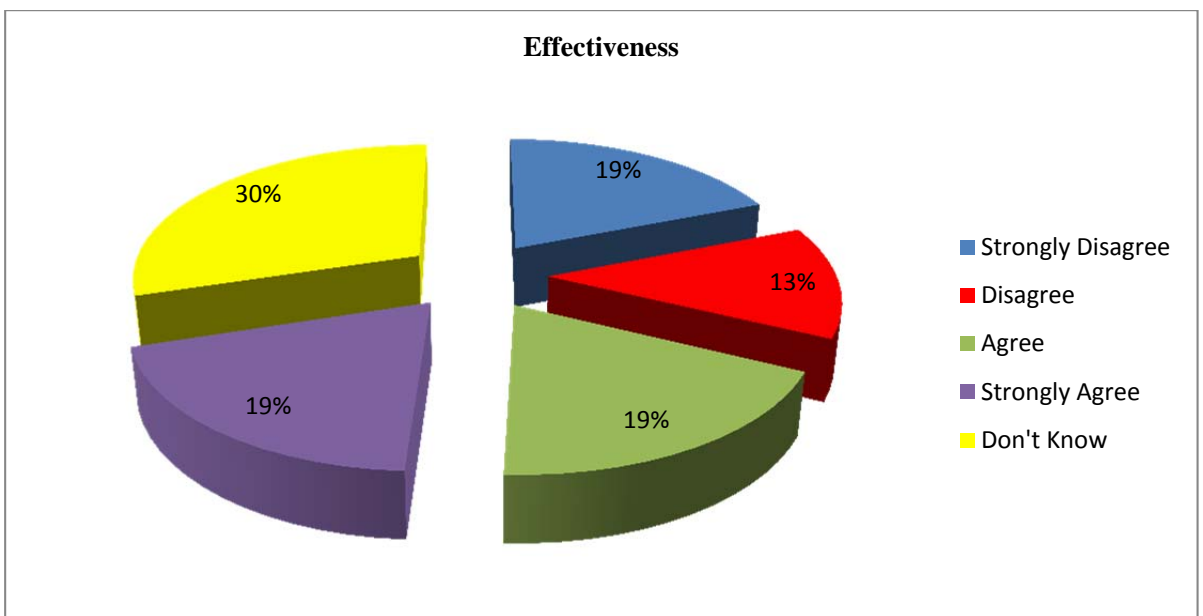
Simplicity: 29.07% strongly agree that the system is simple, 27.32% agree, while 16.86% disagree, 13.96% strongly disagree, and 12.79 % do not know.



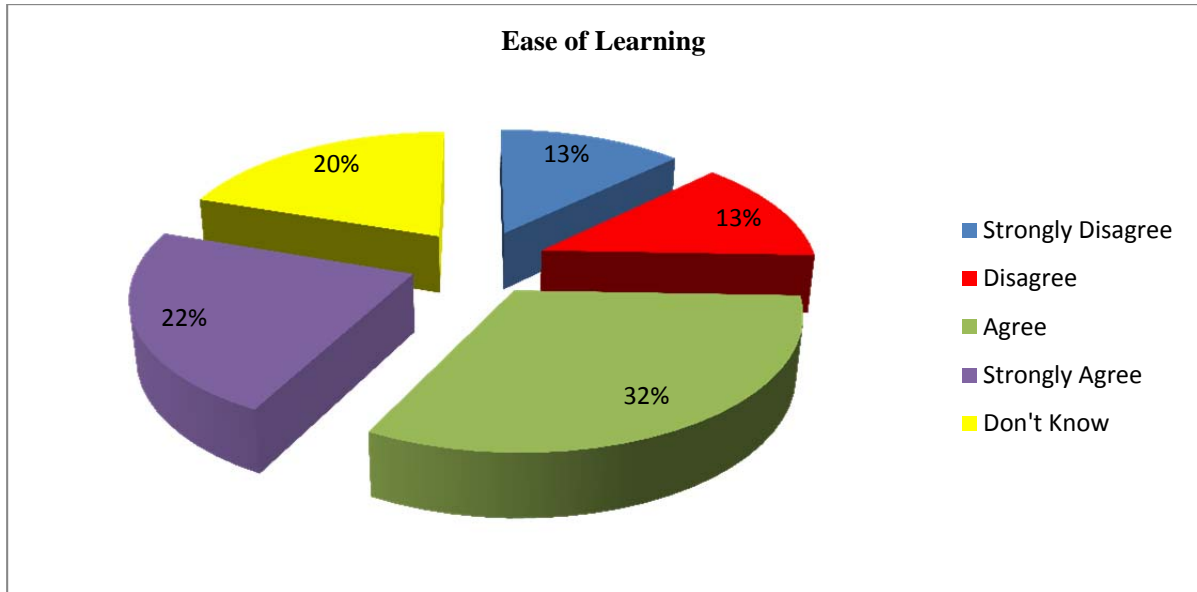
Efficiency: 23.73% do not know whether the system is efficient or not, while 22.79% strongly agree, 22.79% strongly disagree, 13.02% disagree and 17.67% agree.



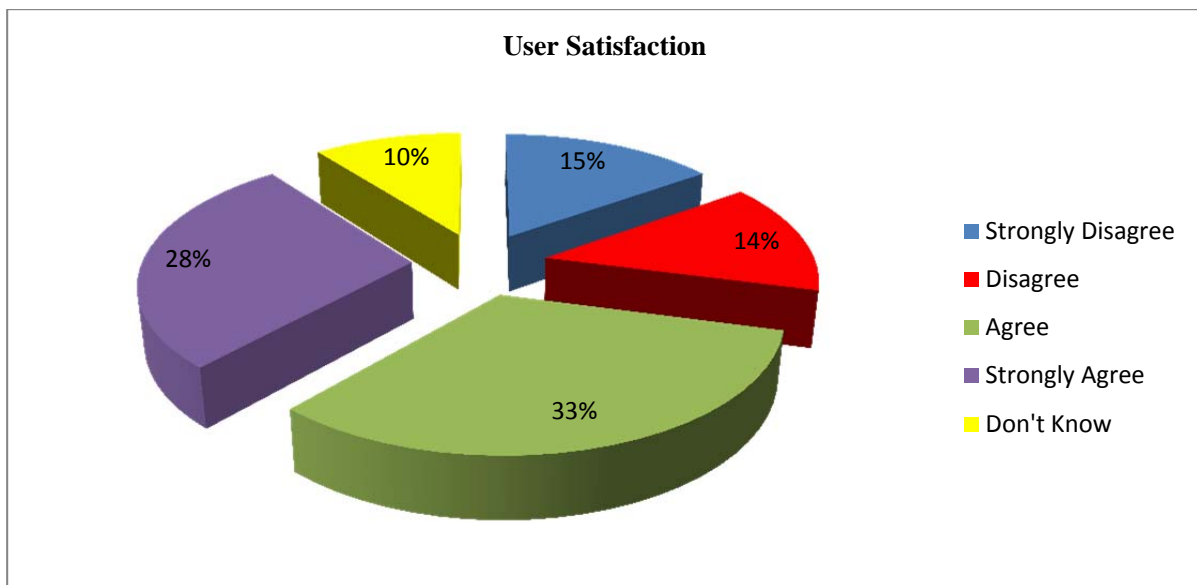
Effectiveness: 29.84% do not know whether the system is effective, while 19.37% strongly agree, 18.61% agree, 19% strongly disagree and 13.19% disagree.



Ease of Learning: 31.98% agree that the system can be used for learning, while 22.67% strongly agree, 19.77% do not know if the system can be used for learning, 12.79% strongly disagree, and 12.79% disagree.



User Satisfaction: 32.56% agree that they are satisfied with the system, while 27.91% strongly agree, 15.12% strongly disagree, 13.95% disagree, and 10.47% do not know.

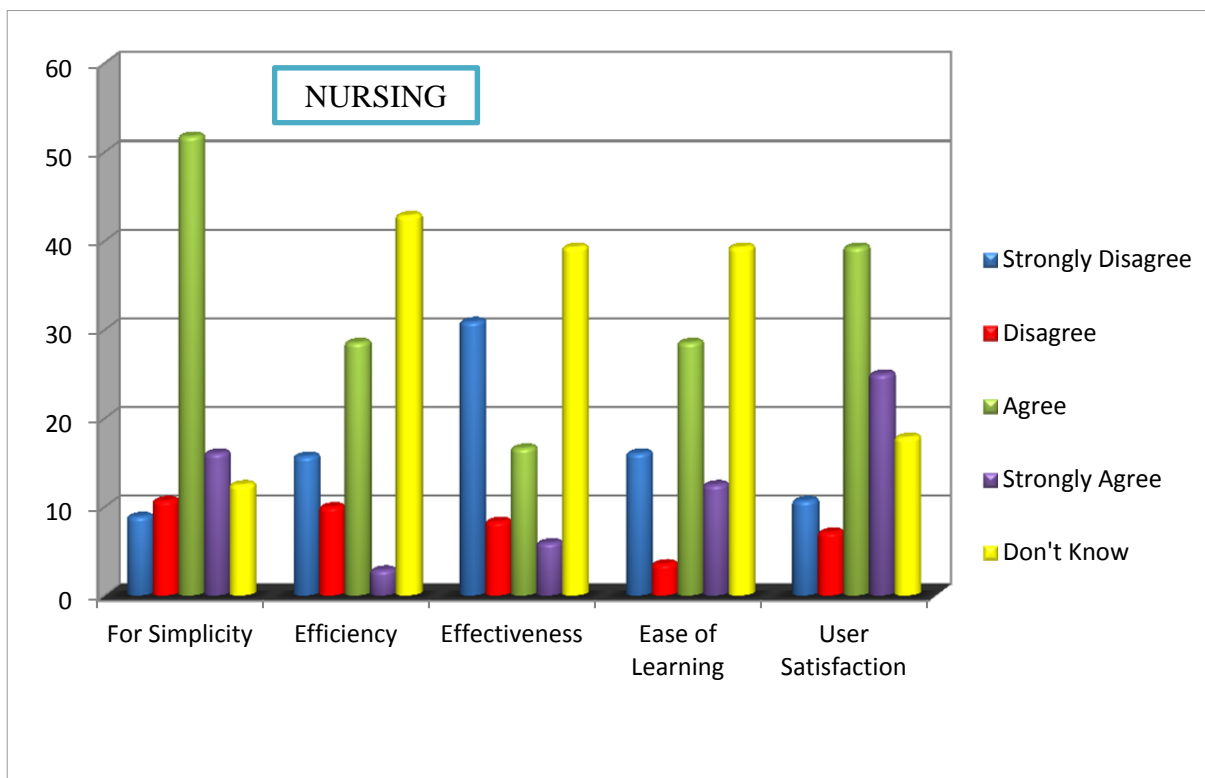


4.4.2 Nursing

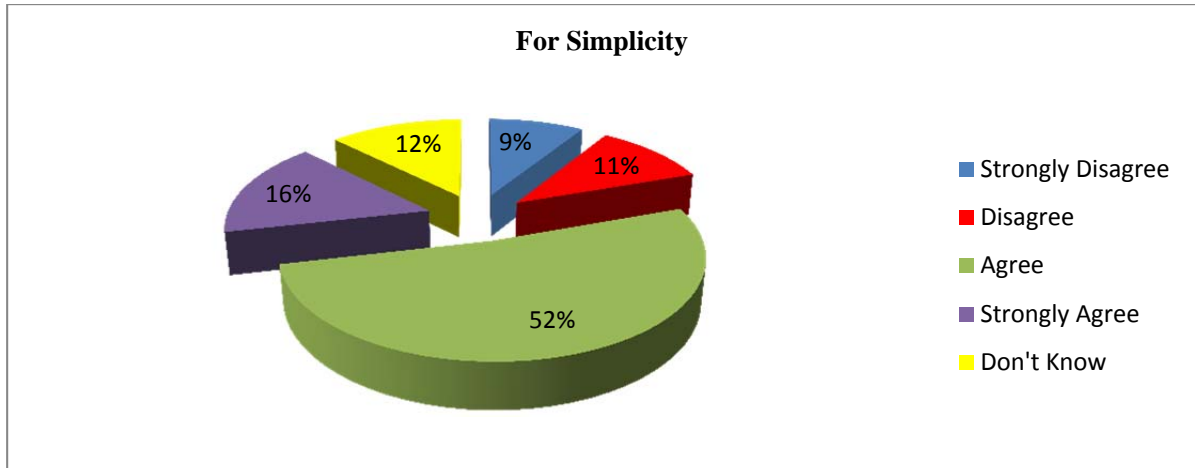
In the Nursing profile, 64.29% have been in their current position between one to five years, 21.43% have been in their current position between 10 to 20 years, while 7.14% have been in their current position between six to ten years. The majority did not indicate whether they like to use computers, or they use computers well for their type of work, while only 7.14% indicated that they like to use computers and are very positive about them, and 7.14% indicated that they are very positive about using computers to do work.

The key findings of the survey in Nursing are the following:

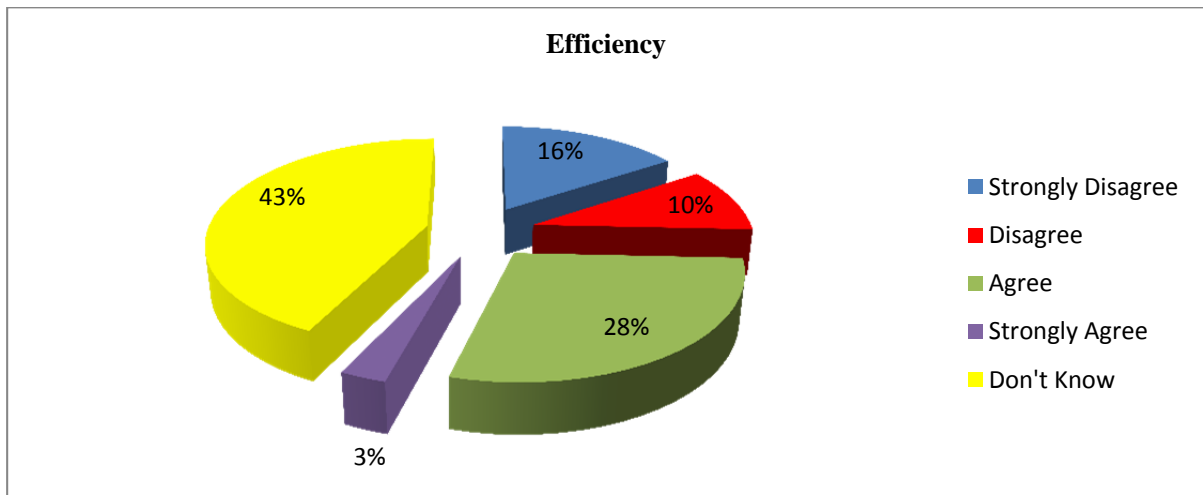
Nursing	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
For Simplicity	8.92	10.71	51.79	16.07	12.5
Efficiency	15.71	10	28.57	2.86	42.86
Effectiveness	30.7	8.13	16.41	5.7	39.07
Ease of Learning	16.07	3.57	28.57	12.5	39.3
User Satisfaction	10.71	7.14	39.3	25	17.86



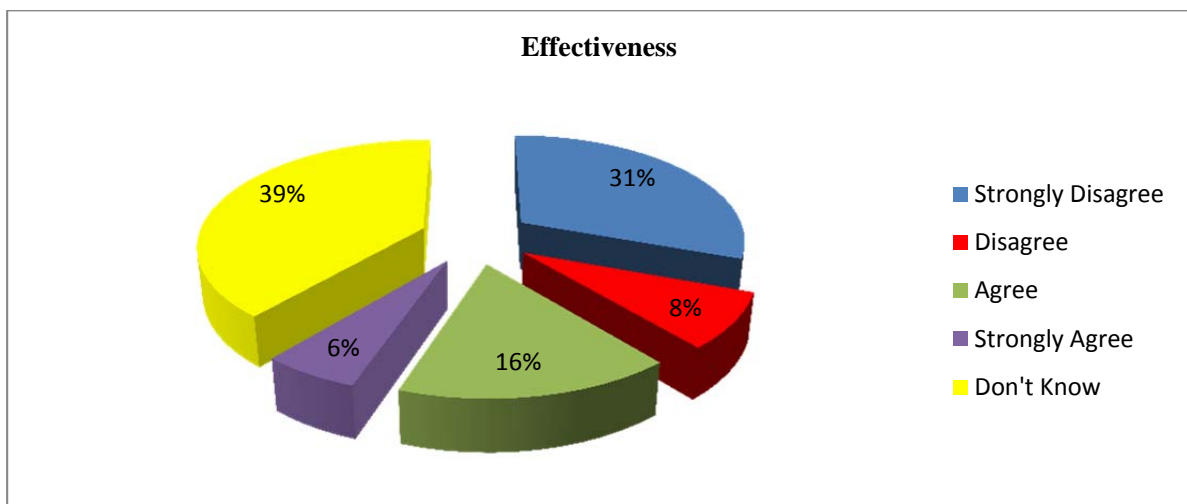
Simplicity: 51.79% agree that the system is simple, while 16.07% strongly agree, 12.5% do not know whether the system is simple or not, 10.71% disagree, and 8.92% strongly agree.



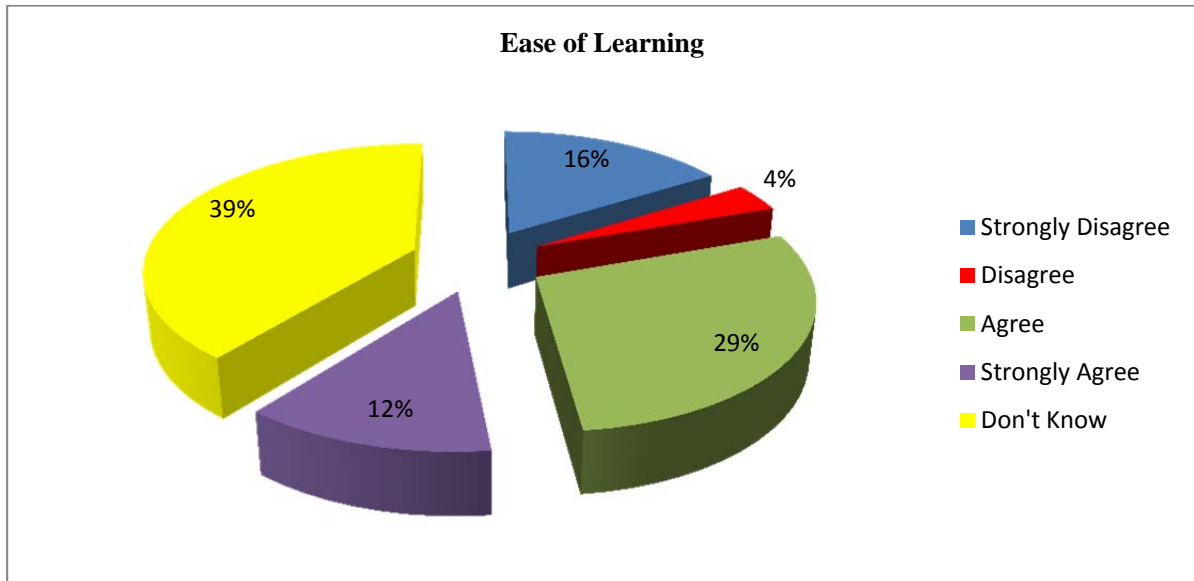
Efficiency: 42.86% do not know whether the system is efficient or not, while 28.57% agree that the system is efficient, 15.71% strongly disagree, 10% agree, and 2.86% strongly disagree.



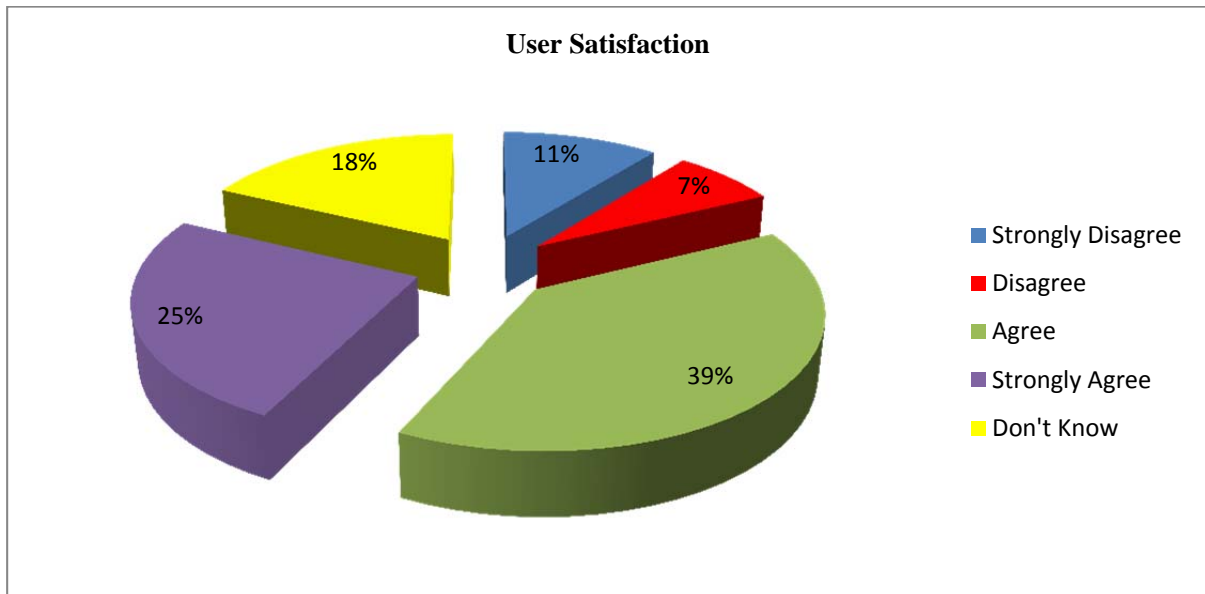
Effectiveness: 39.07% do not know whether the system is effective or not, while 30.7% strongly disagree, 16.41% agree, 8.13% disagree, and 5.7% strongly agree.



Ease of Learning: 39.3% do not know whether the system can be used for learning or not, while 28.57% agree, 16.01% strongly disagree, 12.5% strongly agree, and 3.57% disagree.



User Satisfaction: 39.3% agree that they are satisfied with the system, 25% strongly agree, 17.86% do not know, 10.71% strongly disagree, and 7.14% disagree.



4.4.3 Medical Practitioners (Clinicians)

In the Medical Practitioners' profile, 74.14% have been in their current position for between one to five years, 12.9% have been in their current position with between 10 to 20 years' experience, and only 12.9% have been in their current position for 20 years and longer.

In the category of those with one to five years' experience regarding their liking to use computers: 19.35% are absolutely negative, 3.23% are negative, 3.23% are positive, and

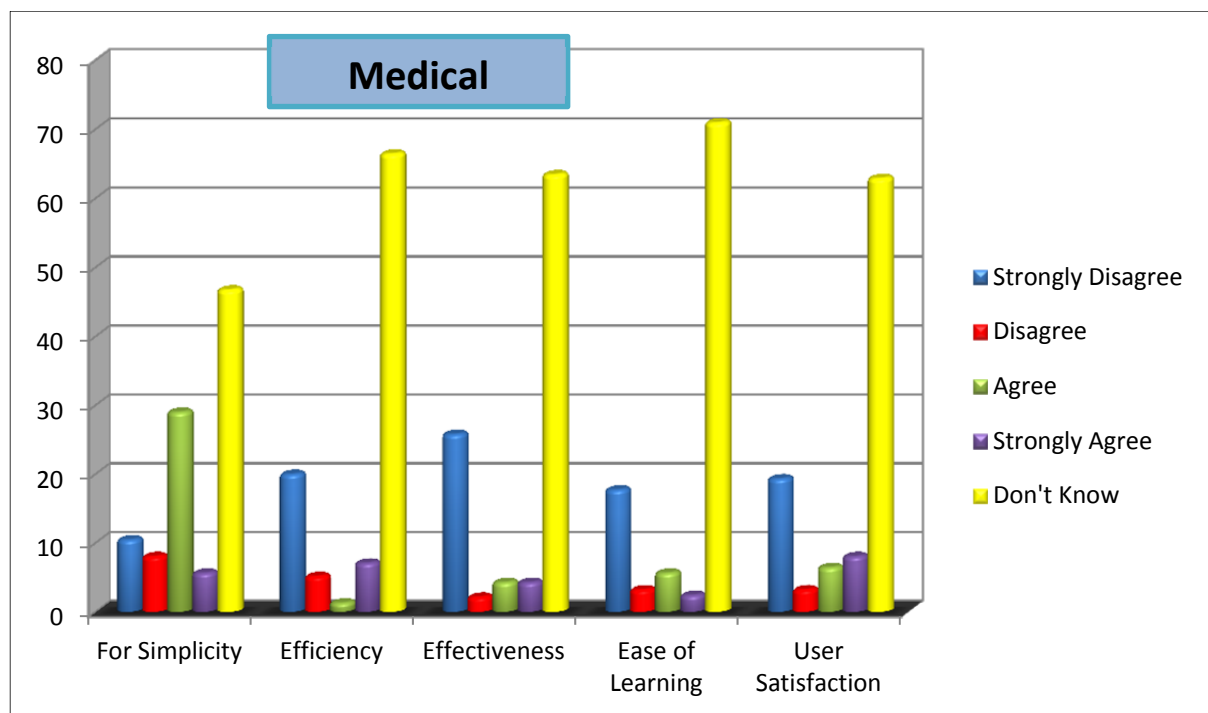
48.38% are very positive. Also in the same category, 19.35% are absolutely negative about using computers for their work, 3.23% are negative, 3.23% are positive, while 48.39% are very positive about using computers.

In the category of 10 to 20 years' experience, 3.23% are negative about liking to use computers, while 9.68% are just positive, and the rest did not indicate their use of computers.

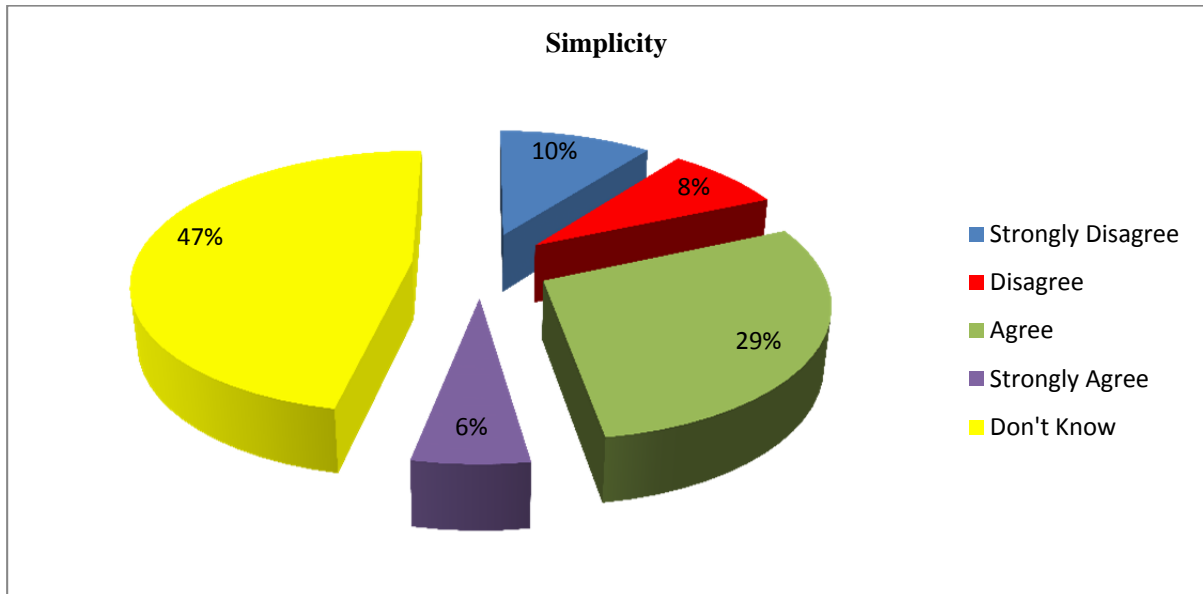
In the category of 20 years and over about liking to use computers: 6.45% are absolutely negative, while also 6.45% are very positive, 9.68% are absolutely negative about using computers for their work, and 3.23% are just negative.

The key findings of the survey regarding Medical (Clinicians) are the following:

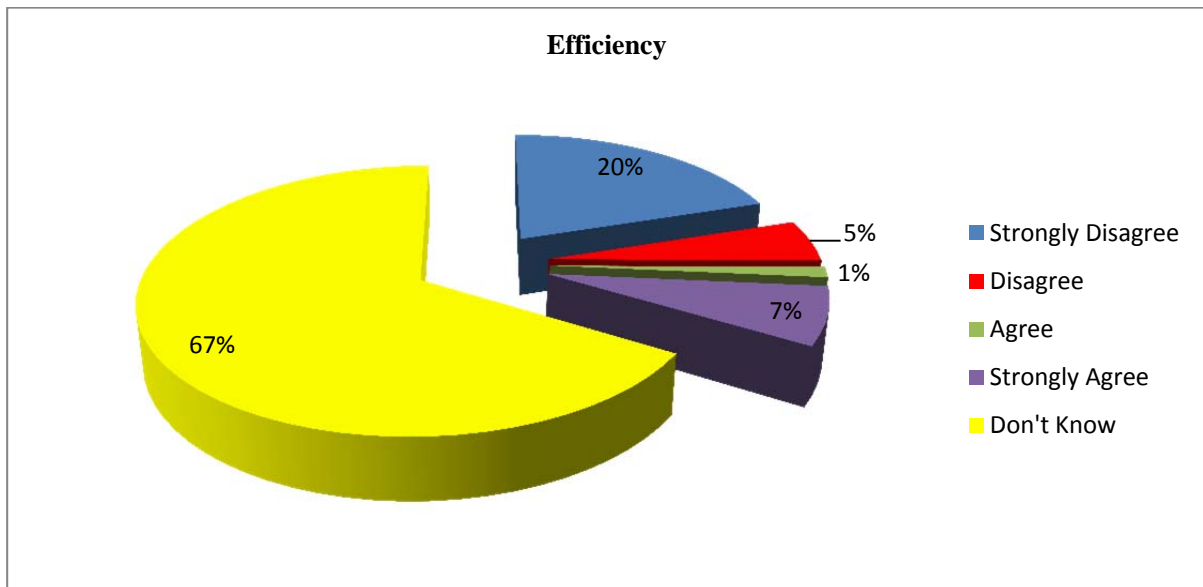
Medical	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
For Simplicity	10.48	8.06	29.03	5.65	46.77
Efficiency	20	5.16	1.29	7.1	66.45
Effectiveness	25.81	2.16	4.29	4.29	63.45
Ease of Learning	17.74	3.23	5.65	2.42	70.97
User Satisfaction	19.35	3.23	6.45	8.06	62.9



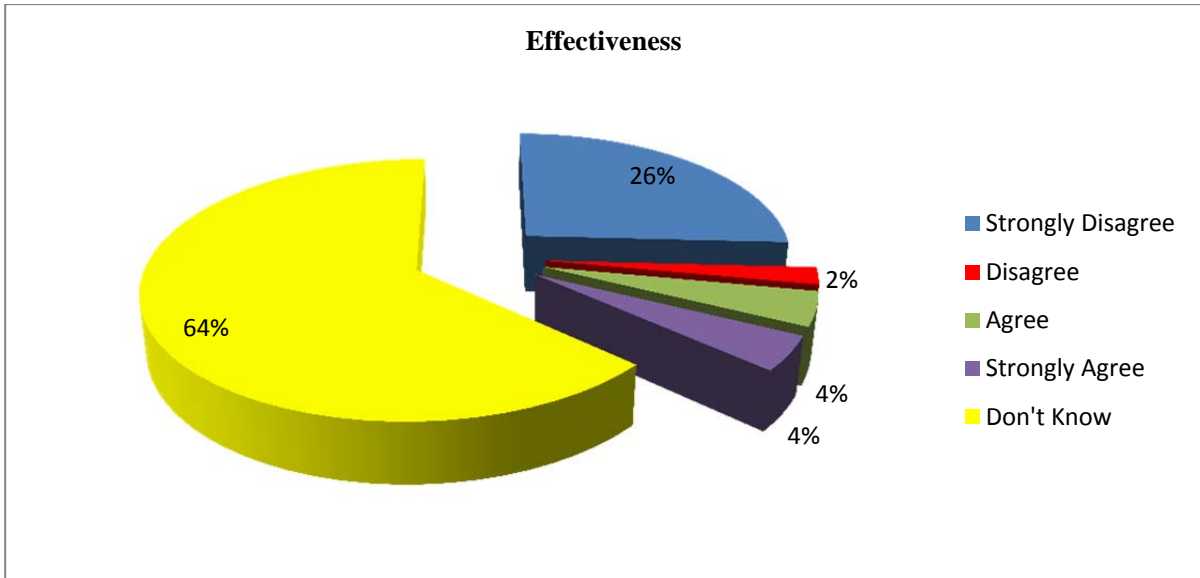
Simplicity: 46.77% do not know whether the system is simple to use or not, while 29.03% agree, 10.48% strongly disagree, 8.06% disagree, and 5.65% strongly agree.



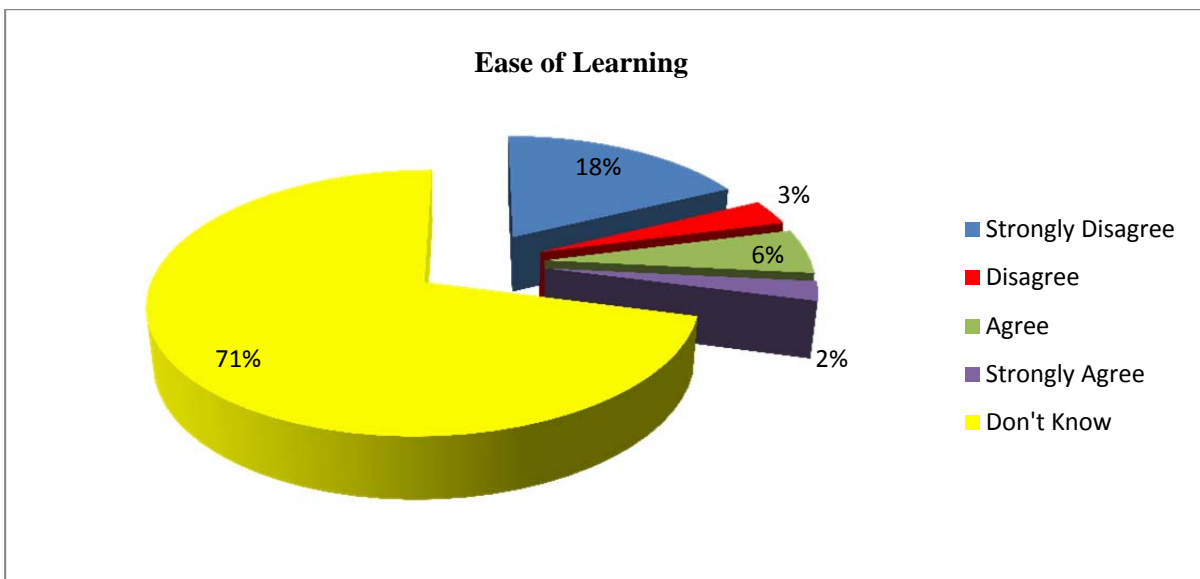
Efficiency: 66.45% do not know whether the system is efficient or not, while 20% strongly disagree, 7.1% strongly agree, 5.16% disagree, and 1.29% agree that the system is efficient.



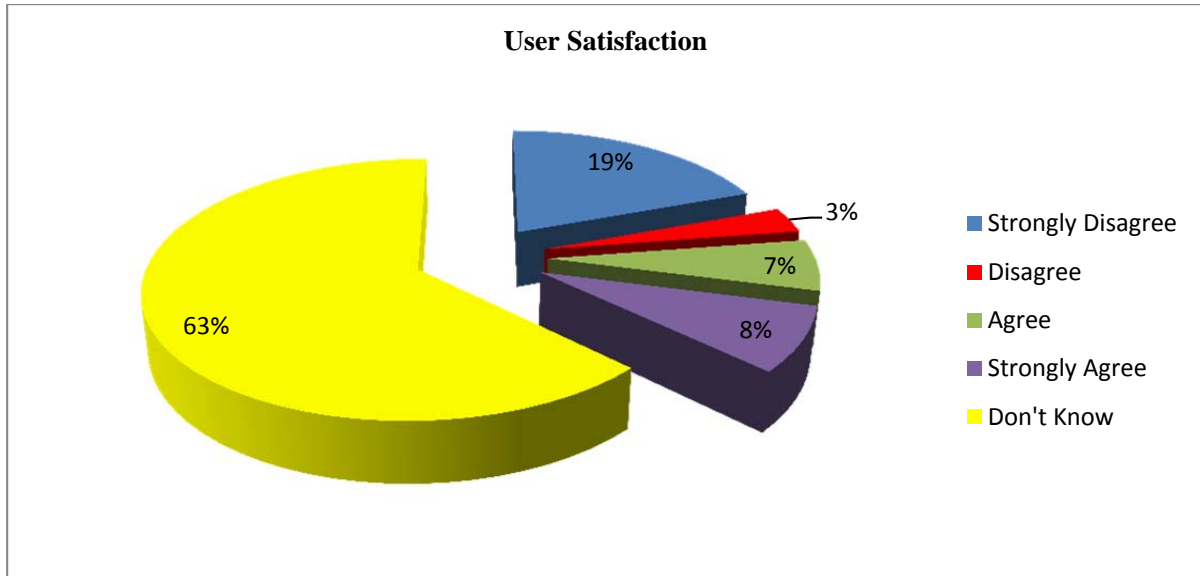
Effectiveness: 63.45% do not know whether the system is effective or not, while 25.81% strongly disagree, 4.29% agree, 4.29% strongly agree, and 2.16% disagree.



Ease of Learning: 70.97% do not know whether the system can be used for learning, while 17.74% strongly disagree, 5.65% agree, 3.23% disagree, and 2.42% strongly agree.



User Satisfaction: 62.9% do not know whether they are satisfied with the system, while 19.35% strongly disagree with being satisfied with the system, 8.06% strongly agree, 6.45% agree, and 3.23% disagree.



4.4.4 Medical Allied

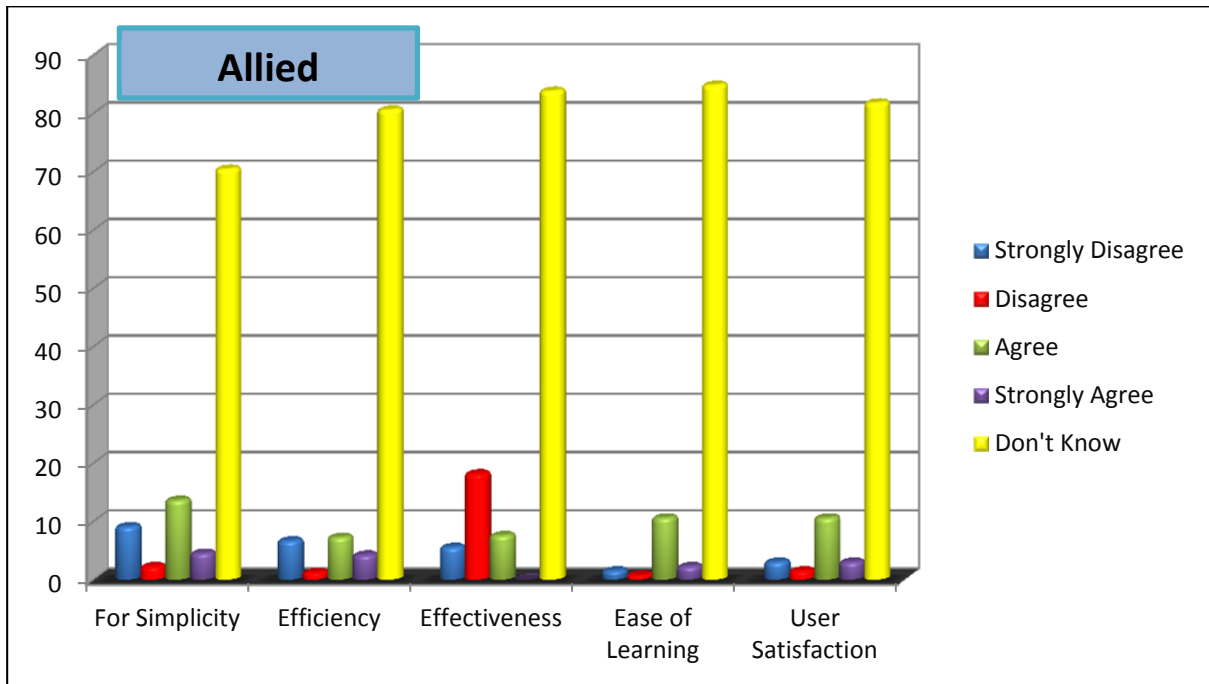
In the Medical Allied profile, 90.91% have one to five years' experience in their current position, while 9.09% have been in their current position for over ten years.

In the category of one to five years' experience in their current position, 6.06% are absolutely negative about liking to use computers, 12.12% are just negative, 30.3% are positive, while 42.42% are very positive. Also in the same category, 9.09% are absolutely negative about using computers for their clinical work, 15.15% are just negative, 33.33% are positive, while 33.33% are very positive.

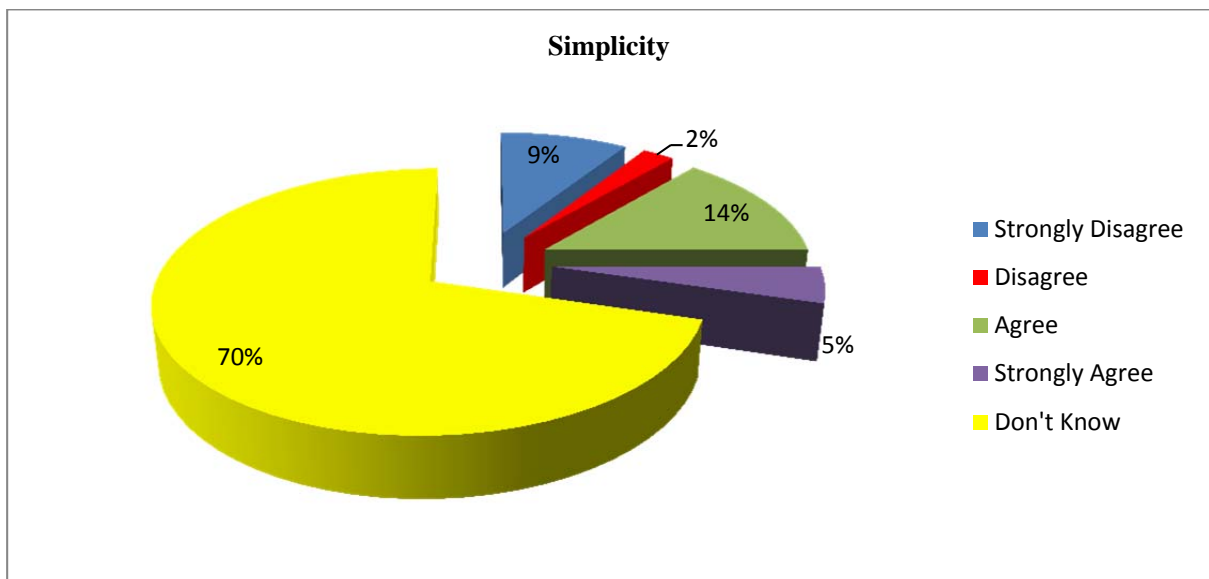
In the category of over ten years' experience in the current position, 3.03% are positive about liking to use computers, while 6.06% are very positive. Also, 3.03% are positive about using computers for their clinical work, while 6.06% are very positive.

The key findings of the survey in the Medical Allied category are the following:

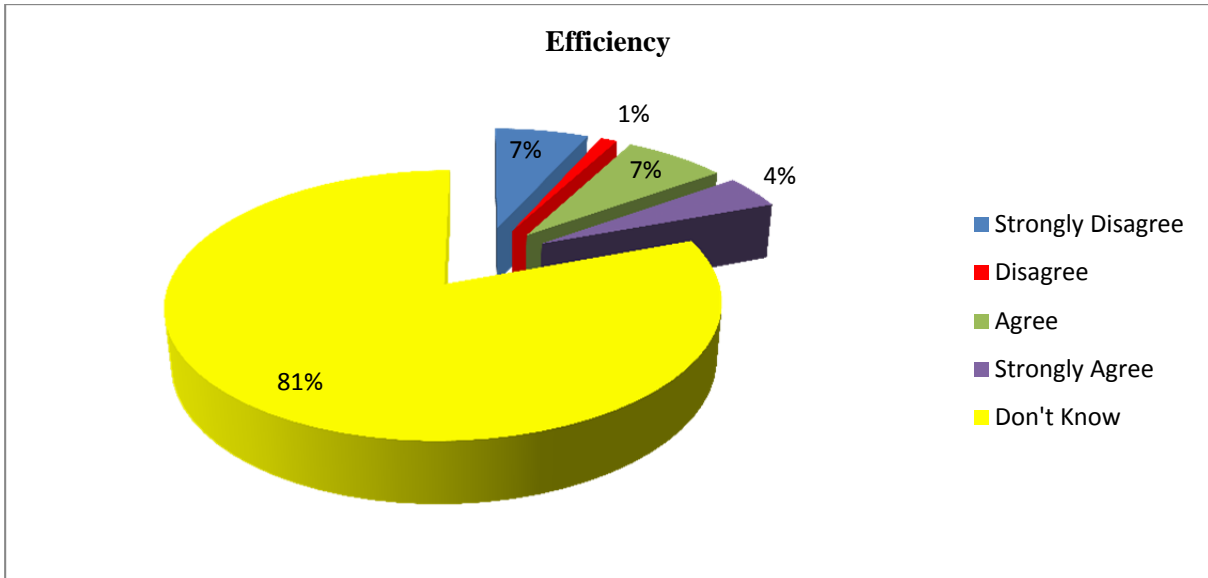
Allied	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
For Simplicity	9.09	2.27	13.64	4.55	70.45
Efficiency	6.67	1.21	7.27	4.24	80.61
Effectiveness	5.55	3.03	7.58	0	83.85
Ease of Learning	1.52	0.76	10.61	2.27	84.85
User Satisfaction	3.03	1.52	10.61	3.03	81.82



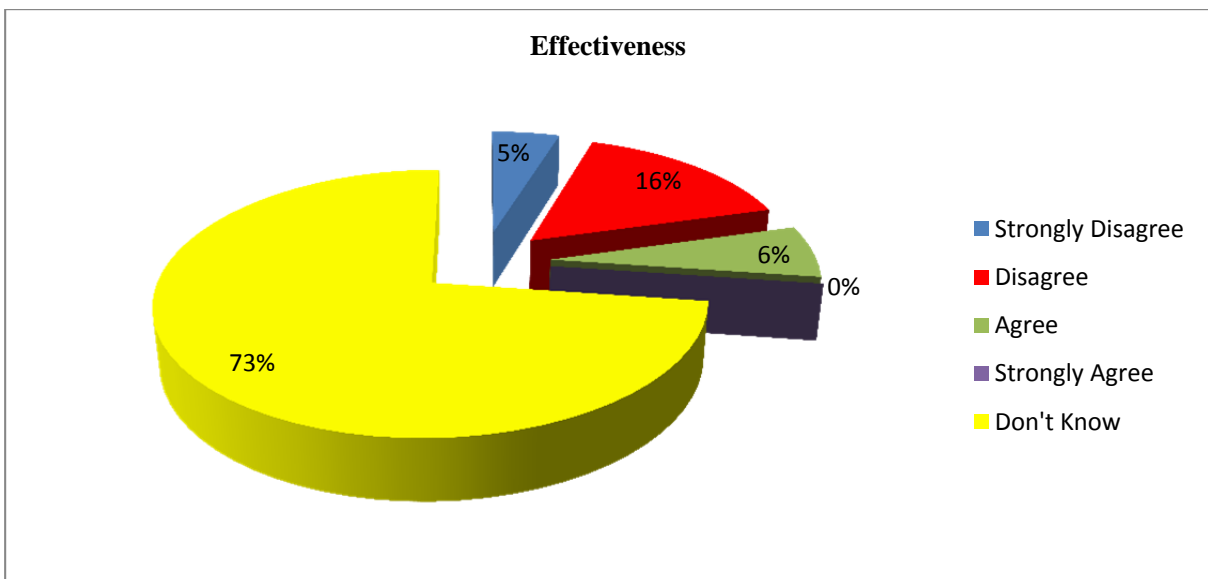
Simplicity: 70.45% do not know whether the system is simple to use or not, while 13.64% agree, 9.09% strongly disagree, 4.55% strongly agree, and 2.27% disagree.



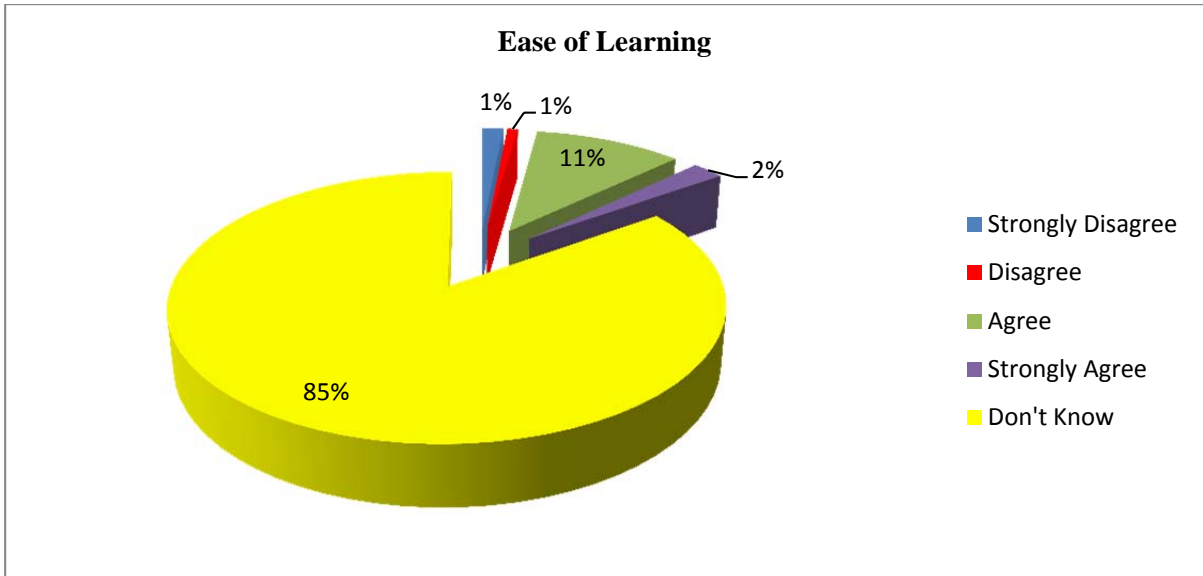
Efficiency: 80.61% do not know whether the system is efficient or not, while 7.27% agree, 6.67% strongly disagree, 4.24% strongly agree, and 1.21% disagree.



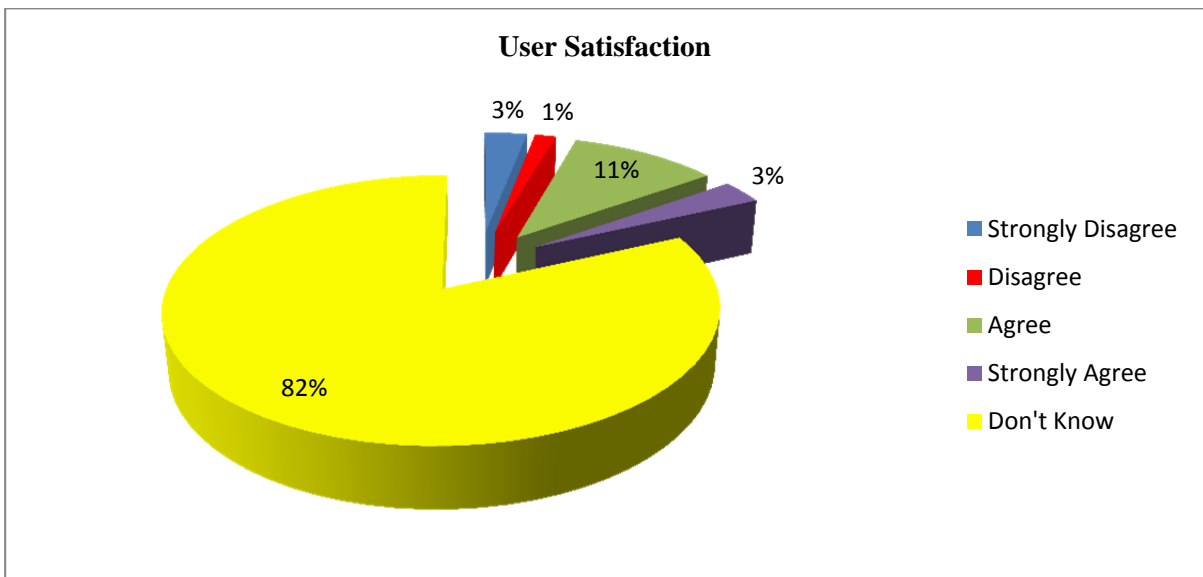
Effectiveness: 83.85% do not know whether the system is effective or not, while 7.58% agree, 5.55% strongly disagree, 3.03% disagree, and 0% strongly disagree.



Ease of Learning: 84.85% do not know whether the system can be used for learning or not, while 10.61% agree that the system can be used for learning, 1.52% strongly disagree, 2.27% strongly agree, and 0.76% disagree.



User Satisfaction: 81.81% do not know whether they are satisfied with the system or not, while 10.61% agree that they are satisfied with the system, 3.03% strongly disagree, 3.03% strongly agree, and 1.52% disagree.



4.5 Comparison of Survey Results between Disciplines

This section details the comparison survey results among the different disciplines in table and graphs formats on system usability.

Simplicity

Simplicity	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Admin	13.95	16.86	27.32	29.07	12.79
Medical	10.48	8.06	29.03	5.65	46.77
Nursing	8.92	10.71	51.79	16.07	12.5
Allied	9.09	2.27	13.64	4.55	70.45

Table 5 – Comparison of survey results among different disciplines – Simplicity

The system seems to be simple in Patient Admin while Clinicians and Allieds do not know whether the system is simple to use, the Nursing agree that the system is simple to use.

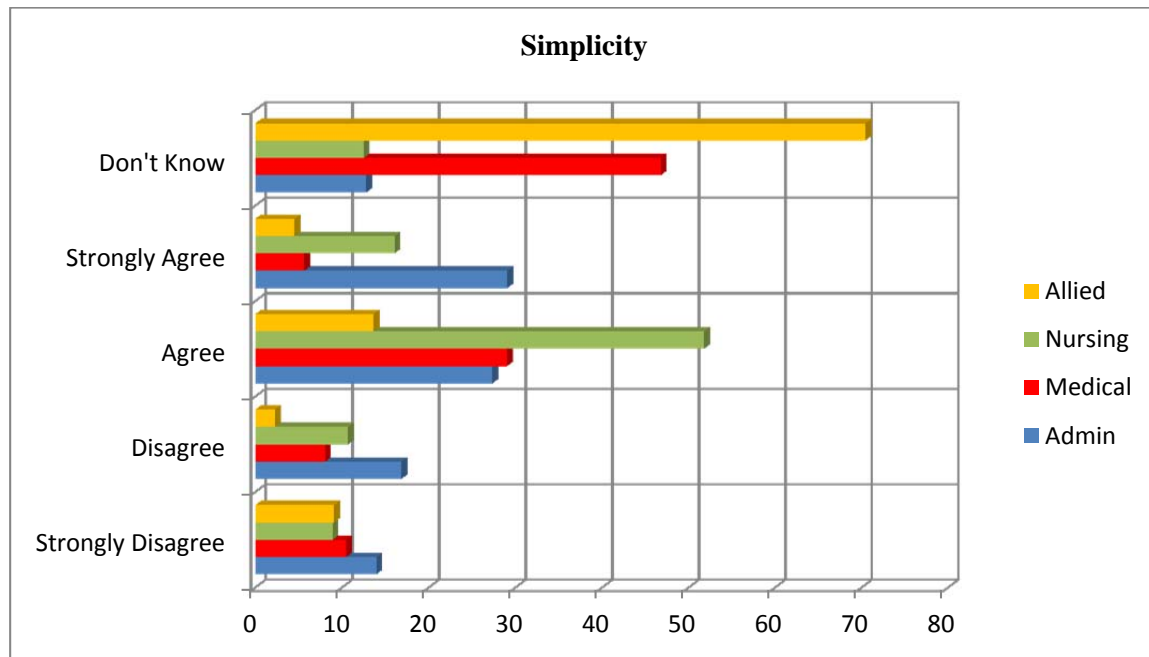


Figure 5 – Bar Chart Comparison of Survey Results – Simplicity

From the graph it is evident that the Medical Allied and Clinicians do not know whether the system is simple to use or not. In the Patient Admin and Nursing the system is simple to use. The implications are that the majority of Allied and Clinicians do not use the system thus the reason they are unable to either agree or disagree that the system is simple, even though the system does cater for the respective discipline. The Patient Admin are the majority users of the system.

Efficiency

Efficiency	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Admin	22.79	13.02	17.67	22.79	23.72
Medical	20	5.16	1.29	7.1	66.45
Nursing	15.71	10	28.57	2.86	42.86
Allied	6.67	1.21	7.27	4.24	80.61

Table 6 – Comparison of survey results among different disciplines – Efficiency

From the table above, a high percentage of Medical and Allied do not know whether the system is efficient while Nursing and Patient Admin are split.

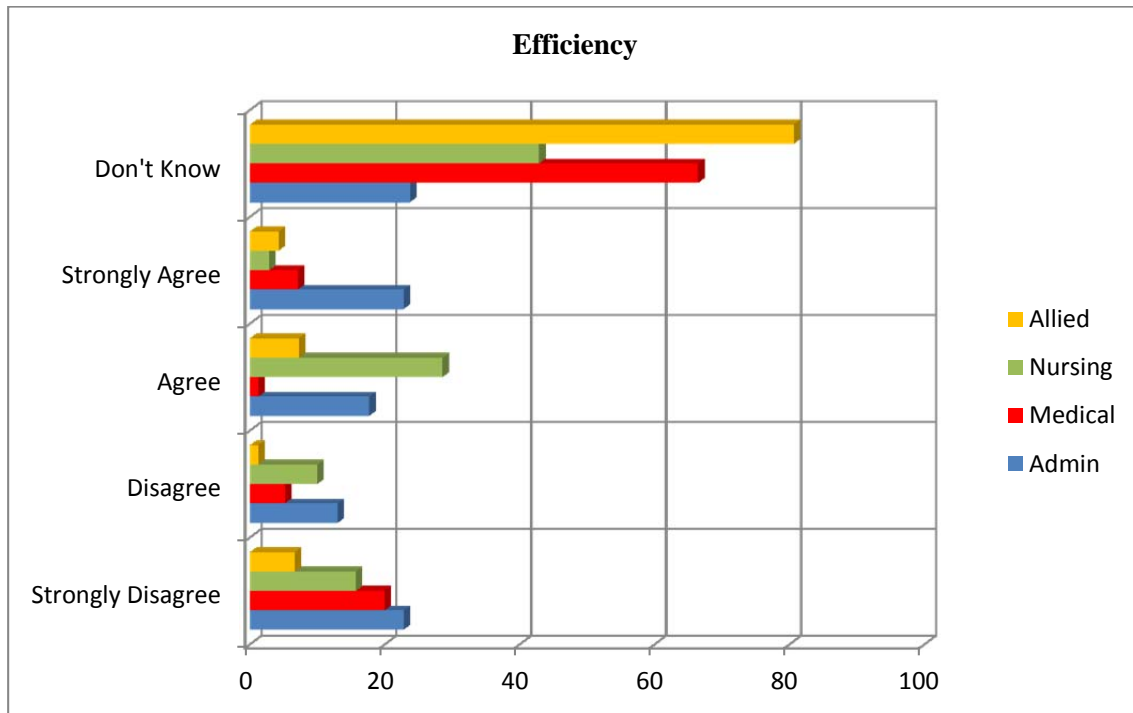


Figure 6 – Bar Chart Comparison of Survey Results – Efficiency

From the graph it is evident that the Medical Allied, Nurses and Clinicians do not know whether the system is efficient or improves efficiencies. In the Patient Admin, although the system is in use, the system does not seem to be efficient. The implications are that the majority of Allied and Clinicians do not use the system thus the reason they are unable to either agree or disagree that the system is efficient, even though the system does cater for the respective discipline. The benefit of the system is not being realised. Even though the Patient Admin are the majority users of the system, the system does not seem to be efficient.

Effectiveness

Effectiveness	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Admin	19	13.19	18.61	19.37	29.84
Medical	25.81	2.16	4.29	4.29	63.45
Nursing	30.93	8.36	16.64	5.93	39.3
Allied	5.55	18.18	7.58	0	83.85

Table 7 – Comparison of survey results among different disciplines – Effectiveness

From the table above, a high percentage of Medical and Allied do not know whether the system is effective while Nursing and Patient Admin are split.

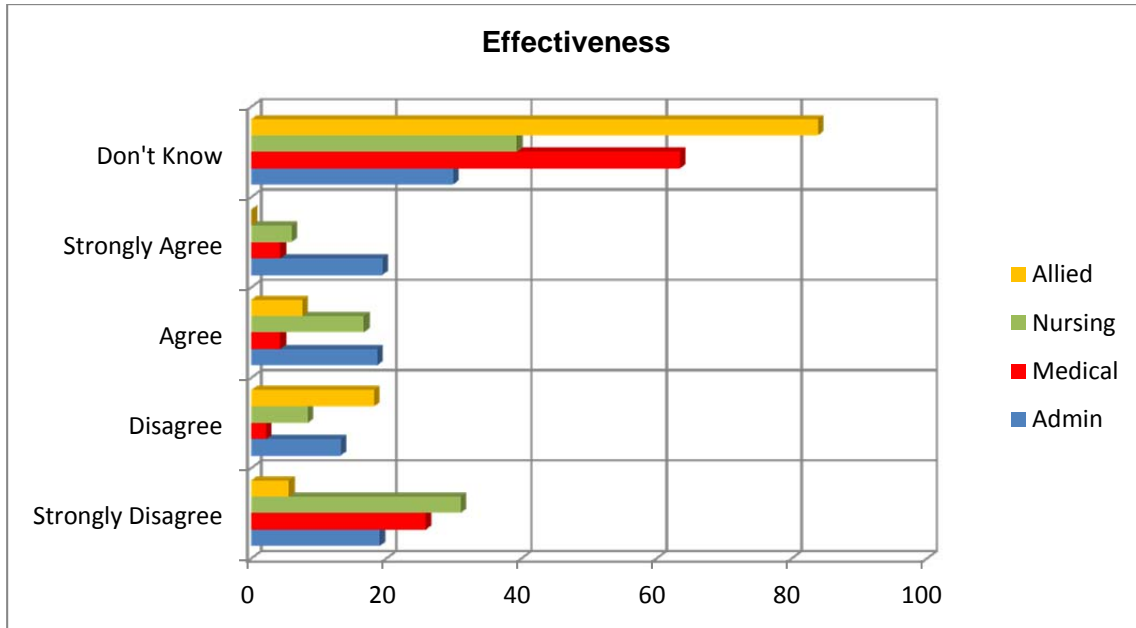


Figure 7 – Bar Chart Comparison of Survey Results – Effectiveness

From the graph it is evident that the Medical Allied, Nursing and Clinicians do not know whether the system is effective or improves effectiveness. In the Patient Admin, although the system is in use, the system does not seem to be effective. The implications are that the majority of Allied, Nurses and Clinicians do not use the system thus the reason they are unable to either agree or disagree that the system is effective, even though the system does cater for the respective discipline, the benefit of the system is not being realised. Even though the Patient Admin are the majority users of the system, the system does not seem to be effective.

Ease of learning

Ease of Learning	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Admin	12.79	12.79	31.98	22.67	19.77
Medical	17.74	3.22	5.65	2.42	70.97
Nursing	16.07	3.57	28.57	12.5	39.3
Allied	1.52	0.76	10.61	2.27	84.85

Table 7 – Comparison of survey results among different disciplines – Effectiveness

From the table above, a high percentage of Medical and Allied do not know whether the system can be used for learning or not while in Nursing and Patient Admin there are splits.

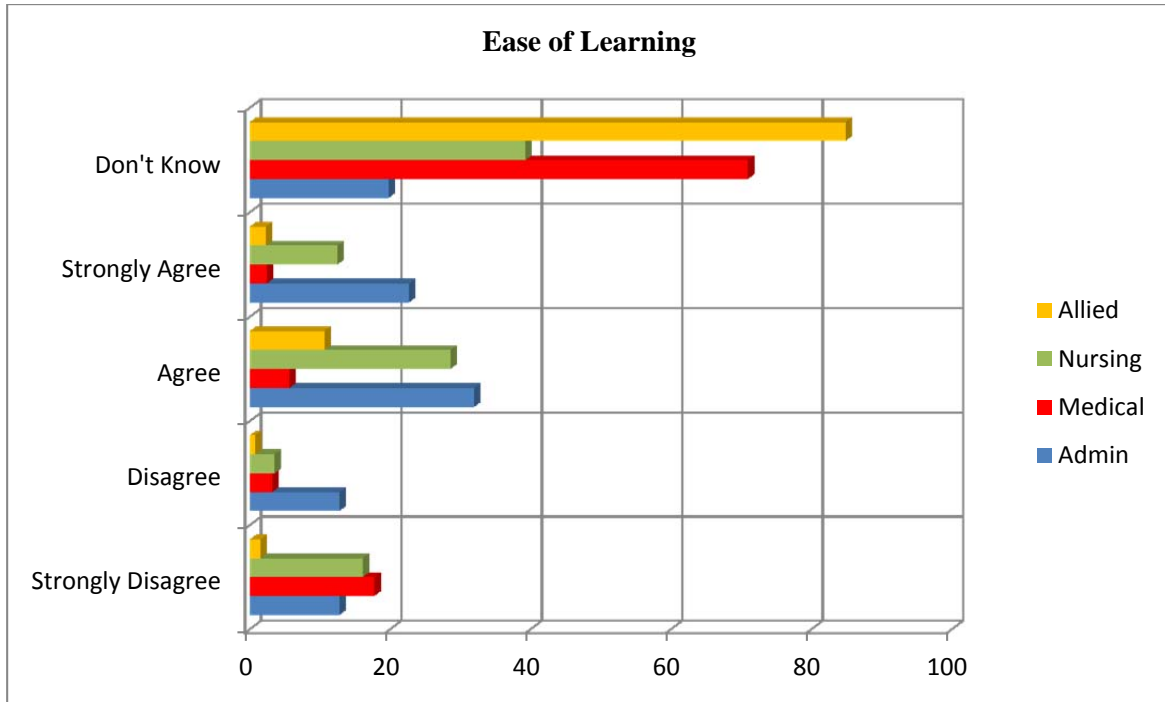


Figure 8 – Bar Chart Comparison of Survey Results – Ease of Learning

From the graph it is evident that the Medical Allied, Nursing and Clinicians do not know whether the system can be easily used for learning or not. In the Patient Admin, although the system is in use, there is not outright majority agreement whether the system can be easily used for learning. The implications are that the majority of Allied, Nurses and Clinicians do not use the system thus the reason they are unable to either agree or disagree that the system can be easily used for learning, even though the system does cater for the respective discipline, the benefit of the system is not being realised. Even though the Patient Admin are the majority users of the system, a slight majority do agree that the system can be easily used for learning.

User Satisfaction

User Satisfaction	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
Admin	15.12	13.95	32.56	27.91	10.47
Medical	19.35	3.23	6.45	8.06	62.9
Nursing	10.71	7.14	39.3	25	17.86
Allied	3.03	1.52	10.61	3.03	81.82

Table 9 – Comparison of survey results among different disciplines – User Satisfaction

From the table above, a high percentage of Medical, Allied and with a slight number of Nurses do not know whether they are satisfied with the system or not while Patient Admin are split.

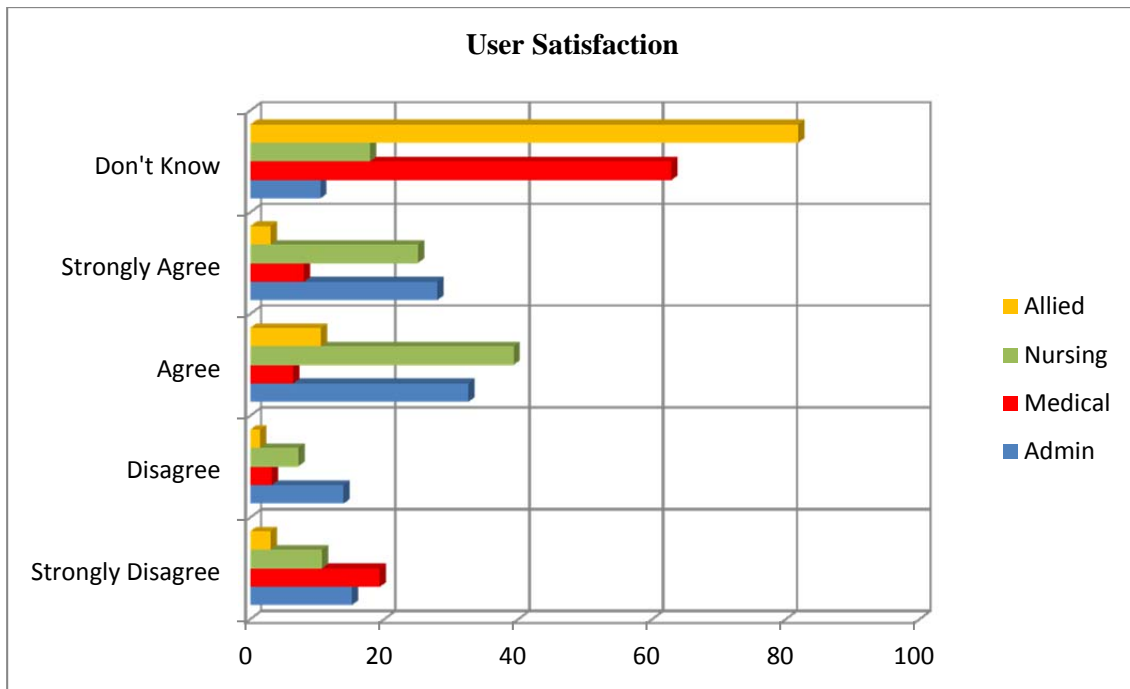


Figure 9 – Bar Chart Comparison of Survey Results – User Satisfaction

From the graph it is evident that majority of Medical Allied and Clinicians do not know whether the system can be easily used for learning or not. In the Patient Admin, although the system is in use, there is not outright majority agreement on user satisfaction with the system. The implications are that the majority of Allied and Clinicians do not use the system thus the reason they are unable to either agree or disagree that they are satisfied with the system even though the system does cater for the respective disciplines. The benefit of the system is not being realised even though the Patient Admin are the majority users of the system, a slight majority do agree that they are satisfied with the system.

The survey results have confirmed the fact that despite widespread use of information technology in other sectors, hospitals, physicians in particular, don't see the long-term value of electronic conversion. In addition, when a new information system is implemented, users may decide to adopt or resist it based on the evaluation of change associated with the system. This suggests that a common theoretical basis is possible for explaining user acceptance and resistance (e.g., Joshi 2005; Martinko et al. 1996). For this reason, this study has leveraged the technology acceptance literature in examining user resistance and system usability. Technology acceptance research has attracted several theoretical perspectives including the technology acceptance model, the theory of planned behaviour and recently, the unified theory of acceptance and use of technology¹⁵⁰.

¹⁵⁰ Kim & Kankanhalli, 2009. User Resistance to IS Implementation. *Journal of MIS Quarterly* (33)3, 567-582

4.6 Summary of the Survey Findings

4.6.1 System Usability in the Hospital

In the Patient Administration category, there seems not be an outright answer about the simplicity of the system. The survey is almost evenly spread, thus making it difficult to say whether the system is easy to use or not, some also indicating that they do not know whether the system is simple enough to use. About efficiency, there is also no clear answer on whether the system improves efficiencies or not, on average, 22.79% strongly disagree while 22.79% strongly agree that the system improves efficiency. In assessing the effectiveness, there seems to be no outright answer on whether the system is effective or not, with only 19.37% strongly agreeing, 18.61% agreeing while 13.19% disagree that the system is effective and 8.17% strongly disagreeing. An estimate of 29.84% does not know whether the system is effective or not. Regarding the ease of learning, 19.77% do not know if the system can be used to increase learning, 22.67% strongly agree and 31.98% agrees, 12.79% strongly disagrees and also 12.79% just disagree. Lastly on general user satisfaction on use of the system, 27.91% strongly agree that they are satisfied with the use of the system and 32.56% agreeing, 15.12% strongly disagree and 13.95% disagrees. The system seems to be generally used by the Patient Administration to administer the patient account.

In the Nursing category, a majority of 51.79% agree that the system is simple enough to operate with 16.07 strongly agreeing. Only 12.5% do not know, 8.93% strongly disagree while 10.71 just disagree. On the other hand, 42.86% do not know whether the system has improved efficiency or not, 28.57% agree that the system has improved efficiencies, 10% disagreeing and 15.71% strongly disagreeing, while 2.86% strongly agree. In assessing the effectiveness, 30.93% strongly disagree that the system is effective, 8.36% just disagrees, 16.64% agree and 5.93% disagrees, 39.3% do not know whether the system is effective or not. 28.57% do agree that the system can be used for ease of learning and 12.5% agree while 39.3% do not know if they can use the system for learning, 16.07% strongly disagrees and 3.57% disagree. An average of 39.3% agree that they are satisfied with the system, 25% strongly agreeing and 10.71% strongly disagrees, 7.14% just disagrees and 17.86% indicating that they do not know whether they are satisfied with the system or not. Although a slight majority have indicated that the system is simple enough to be used, there is no outright commonality on the usability of the system.

In the Medical Practitioners (Clinicians) category, 46.77% of the respondents do not know whether the system is simple enough to be used or not. Only 29.03% agree that the system is

easy enough to be used with 5.65% strongly agreeing, 10.48% strongly disagreeing, 8.06% just agreeing. A majority of 66.45% do not know whether the system improves efficiencies or not with 20% strongly disagreeing that the system improves efficiencies, 2.16% just disagrees, only 1.29% agrees and 7.1% strongly agrees. From this, the majority of the Clinicians have not experienced improved efficiencies as a result of the system. In assessing effectiveness, a majority of 63.45% do not know whether the system is effective or not, 25.81% strongly disagree, 2.16% just disagrees, and 4.29% agree and also 4.29% agree that the system is effective. With this results, the Clinicians are either not using the system or have not experienced effectiveness as a result of the system. A majority of 70.97% do not know whether the system can be used for ease of learning or not, 17.74% strongly disagree that the system can be used for learning, 3.23% just disagrees, 5.65% agree and 2.42% strongly agree that the system can be used for learning. The majority are not using the system to improve learning but use other means for learning. 62.9% do not know whether they are satisfied with the system because they are not using the system, while 19.35% strongly disagree that they are satisfied with the system and 3.23% just disagreeing, 8.06% strongly agree that they are satisfied with the system and 6.45% just agreeing. It seems that the system is generally not used amongst the Clinicians.

In the Medical Allied category, a majority of 70.45% do not know whether the system is simple enough to be used, 13.64% agree that the system is simple enough to can be used, 4.55% agree, 9.09% strongly disagrees and 2.27% just disagrees. With this majority, one can infer that the system is not being used and that there is no experience on the use of the system. 80.61% do not know whether the system has improved efficiency or not, 7.27% agree that there are improved efficiencies, 4.24% strongly agrees, 6.67% strongly disagrees and 1.21% just disagrees. Majority of 83.85% do not know whether the system is effective or not, 18.18% disagree that the system is effective and 5.55% strongly disagreeing, only 7.58% agree that the system is effective and 0% strongly agreeing. It can thus be deduced that the system is generally not being used by the Medical Allied staff. 84.85% do not know whether the system can be used for ease of learning or not, 10.61% agree that the system can be used for ease of learning, 2.27% strongly agree, 1.52% strongly disagree and 0.76% just disagrees. 81.82% do not know whether they are satisfied with the system, 10.61% agreeing that they are satisfied with the system and 3.03% strongly agreeing, also 3.03% strongly disagrees and 1.52% just agreeing. It thus be deduced that majority of the Medical Allied are not using the system and has also not experienced any benefit of using the system.

Charlotte Maxeke Johannesburg academic hospital is still relying on some level of manual analysis to facilitate quality reporting. In addition, the most widespread method deployed for measuring clinical quality is the use of hand collected data and chart reviews. Manual processes for capturing, collating and analyzing data may be a response to the lack of electronic means to conduct these functions, which is supported by the fact that majority of respondents noted that they needed additional IT resources in order to better report on quality measures. Having the staff required to improve the reporting capability is also a barrier. Majority of respondents noted that their organization needs additional resources in order to report appropriately on quality measures. This is of particular concern, because many respondents also noted that one of their key gaps to reporting on these measures was not a lack of knowledge about the meaningful use requirement or a lack of organizational commitment, but rather that the staff at the organization just does not have the time needed to do everything that is necessary. This becomes a particular concern when hospital executives don't have direct access to quality reports or specialized IT staff has to intervene to develop reports because the staff running the reports do not have the authority to directly create them. Healthcare professionals are frustrated with the need to interrogate multiple systems to find clinical results, reports and/or images. The need for clinicians to memorize multiple security access codes often discourages them from using the tools at their disposal. Enabling healthcare professionals with easier and more consistent access to qualitative and quantitative patient information can improve their satisfaction of the clinical applications available. Physician satisfaction can be enhanced too, by providing an integrated data repository for all clinical results. Ease of reporting is extremely beneficial for those participating in clinical trials and researching effectiveness.

Charlotte Maxeke Johannesburg Academic Hospital today is faced with many challenges including regulations high patient and staff turnover complicated by the tight labour market. This environment has forced the hospital to maximize operational efficiencies. Despite these efforts, the hospital continues to wrestle with many issues including:

- i. High turnover and inability to hire employees with exact skill set matches;
- ii. Inability to track employee competencies and training compliance;
- iii. Challenges in adequately allocating scarce training resources;
- iv. Difficulties coordinating course offerings in accordance with employees' busy schedules; and
- v. Challenges presented by the need to continuously train employees on ever-changing

healthcare regulations.

4.6.2 System Design

Existing efforts to evaluate Health Information Systems are insufficient for the broad identification of best practices in information design. Further, the recognition of usability as a critical issue varies across organizations responsible for setting standards and not enough objective evidence currently exists for specific design considerations. Developing standards and guidelines for the design of Health Information System user interfaces is a necessary undertaking to ensure current investments in health IT deliver the expected returns in efficiency and quality.

Design should reflect physician cognition and environmental stressors. Physicians as experts in cognitively demanding, time constrained, and highly interruptive environments operate in what is known as rules-based decision making mode. This method of decision making is fast, economical of effort, and based on well-encoded individualized "procedural knowledge." The nature of the clinical care environment puts the physician at risk for information overload errors such as break-in-task or loss of activation¹⁵¹. Health Information System user interface design should be engineered to support and enhance rules-based decision making by highly practiced experts who do not all use a single or consistent task structure. The form and timing of information presentation must respect the risks of break-in-task and loss of activation events that can be caused by introducing competing tasks and distracting information into the already-saturated workflow.

Displays should support collaborative work processes. Medical care is delivered in a highly cooperative environment where roles and responsibilities are filled by physicians, nurses, support staff, patients, and others. Each of these groups has the potential to have different tasks, goals, incentives, and mental models of the system that occur at differing stages of the care process. The HIS, as an artefact which supports that work, must be designed to support the individual tasks, the collaboration between individuals that exists to support these tasks,¹⁴ and the overall integrated care process.

Displays should facilitate quality care. HIS hold great promise and in many cases have achieved great successes in improving the quality and efficiency of health care. HIS design, through effective and intuitive displays of information, coupled with appropriate decision support, should make it easier for clinicians to more consistently provide high quality care to

¹⁵¹ Leape L. 1994. Error in medicine. *Journal of American Medical Association*. 272(23), 1851-7

each patient. High quality care can be defined as care that is safe, efficient, effective, patient-centred, equitable, and timely.

A software system should be designed to reduce the cognitive load experienced by users. In alignment with tasks the user is attempting to accomplish, appropriate information should be displayed, graphics and visualizations used effectively, and clutter should be reduced or eliminated.

4.6.3 Managerial Level

Senior management at Charlotte Maxeke Johannesburg Academic Hospital is aware that some workflow issues and staff dissatisfaction is related to usability issues. Senior and mid-level management may develop a more proactive approach to usability issues, including the institution of usability evaluation processes for a small number of IT functions and/or applications. This approach may also include documentation and benchmarking that leads to more consistent results, which, in turn, increases the ability of the organization to apply these processes across the work processes of the entire organization.

Management may begin to realize that usability is a concern that has an impact on work processes and organizational outcomes. They may, however, see usability as a characteristic that is limited to specific functional areas such as IT development or at certain points in the process (e.g., to conduct usability testing after development is complete). Within the organization there may be a beginning of systems approach to usability, but this approach is not widely understood nor typically championed by senior management.

From the executive perspective, attention to data and processes is insufficient to bring about institutional change. Change management requires attention to skills, interests, historical behavioural patterns, as well as incentive structures. Providing advanced technological solutions alone is never an effective approach.

Information technology initiatives offer tremendous potential benefits, but also might be the riskiest undertakings for hospitals and health care provider organizations due to the large expense and high complexity of these projects. Across industries, information technology project failures abound, 66% of major information technology projects fail, for reasons that include projects not meeting requirements, late completions, and budget overruns. Physician leadership of health care information technology projects has been identified as a key

requirement for success¹⁵². A 2003 Journal of the American Medical Informatics Association case study on the advanced clinical use of computers at several hospitals identified high level leadership as the single most important factor associated with a successful implementation, and that “all sites appointed people with clinical backgrounds to lead the move to computerization.”¹⁵³

4.7 Conclusion

Organizations by the nature of their culture, politics, and other institutional variables in and of themselves can provide barriers to the adoption of enterprise technology. Healthcare IT managers should remain aware of this, and should take time to assess those variables within their own organizations, as they prepare to meet the challenge of attempting to remove such barriers. Some reasons for those obstacles are constant from one organization to another, while other barriers stem from the organization’s unique complexion. The next chapter will focus on implications and applications of Health Information System

It is well known fact that Health Information Systems are quite complex and controversial, and a lot more expensive than they would seem on the surface,” a Massachusetts-based internist told the paper. Charlotte Maxeke Johannesburg Academic hospital has spent millions of South African Rands in implementing a system that is not fully operational. So, there may be barriers to full adoption of Health Information Systems and this can include excessive costs for setup and maintenance, disruption to physician’s productivity, and insufficient financial or clinical benefits. A prescient commentary 15 years ago predicted numerous obstacles that have prevented systems adoptions from coming true in clinical practice. Several factors continue to echo the challenges faced in this area, including lack of investment; lack of leadership from practicing physicians, medical schools, and professional societies; and continuing control of information services in most health care organizations by chief information officers and other administrators¹⁵⁴.

Other areas of challenges for public health informatics is developing coherent, integrated national public health information systems, developing closer integration of public health and clinical care, and addressing pervasive concerns about information technology on

¹⁵² Leviss J, et al. 2006. The CMIO – A New Leader for Health Systems. *Journal of the American Medical Informatics Association* (13)5, 573-578

¹⁵³ Doolan DF, Bates DW, James BC. 2003. The Use Of Computers For Clinical Care: A Case Series Of Advanced U.S. Sites. *Journal of the American Medical Informatics Association*. (10)1,94-107

¹⁵⁴ Classen D.C. 1998. Clinical Decision Support Systems to Improve Clinical Practice and Quality of Care. *Journal of the American Medical Association* 280(15)

confidentiality and privacy¹⁵⁵.

It is evident from the results of the survey that system implementations are complex and problems associated with the system usability are not easily resolved or understood by all involved, system developers and enterprise clinicians. This problem is not unique to Charlotte Maxeke Johannesburg Academic hospital but it is experienced elsewhere in the world, this is backed up by lots of literature studies on Health Information Systems.

¹⁵⁵ Koo Denise, O'Carrol Patrick, LaVenture Martin, 2001. Public Health 101 for Informaticians. *Journal of the American Medical Informatics Association* (8)6, 585-597

Chapter 5

Implications and Applications

5.1 Introduction

The survey clearly identified dual IT-paper processes as affecting clinical workflow, as well as serving as a barrier to the effective business operations of IT applications and tools. Optimizing the functionality of these tools to eliminate the need for the dependence on paper processes, implementing the optimized systems and gaining consistent use would go a long way in eliminating this barrier.

The high-level intentions of this study were to gain a better understanding of the impact of HIS on the role of Patient admin, Clinicians, Allied and Nurses.

Before conducting the survey, it was hypothesized that despite the fact that HISs are implemented in hospitals, health professionals are unable to access data quickly and utilise it to do their jobs effectively. Medical professionals are still capturing information and doing report writing manually because of the lack of widespread interoperability and depth in the deployment of applications. HISs have not as yet had an overall positive impact on interdisciplinary communication and therefore it was not anticipated that respondents would report a high degree of satisfaction with applications and tools currently available. Survey responses across the four discipline of work, Patient admin, Clinicians, Medical Allied and Nurses, indicated an overall low level of system usage, as indicated in Chapter 4.

The results, therefore, indicate that a range of strategies may be needed to promote greater HIS usage and to ensure that the system supports hospital processes. Institutional policies and practices that employ HISs with the intent to improve usage need to be clearly indicated. A focus on the development of HISs and tools with features associated with greater usability are needed, including features to facilitate the improved ability to support patient-centred care.

Based on the respondents' comments, it was clear why there was such significant agreement regarding this element. Every healthcare organisation is in transition from paper systems to IT systems and no one has completed the process as yet. There were three main themes voiced in the comments regarding this question. Dual systems result because of the design of the transition from paper to computer, as well as the inconsistent use of the computer systems even when they are available. Inconsistent use is a major factor, accentuated by culture and organisational expectations, and IT tools currently are not able to universally meet business needs yet, thus requiring paper dependence for some activities. Tools are not utilized consistently by all staff.

Any HIS is only as effective as its users. It was found that, even if an electronic record is retrieved, users still need to leave a handwritten note on the order sheet, or speak with the practitioner face-to-face, to ensure that the message gets through. Many of the health practitioners prefer not to learn how to navigate the computer, causing the nursing staff to double and sometimes triple documents

5.2 Implications of Health Information Systems

The adoption of HIS by clinicians remains an enormous challenge in any effort to implement health IT. If clinicians do not buy into a new health IT tool, they will not use it; if they do not use the tool, the project will be a failure.

The operations in a hospital require the evaluation of a significant amount of data at the right time and place and in the correct context. Moreover, there is a significant amount of data hidden from the patient-care environment that helps to define and control specific events in healthcare. These clinical, administrative and operational sources of data are typically kept in separate and disparate operational repositories; a master set of data can be kept in a single data repository from which queries can be made that cross these specific disciplines.

Alternatively, virtual agents can search these separate data sets simultaneously, and combine at another level to provide a response to a query. Combining all the disparate data into a single repository, a data warehouse, will result in the creation of a store of data that can be used to make intelligent clinical and management decisions about healthcare and its delivery. This combination of data sets will lead to improved operations through the harnessing and evaluation of this rich data content for a variety of healthcare related improvement purposes, ranging from improving overall outcomes of care for patients and support for clinical research to economic issues, such as product-line cost and clinical productivity costs.

Given the advancement of the information tools and techniques of today's knowledge-based economy, it is imperative that they be appropriately utilized to enable and facilitate the identification and evaluation of pertinent information and relevant data about the efficiency and effectiveness of delivering health-care. With the advent of the electronic health record, data warehouses will provide information at the point of care, and provide for a continuous learning environment in which lessons learned can provide updates to clinical, administrative and financial processes.

This research found the existence of dual environments to be a major impediment to physician efficiency, that is, manual capturing of data on paper and electronic data capturing. The negative effect was seen in both information viewing and entry, from both system and manually generated. For viewing, the primary inefficiency was related to the necessity of checking records in multiple places, both electronic and paper, in order to get a complete view of the patient's record. For data entry, inefficiencies were a result of having to remember different processes for various documentation systems.

Charlotte Maxeke Johannesburg Academic hospital like many other academic healthcare organisations is an intricate structure to manage and the traditional well known systems development life cycle might not be applicable due to some of the following:

- i. Lack of capacity,
- ii. High patient turn-around (presently Charlotte Maxeke Johannesburg Academic hospital manages ± 2000 patients daily),
- iii. Lack of infrastructure investment, and
- iv. Management in leadership.

Even though more health systems are involving clinicians, health insurers, and patients in their meaningful use initiatives, they seem less confident about achieving full adoption within the government-specified time frame. Not only is there a void in patient access to electronic data, but also a lack of understanding of the requirements for achieving access.

The study noted that barriers to wider adoption of Health Information Systems include:

- i. Systems not meeting business requirements,
- ii. High initial acquisition and implementation costs,
- iii. Slow and uncertain financial payoffs for health care providers,
- iv. Disruptive effects on physician practices during implementation, and
- v. Payment systems that result in most Health Information Systems-enabled savings

going to insurers, patients, and government payers, while most adoption and care improvement costs are borne by providers.

Health Information Technology is an essential, foundational element of any serious attempt to transform South Africa's healthcare delivery system. While the South African nation is engaged in a long-term debate over how to reform our healthcare system, there continues to be widespread, bipartisan support for efforts to move away from a delivery and payment system that rewards volume, toward a system that rewards efficiency and quality outcomes by enabling providers and patients to access the right information at the right time. Robust health IT is essential to achieving any meaningful delivery and payment reforms, enabling timely and accurate collection and dissemination of the patient information in a privacy-protected and secure manner. Building on the system-wide adoption of Health Information System and exchanging electronic information via standards-based health information exchanges (HIE), a health IT-enabled transformation of healthcare will enable dramatic enhancements in research; improve clinical care; implement necessary payment reforms; and significantly enhance the nation's population health management. Such enhancements will not only improve the quality of healthcare by ensuring readily available and accurate health information to guide clinical decision making and patient and family choices, but will improve coordination of care among healthcare stakeholders and reduce medical errors, simplify business processes, and save resources.

5.2.1 Data Delivery

In Chapter 2, it is explained that data capturing is essential to drive the clinical decision support "knowledge engines" and performance measurement systems. All of the processes for delivering and measuring care can be mapped to the requisite data required for superior performance.

With data gathered from various sources and advanced analytics in place, healthcare providers can shift their focus to the manner in which they are deployed and produced. At this point, it is critical to evaluate each stakeholder's needs to deliver relevant information or reports.

A strategic, mature HIS solution can be implemented easily and relieves significant burdens wherever manual data collection is required to create analytical reports. In addition to expediting reports, it enables employees to focus on more strategic programmes.

Technically, faster data gathering and meaningful analytical report production helps in decision support and operational management, while seamless integration and pre-data

integration efforts cleanse data and remove duplicate data from various sources. They also provide high-quality data for enterprise decision making. In addition, if deployed carefully, departmental applications and operational systems provide essential information on staff and overtime utilization and predict trends to help authorities prepare for new endeavours.

HIS also enables healthcare organizations to gather their data in a single repository and compare it across other systems, helping users make better healthcare decisions, while providers create differentiating strategies. In short, more effective data dramatically improves care while increasing patient safety. Business Intelligence capabilities are becoming a key infrastructure component and enabler as developers solve data integration and management problems. Clearly, combining thorough analysis of real-time data that spans the continuum of care with data derived from disparate sources is the best way forward.

Automation of clinical, financial and administrative transactions is essential to improving quality, preventing errors, enhancing consumer confidence in the health system and improving efficiency.

5.2.2 Efficiencies

As explained in Chapter 3, Efficiency, as a test metric, is the speed with which the user can successfully accomplish the task at hand. There are a number of variants on one-on-one usability tests aimed at evaluating efficiency. The most common measures of efficiency are:

- i. Time to perform a particular task,
- ii. Number of key presses or interactions to achieve task,
- iii. Number of screens visited to complete a specific workflow scenario and
- iv. Time to execute a particular set of instructions.

With the implemented system mainly being used to administer patients and minimally for the patient's clinical care, resulted in unintended consequences. The system is not being used by the core business in the hospital for daily operations.

Papers, spread sheets and word documents are moved from one to the other, thus resulting in a huge challenge to have a single repository of information. Lots of time and effort are spent on managing documents, the version control of documents, documentation sent across the hospital, trying to store paper documents, security of created documents both hard and soft copies are under threat, and high degree of wasted effort involved as additional capacity will be needed for this purpose. Clinical and management reports are manually done and this compromise data integrity.

The process of making business decisions is limited, delayed, and there is inaccurate knowledge of patients, inventories and business processes such as delivery, order fulfilment times and order entry. This means decisions are made using information that is at best approximate, and often wrong. In this environment, as a response to the information uncertainty, the solution was to double up people.

The other unintended consequence of the implementation is the failure to truly understand the problems that were intended to be resolved. Essentially management failed to note that the problem at hand was one of an adaptive, rather than one of a true technical nature. However, the system is a developed technology to facilitate the process of running patients but no solution has been met with satisfactory acceptance. The reason for this failure has very little to do with the effectiveness of the technologies as developed by the vendors, but has everything to do with the adaptive nature of the problem¹⁵⁶. Although the system might have its short falls, health professional are not using the functionality available of the system to perform their daily operations, it is a paper trail in almost every part of the hospital.

Enterprising clinicians were quick to hone in on areas of frustration and data management challenges. The current business system is in support of registration, scheduling, billing, and collection but no developed clinical tools to support the radiology departments with radiology information systems as well as systems for laboratory, pharmacy, and operating room purposes, etc. The consequence is that the hospital has a highly effective system in patient administration serving only a single purpose which does very little to bridge the care of patients from location to location within the hospital. In essence, the system lacks interoperability, the ability to exchange data and make use of the exchanged data, and also lacks integration, as well as the ability to simply exchange data.

5.2.3 User Productivity

In Chapter 2, it is explained that in general, results show that computers save clinicians time in performing clerical activities. Computers that manage the flow of information between clinicians and ancillary departments save time for clinicians.

Many aspects of clinician workflow rely on the efficacy and efficiency of clinical display. When distractions, such as data that is hard to find or which is arranged illogically, or multiple tools or systems are required, clinician productivity suffers. A comprehensive, concise, and impactful display of clinical information is needed.

¹⁵⁶ Raymond A. Gensinger, Jr. 2010. Introduction to Healthcare Enabling Technologies.

In addition, within a clinician's office, there are obstacles that relate to the communication and workflow handoffs between clinicians and other clinical staff. Where system communications are intended to be directed to one member of the team, there may be instances where another clinical staff member is actually the recipient of a system message.

Finally, if the information displayed is not easily and readily interpreted correctly, the information may be missed or misleading. If the display of data does not enhance, or worse distracts or misinforms clinicians, implementation of HISs may be limited or important functions may be disabled.

5.3 Applications of Health Information Systems – Transition State

As health information systems diffuse through the healthcare industry, it is essential that knowledge about how to effectively implement these systems be obtained and disseminated, this explained in details in Chapter 2. Formative evaluation, which focuses on the process of implementation rather than the outcomes, can enable organizations to make changes while they are in the midst of an implementation, and can provide essential information about implementation strategies that work.

Organizations should use published studies along with their internal research findings to develop and refine their HIS implementation strategies. As HIS modules are launched, data on how staff perceives the quality of training, whether support is adequate, and the emergence of unintended negative effects can be used to ensure that subsequent launches work better. The evaluation effort is worth at least minimal investment and, as with many other things, greater investment often leads to greater rewards.

When implementing Health Information Systems and decision support systems, the health care organization often begins in a paper-based state with technology supporting some ancillary and administrative systems. Implementation of application functionality usually progresses in a sequential fashion that permits ever-increasing richness of decision support and structured data capture.

To accelerate Health Information Systems usability, the study recommends that the government act more aggressively in the early stages of adoption to ensure widespread use of:

- i. Health Information Systems that conform to a national set of standards,
- ii. Information exchange networks sharing approved data among providers and patients, and

- iii. Programmes to measure, report and reward the provision of high-quality, efficient care.

There are other points to consider like involvement of senior management, negative impacts during the transitional period like organisational disruptions, resistance to change by users etc.

5.3.1 Possible Factors to Explain the Low Rates of Usability of Health Information Systems

In spite of the apparent advantages that HIS offers to physicians and hospitals, the proportion of healthcare providers that actually use such systems is relatively small as confirmed in the survey. Several factors may explain the low rate of adoption, including the challenges that arise in implementing the systems, the inability of providers to capture all of the financial returns of the HIS systems that they procure, the possibility in the case of health insurance plans that the efficiencies they garner through the use of HIS will benefit their competitors, and uncertainty about the value of the advantages to be gained from adopting a HIS and the evolution of laws affecting its acquisition and financing.

a) Challenges in Implementing Health Information Systems

Adopting a HIS involves more than just deciding to spend money; it is a major organizational commitment that, for hospitals in particular, will probably last for several years. To take full advantage of such a system may require physicians to substantially redesign the way they practice medicine. HISs are only as helpful as the information that goes into them. Some of that information is part of the system when it is purchased, but much of the technology's value comes when physicians devote considerable time to training, to personalizing the system, and to adapting their work processes to achieve the maximum benefits. Not surprisingly, the adoption rates for HISs are higher among younger physicians, who in general are more familiar with computers than their older colleagues. In implementing a HIS, providers must choose from among a wide array of vendors and options.

With so many choices and rapidly developing technologies, many health care providers may be concerned about buying the wrong kind of system for their practice, acquiring technology that has already become outdated, or purchasing a poor-quality system. They may wish to postpone the decision until more of their colleagues have purchased systems, allowing them to benefit from others' experience. Research suggests that providers who have purchased an Health Information System tend to be in practices in which at least one physician has technical savvy and able to champion the cause of the HIS. But relatively few practices

include such a physician, which may lead many providers to wait until the systems become more standardised and demand coalesces around fewer but better-known choices. The large number of vendors and products may slow down adoption in the short run, but the examining process that occurs as some vendors leave the market is likely to identify the products that deliver the greatest value per Rand spent.

Indeed, hospitals and large provider groups have already begun to complain about the difficulty of finding qualified technicians to maintain their systems.

b) Inability to Capture Financial Returns from Health Information Systems

Many, if not most, healthcare providers would like to make more use of HIS in their practices, recognizing the technology's potential to improve the quality of the care they provide, increase convenience for their patients, and perhaps reduce costs in their office. Many hospitals cannot generate the additional income necessary to justify the significant investment in time and money that the adoption of such a system would require. Some benefits to be derived from HIS increase in value as the network of those using the technology expands. Health care providers who can perform functions electronically (such as communicating with each other, sending and receiving medical records, prescribing medications electronically, and ordering laboratory and imaging procedures) gain when other providers develop similar electronic capabilities.

HIS can contribute to improvements in the quality of health care that providers deliver, but it is relatively rare for providers to be compensated for such improvements. Pay-for-performance programmes are in effect in some managed care. Such programmes do not create a strong incentive to invest in HISs, though, because the payments are fairly modest.

A clinician's reputation for providing high quality care might improve as a result of investing in HIS and patients might want to see a clinician who uses an HIS because they believe they will get better quality care. Clinicians who used HISs were more attractive to patients than clinicians who did not.

Other benefits, such as lower costs for maintaining medical records and transcribing clinical data, clearly accrue to the clinicians who purchase the HIS.

5.3.2 Identifying The Barriers

In systems implementation, planning requires participation of and input from every area in an organization, whether or not it is immediately obvious an area would be affected as explained in Chapter 2. Operational departments understand their requirements and what needs to occur

to complete them, often due to an evolving healthcare industry, the requirements can become even more specialized. They may not, however, be able to communicate clearly about what technology or systems support is necessary to achieve the desired results. To the contrary, IT resources often do not evolve within the healthcare industry, but rather formal technological training is often the background with a focus upon programming or development tools (medical billing software is not often categorized as challenging). The operational requests are often delivered to IT in concise, clear operational language, but there is no mechanism to translate the request into concise, clear technical terms routinely utilized in IT. Thus, IT may either push back for additional information, creating frustrations by the requestor who “knows” what they asked for, or attempt to fill the needs of operations without a clear understanding of the request, wasting valuable time and resources to deliver what is not the desired outcome. Operations, in turn, may cease the healthy utilization of intra-departmental communication to express frustrations and simply turn towards internal complaining.

The reverse is true as well. In many healthcare organisations IT is responsible for finding new technological ways of enhancing the business financially and operationally. Does IT know what to look for if they are not aware of the operational functions and workflows they support if they are speaking a different language? Again, medical billing and operational software are not regularly offered course curricula. This can lead to missed opportunities to enhance an organisation’s performance, efficiency or effectiveness. In addition, when IT presents potential new technologies to operations and is unable to clearly communicate the operational impact or the usefulness of the product at an operational level, communication again breaks down. Operations, on the other hand, should be communicating the information they learn about the ever-evolving healthcare industry to IT. The transfer of information needs to move both ways.

Barriers to communication, as explained in the above section, exist on both sides. Operational resources within a healthcare organisation often rise through the ranks and/or have focused their higher educational majors within other industries in which they have worked.

IT resources, although well-educated and versed in the field of technology, more often than not have not focused upon the nuances of the healthcare industry in preparation to deal with the industry’s technology, terminology or specific requirements.

5.3.3 Options to Promote Usability of Health Information Systems

One of the principal obstacles to a wider adoption of HIS and other clinical systems is the cost of acquiring and maintaining these systems. Appropriate financial incentives to promote

the adoption and use of these may be needed. If electronic systems supporting delivery of care have limited adoption, the benefits to overall health care costs and patient care may not be realized.

Paying a bonus to healthcare providers that use HIS would enable practitioners to capture more of the benefits that their use of health IT would produce and give them a stronger financial incentive to invest in a system. This approach, would likely lead to a net cost for the government, and possibly a large one. Even a small bonus could be expensive because it would be paid not only to those healthcare providers who newly procured HIS but also to health care providers who already have implemented such systems. Because a small bonus would attract relatively few takers, the bulk of the bonus would be paid to health care providers that already have HIS. A large bonus would entice more new consumers, but it would add further to the overall net cost of the government subsidy.

A mandate for the procurement of HIS, or to procure a particular functionality such as e-prescribing, by contrast, would probably induce nearly all healthcare providers to adopt it at a small cost to the government, and might produce net savings in health care spending. The requirement could be enforced either by not paying healthcare providers who failed to adopt such a system for other health care services that they delivered, or by imposing a specific penalty on those who did not comply. A less prescriptive version would involve paying healthcare providers without a Health Information System less for any given procedure than healthcare providers with a HIS, which would create an implicit penalty for failing to adopt the technology. Either of those approaches, though, would come at a cost to healthcare providers, and that cost would be greatest for healthcare providers who were least able to capture the financial benefits of HISs. If policymakers are interested in promoting HIS, some version of a requirement or an explicit or implicit penalty for healthcare providers who fail to adopt HIS is likely to be more cost-effective for the government than a subsidy.

Building fundamental skills in healthcare is one way in which management can address the need to be more efficient, productive, and cost-effective. There are an increasing number of ways to educate staff members and they need to be evaluated in terms of their ability to meet the goals and objectives of the organisation. Management must be intricately involved to help sort through the issues and select methods that most closely suit the goal and objectives, audience, and budget.

5.4 Conclusion

It has become clear that the task of implementing HIS is not easy and presents multiple challenges. Issues encountered are the same as others elsewhere experience who have tackled implementing HIS. Experiences and lessons learned reemphasize the need for strong leadership, a solid implementation approach, good relationships with developers, strong training programmes, and an approach to adoption that encompasses all that we have learned to date.

From a clinical perspective, there are many positive benefits and overall gains from the establishment of information technology targeting a healthcare organization at its enterprise or global corporate level, if it is a health system comprising multiple facilities. However positive those gains could be, they are not always easy to achieve. The development, implementation and sustenance of a Health Information System and in particular integral component of overall integrated enterprise type system is, at the very least, a daunting task.

The survey results indicate that in the case of business activity systems, implementation of Health Information System scope does not impact performance, but digitization experience has a significant positive impact on performance.

However, a different pattern of results emerge when surveying the effects of digitizing clinical activity systems. The survey results indicate that in the case of clinical activity systems, digitization experience alone is not sufficient and in fact has negative impacts. This suggests that limited digitization of the parts of the clinical activity system hampers the performance of the doctors and nursing staff as they have to coordinate work across manual and digital systems.

In spite of limitations already explained in Chapter 1, the survey results also shed interesting insights on the implementation of two important activity systems of HIS, clinical and business. In business, that is patient admin, the system is widely used while in clinical operations usage is limited.

Organizations encounter two main challenges in digitizing their activity systems:

- i. Firstly, a wide range of information technologies are available for digitization and organizations must explore which of these technologies are appropriate for their digitization efforts.
- ii. Secondly, organizations must also develop insightful experience of the specific technologies so that they can implement the needed complementary systems (e.g.,

business process adaptations, rewards and incentives) and assimilate the technologies into their activity systems.

In order to improve on system usability, future research could examine more complex interactions such as those across business and clinical systems and explore the pattern of results that emerge when these systems are integrated.

Fundamentally, significant healthcare delivery transformation is impossible without meaningful, system wide usability of HIS and health information exchange. Without the health IT incentive funding programme, providers and hospitals across the country, including many small healthcare practices and rural healthcare facilities, would find it difficult to make the transitions needed to support such system changes.

This case study has surveyed today's Health Information System landscape in Charlotte Maxeke Johannesburg Academic hospital, including opportunities associated with technology.

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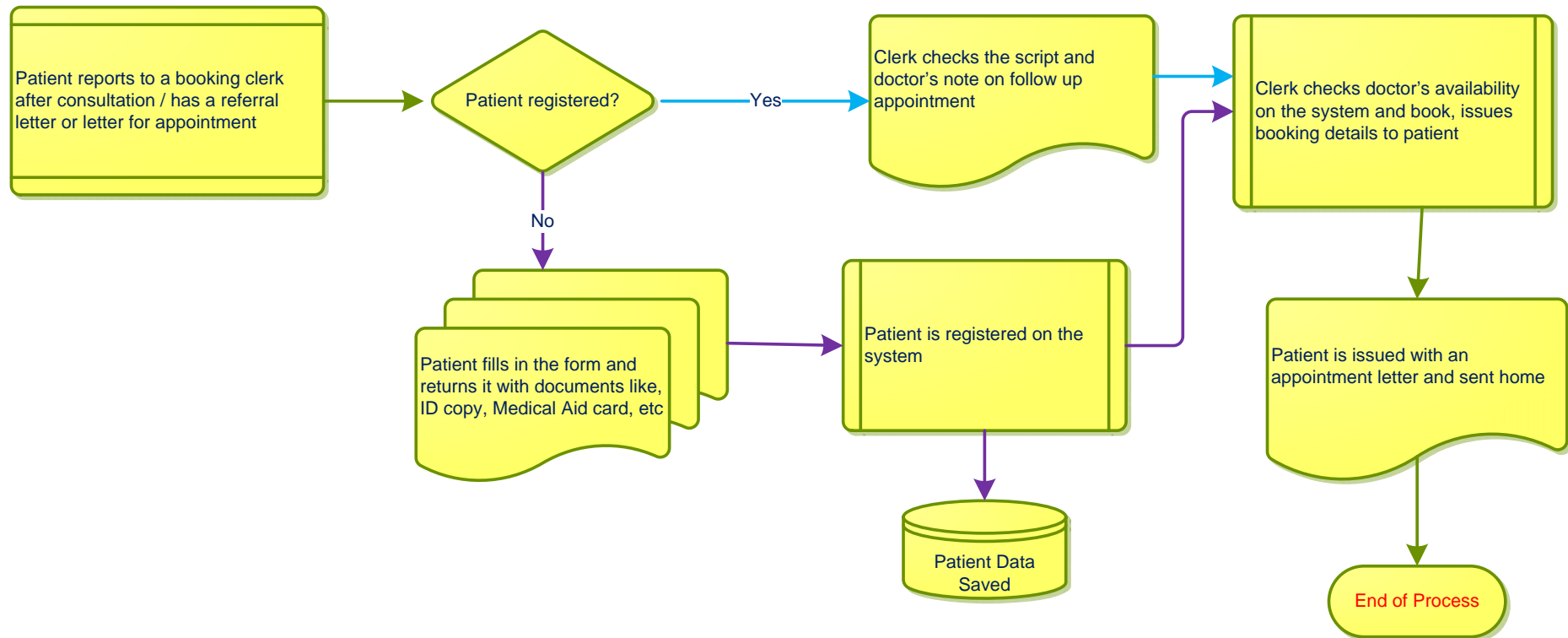
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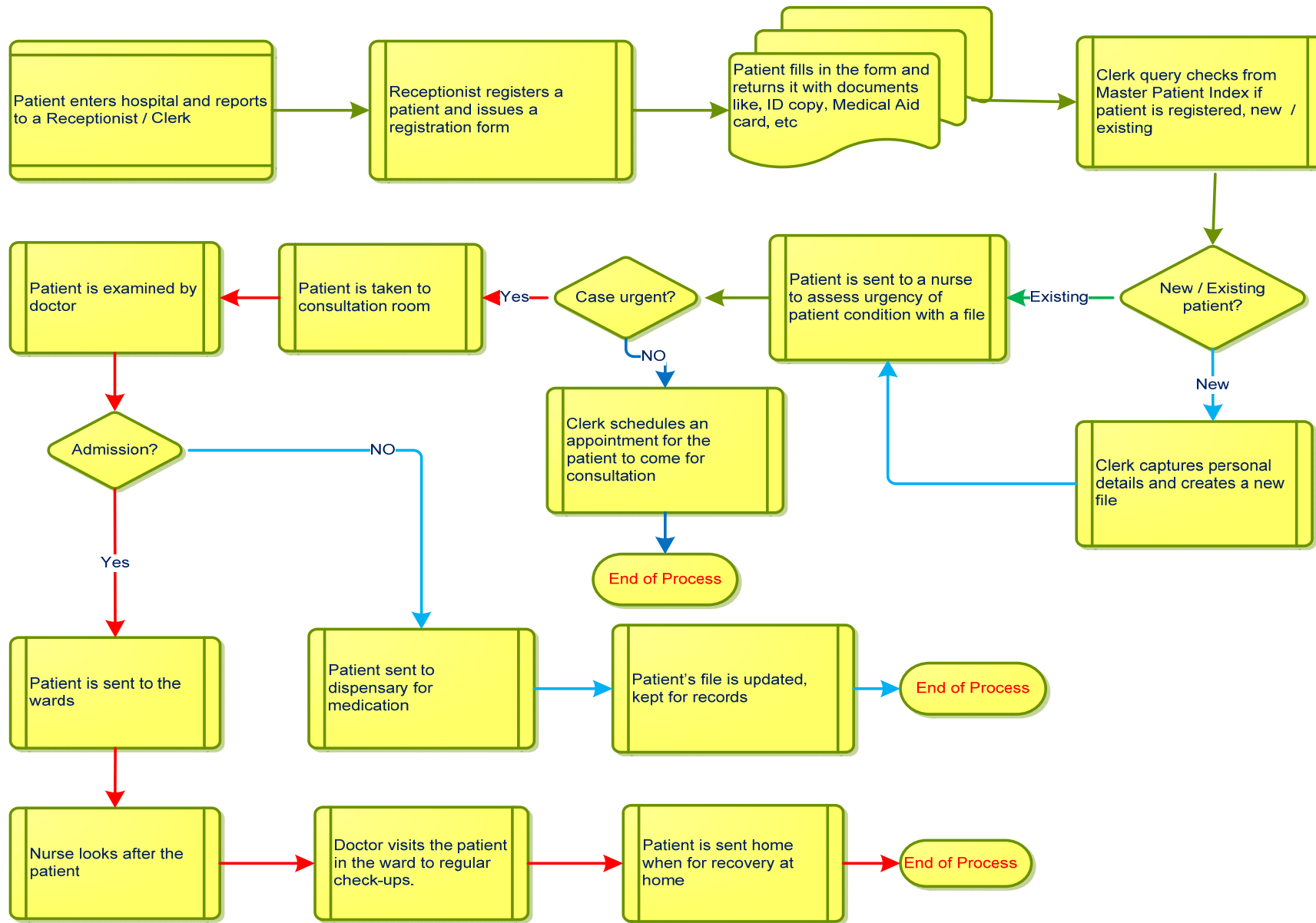
Appendix A

Appointment Scheduling Process

High Level Overview of Charlotte Maxeke Johannesburg Academic Hospital Process Flows

The patient administration process is described using a flow chart.





Appendix B

List of Questionnaires

1. GENERAL

	Background Information	No. of Years	
1.1	Kindly indicate your number of years in the medical profession.		
1.2	How long have you been in the current position / job?		
Scale: (1-3) = Absolutely Negative, (4-5) = Negative, (6-7) = Positive, (8-10) = Very Positive			
	Self-Assessment of your use of Computation	Scale (1-10)	
1.3	How much do you like to use computers?		
1.4	How well do you use computers for your work?		
Indicate your category of profession by ticking the box			
Clinician	Nurse	Allied	Patient Administrator

2. System Usability

Scale

1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree; 5 = Don't Know

Tick ONLY ONE number per statement.

No.	Scenario	Design Principles					Usability Scale					
		Simplicity	Efficiency	Effectiveness	Ease of Learning	User Satisfaction						
1.	I find the system to be easy to use	X					1	2	3	4	5	6
2.	The system has clear, clean uncluttered screen design	X					1	2	3	4	5	6
3.	I find most functions in the system not well integrated	X					1	2	3	4	5	6
4.	I find two functions in the system not well integrated	X					1	2	3	4	5	6
5.	Revenue collection has improved because of the system		X				1	2	3	4	5	6
6.	The system helps in improving general productivity levels		X				1	2	3	4	5	6
7.	The hospital has reduced inpatient length of stay as a result of the system		X				1	2	3	4	5	6
8.	The hospital has measurably improved turnaround time for medications, radiologic studies or any other efficiency metric		X				1	2	3	4	5	6
9.	The system expedites communication of patient information between health care facilities		X				1	2	3	4	5	6

10.													
11.	Medication can be dispensed using the system			X			1	2	3	4	5	6	
12.	The system supports ordering of medical examinations for patients			X			1	2	3	4	5	6	
13.	A patient's move between care venues can be tracked seamlessly using the system			X			1	2	3	4	5	6	
14.	Details orders of meals according to the needs of the patients can be entered on the system and located to patients			X			1	2	3	4	5	6	
15.	System problems are due to vendor's inability to effectively deliver product or service to the hospital			X			1	2	3	4	5	6	
16.	The system integrates optimally with peripherals such as network, hardware, software			X			1	2	3	4	5	6	
17.	The information from the system assists with quality decision-making				X		1	2	3	4	5	6	
18.	The system allows documentation of the results of an inspection, eg ultrasound sonic examination, or radiology report, etc				X		1	2	3	4	5	6	
19.	Documentation of diagnostic findings by a physician using ICD10-code can be entered directly on the system				X		1	2	3	4	5	6	
20.	Since implementation of the system, patient administration processes are more standardized				X		1	2	3	4	5	6	
21.	There is generally lack of top management support for the system					X	1	2	3	4	5	6	
22.	I would like to use this system frequently					X	1	2	3	4	5	6	

