The Economics of Information Technology in Public Sector Health Facilities in Developing Countries: The Case of South Africa

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Working Paper 251

October 2011

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October 14, 2011

Abstract

The public healthcare sector in developing countries face many challenges, including weak healthcare systems and under resourced facilities that deliver poor outcomes relative to total healthcare expenditure. Healthcare delivery, access to healthcare and cost containment has the potential for improvement through more efficient healthcare resource management. Global references demonstrate that information technology (IT) has the ability to assist in this regard through the automation of processes, thus reducing the inefficiencies of manually driven processes and lowering transaction costs. This study examines the impact of new systems implementations on service delivery, user adoption and organizational culture within the hospital setting in South Africa, as perceived by doctors, nurses and hospital administrators. The research provides some insight into the reasons for investing in system automation, the associated outcomes, and organizational factors that impact the successful adoption of IT systems. In addition, it finds that sustainable success in these initiatives is as much a function of the technology as it is of the change management function that must accompany the system implementation.

Keywords: Hospital information systems; healthcare management; electronic health records; South Africa, mixed methods

1 Introduction

Information Technology (IT) has significant potential to contribute to improving access to care, lowering overall costs, and streamlining operational efficiencies in the health system. Clinical automation and business process management are major global trends affecting both mature and developing healthcare markets (Braa et al. 2007). The motivation behind these trends lies in the potential to reduce the complexity of multiple legacy and paper-based systems, improve capacity of health systems to manage patients and their data, increase compliance with health regulations, ensure availability of information to support more efficient care, and enhance security around patient confidentiality.

In emerging markets such as South Africa, primary and secondary clinics are often located in rural areas with poor road networks and interrupted services such as electricity and water. Manual paper-driven processes are relied upon for delivering patient care and fulfilling administrative tasks. Patient records are paper based, and health statistics are recorded in log books which are sent infrequently to a regional office for data capturing of metrics (e.g. infant mortality rates) into a centralized database (Garrib et al. 2008). In South Africa, the value of automation within the healthcare system is poorly understood as the investment in IT is often considered against the

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opportunity cost of improving basic infrastructure for the clinic, hiring additional health worker resources, or purchasing medicines or consumables required to improve access to care. However, the evidence is growing that in an economic environment of severe constraints the use of IT in health care has the ability to improve capacity and resource utilization precisely because it frees up other valuable inputs. Given the imminent introduction of the NHI it becomes all the more pressing that South Africa invests in appropriate systems to ensure efficient resource utilization.

The purpose of this research is to investigate how access to healthcare by large population bases could be improved through more efficient healthcare resource management. To this end, the research examines the role of IT and how it can be leveraged to introduce efficiencies into everyday processes. The research identifies the qualitative and quantitative factors associated with manual paper-driven processes that contribute towards the cost of healthcare delivery in a hospital or clinic setting and identifies the efficiencies that may be introduced into the system through technology. Furthermore, it determines the systemic and workflow-related strategic and cost benefits that result from automating healthcare systems in South Africa.

2 Literature review

The "automation of healthcare systems" is a broad-reaching term that describes the process whereby the end state is crystallized as the implementation of end-to-end electronic health records (EHRs), meaning that all actors, be they patients, healthcare providers, or administrators, are uniquely identified, tracked and potentially managed within the healthcare IT system. Investments in system automation have yielded improved labor productivity and better utilization of hospital resources, reduced duplication of manual tasks, minimized paperwork, decreased unnecessary treatments and lowered medication errors (Hillestad et al. 2005). Reforming health systems in order to contain costs and enhance service delivery requires increasingly effective utilization of resources within the health system, improved policy formation and decision-making capabilities, and a developed system that enables enhanced delivery of healthcare services that leverage knowledge management systems and efficient processes.

2.1 Trends in information technology policy and investment

Several countries have developed policy, committed investment and initiated programs targeting IT as an enabler for optimized national health services. Germany initiated a national health information technology network in 1993 and has implemented smart cards as a means of capturing patient and provider data (Anderson et al. 2006). Canada established the Advisory Council on Health Infrastructure in 1997 and in 2001 launched the Canada Health Infoway tasked with making electronic health records available to 50% of Canadians by 2010 (Webster 2011). The UK prioritized system automation as far back as 1998, when the National Health Service (NHS) Executive set a target for EHRs to be operational by 2005.

On 17 February 2009, US President Obama signed into law the Health Information Technology and Clinical Health Act (HITECH) as part of the American Recovery and Reinvestment Act – a $787 billion economic stimulus package. Of this money, $19.2 billion was reserved to promote the adoption and use of health IT. The Act stipulates a significant investment in IT, recognizing that "only 17% of U.S. physicians and 8 to 10% of U.S. hospitals have at least a basic electronic health record system" (Steinbrook 2009: 1059). This measure was taken as part of the effort to control costs of federal and state-funded healthcare in the US. From 2011, the program will provide financial incentives over a number of years of up to $65,000 per physician and up to $11 million per hospital for making reasonable use of health IT such as electronic exchange of data, e-prescriptions and automated reporting tools (Steinbrook 2009). HITECH initiatives will be focused on increasing quality of care, lowering costs and improving access through better methods of storing, analyzing and sharing health information (Buntin et al. 2010).

In South Africa, health information strategy and system development has developed in different directions when comparing the public and private sectors. Government has largely focused on the idea of achieving a comprehensive and integrated health information system; health information standards; access to Information and Communications Technology (ICT) infrastructure for all healthcare facilities; a national telemedicine program; an integrated health promotion strategy; an EHR strategy; and the promotion of research and development in e-health (South Africa National Department of Health 2008). The private sector has concentrated more on the commercial aspects of reimbursement and on the clinical and managed care interventions (Matshidze and Hanmer 2007). In 2004, the South African national Department of Health issued the "Strategic Priorities for the National Health System: 2004-2009 policy", which identified hospital information systems (HIS) as a key enabler for planning, budgeting, monitoring and evaluation. However, the implementation thereof has lagged but has become all the more urgent with the soon to be introduced NHI.

2.2 Public sector healthcare in South Africa

The South African public healthcare sector, like most developing countries, is burdened with many challenges, including the consequences of HIV/AIDs, tuberculosis and malaria; weak healthcare systems; under-resourced provider networks; and low staff morale (Braa et al. 2007). These challenges have translated into poor health outcomes relative to total health expenditure (Harrison 2010). The key challenge facing the sector is inefficient distribution of resources, rather than lack of funding as South Africa's total healthcare expenditure is higher than other countries of similar level of economic development. The human resource challenge is also limiting the sector's ability to improve overall healthcare performance. There is an absolute shortage in the number of health professionals available to deliver service, with 0.77 physicians for every 1,000 of the population (the ratio in the US is 2.56 and in the UK is 2.30) (Shona 2008). The nursing statistics are equally discouraging, with 4.08 nurses for every 1,000 of the population (the US ratio is 7.28 and the UK is 12.12.)

The Department of Health (2008) lists the quality issues that plague the public healthcare sector as follows:

- Inadequate diagnosis and treatment of patients;
- Inefficient utilization of services and resources;
- Insufficient resources, including human capital;
- Inconsistency in service delivery;
- Poor information;
- Inadequate referral system;
- Drug shortages;
- Poorly kept medical records;
- Avoidable errors; and
- Disregard for human dignity.

These failings threaten patients' health, introduce unnecessary costs into the health system and negatively impact on productivity. The paper identifies the need to invest in information systems as a required intervention in order to lower transactional costs, co-ordinate care, improve human resource management and measure improvements.

2.3 Foci and benefits of workflow automation in healthcare services

The demand for effective and efficient healthcare services necessitates innovative ways of relooking core hospital processes. Workflow automation ensures that the appropriate person obtains accurate information in a timeous manner concerning the procedure or process under consideration. This usually implies business process reengineering, which requires an analysis of current business processes, comparing these with proposed more efficient processes (usually with the assistance of technology) and then mapping the 'As Is' state to the 'To Be' desired end point, given budget and resource constraints (Carmichael 1994). The primary driver is associated cost savings through more efficient processes, but successful implementation also delivers improved customer satisfaction and a reduction in rework and errors (Capgemini 2004). Song et al. (2006) defined six types of workflows within the hospital environment, illustrating the interaction between providers, patients and, potentially, systems:

1. Administrative – aimed at managing patients and the healthcare organization, with the goal of improving administrative efficiency;
2. Financial – aimed at improving management of revenue, with the goals of increasing profits, reducing financial errors and speeding up reimbursements;
3. Clinical Operational – aimed at streamlining diagnosis and treatment tasks, with the goals of improved quality of care, optimal patient safety and better training;
4. Clinical Decisional – aimed at improving patient assessments and treatment plan development, with the goals of better outcomes and more efficient clinical trials;
5. Clinical Therapeutic – requiring the input of Clinical Operational and Clinical Decisional, with the goals of improved service quality, better care outcomes and efficiency of devices; and
6. Laboratory – aimed at acquiring data that supports diagnosis, with the goals of improved efficiency and service quality in the laboratory.

2.4 Determining the impact of technology

The impact of technology in terms of costs and benefits is difficult to measure. Unlike other investments, workflow improvements within the hospital address inefficiencies, but struggle to demonstrate additional direct revenue or billable services (Otieno et al. 2008). Otieno et al. (2008) propose a conceptual framework that allows for comparative analysis of electronic medical record (EMR) implementations against four vectors (system quality, information quality, use, and user satisfaction) in order to measure the effectiveness of EMR solutions. Most IT is implemented as a supporting service, to improve process rather than to enable a new billable product or function. Thus, accurate Return on Investment (ROI) is difficult to quantify, especially when the improved process or service may benefit the patients or health insurance companies which do not necessarily pay for the service. Menachemi and Brooks (2006) investigated the challenges around measuring the ROI of IT investment in hospitals and noted that the incentives for adopting information systems were misaligned. Providers were paid the same regardless of the quality of care that was delivered and in some situations error-prone inpatient care actually led to increased bills from additional hospital events and longer stays.

Despite the aforementioned challenges, a number of studies (Wang et al. 2003; Barlow et al. 2004; Menachemi and Brooks 2006; Goldzweig et al. 2009; Byrne et al. 2010; Furukawa et al. 2010) have successfully demonstrated positive ROI associated with health IT projects. Wang et al. (2003) demonstrated a positive ROI associated with an EMR system, attributing savings to a reduction in drug expenditure, improved radiology utilization, improved charge capture and reduced billing errors. Barlow et al. (2004) also demonstrated positive ROI metrics as a result of reduced spending

and increased revenue. The reduced spending was ascribed to lower transcription expenses, a reduced need to generate patient charts and fewer space requirements (fewer full-time employees are required to assist with charting) while revenue growth was realized from increasing patient volumes.

Williams and Boren (2008) conducted a systemic review of EMR implementations in developing countries and found encouraging evidence of technology-enabled efficiencies. In Cameroon, a locally designed EHR demonstrated a significant decrease in coding time and consultation, and better management of patients (e.g. making data from previous contact visits readily available). Another example was highlighted in Kenya, where the Moi University School of Medicine developed a medical record system that improved the quality of care, research and training delivered.

2.5 Organizational influences on process automation

Notwithstanding concrete evidence proving that EHRs have the potential to improve workflow efficiencies and quality of medical care, the majority of health workers continue to follow manual processes within the clinical setting (Simon et al. 2007). Simon et al. (2007) speculate that the success of new system inheritance into daily workflow is dependent on how effectively the workplace culture emphasizes quality and innovation, as well as the characteristics of the health workers involved, together with technology-related factors (in this regard, offices with EHRs were more likely to be using email, computerized scheduling systems and e-prescribing).

Goldzweig et al. (2009) also studied the cultural barriers to system implementations in hospital and confirmed that 77% of practices without an EHR are resistant to EHR systems, 72% of physicians believe that moving towards an electronic system will result in frequent downtime, 64% believe that the system will increase the physicians' work time, and 60% fear that they do not have sufficient computer skills. Despite all the cultural and organizational issues cited, the number one barrier noted by the authors was cost. The business case is a challenge, as it is not clear who benefits from the investment. One recommendation from the research is to pursue a model where the funders subsidize some of the costs as it is they who benefit substantially from the financial aspect, more so than the health providers or patients.

Littlejohns et al. (2003) found that introducing technology initially increased the workload for the clinicians, who were expected to adapt their workflow to the new systems without appreciating why they should commit additional effort to perform effectively the same job function. This highlighted to the researchers the need to ensure that users understand the reasons for implementation from the beginning together with the complexity of the healthcare task that is being automated (Littlejohns et al. 2003).

2.6 Research Questions

In South Africa, very little has been carried out in terms of computerizing managed care pathways. Doctors decide on treatment protocols and are incentivized according to agreed diagnosis and procedure associated fees. Public sector hospitals and clinics in South Africa are devoid of basic IT and communications infrastructure to enable delivery of high quality healthcare services. While the literature suggests that there are definite advantages to adopting HIS, the barriers to implementation include cost considerations, organizational and cultural issues, the need for a project champion in each region where a system is to be implemented and executive buy-in from the provincial and national ministry of health. The implementation of healthcare systems need not be approached as a holistic endeavor, but can be approached as contained areas within the hospital or clinic, where IT systems can be implemented in a step-wise fashion.

2.6.1 Research Question 1

What are the perceived reasons that influence the investment of automated systems within the hospital?

2.6.2 Research Question 2

What are the outcomes (in terms of perceived cost and strategic benefits) experienced from automating systems in hospital departments?

2.6.3 Research Question 3

What organizational factors influence the sustained successful adoption of healthcare systems?

3 Research Methodology

A mixed method approach was followed that consists of a quantitative approach to comparatively analyze user perceptions and experiences from various user groups, and a qualitative approach to unpack the reasoning behind user attitudes toward system automation. Structured interviews were conducted, as a combination of ordinal data, closed-ended and open-ended questions, with three hospital population groups (nursing staff, doctors and hospital administrators). Results from the three user groups were collated and cross-checked to provide a richer, more complete understanding of system automation within public sector hospitals in South Africa. Survey-based interviews were conducted in person with hospital personnel across two hospital locations.

The population consists of all doctors, nurses, and hospital administrators employed at Albert Luthuli Hospital in KwaZulu-Natal Province and Sebokeng Hospital in Gauteng Province. Both facilities are public sector hospitals that have implemented various components of automated systems. Purposive sampling was conducted, which ensured an intentional non-random selection of data sources. Respondents were required to have been exposed to the system for at least a year in order to indicate familiarity with the dynamics of workflow associated with technology. A total of 94 interviews were conducted (including three pilot study interviews) with the total sample (Table 1).

In accordance with the research survey method, the research instrument consists of a combination of a series of statements and open-ended questions. The first section of the questionnaire consists of questions relating to demographic data of the respondent. The second section of the questionnaire consists of 41 statements using a Likert scale relating to various system technologies that are part of daily workflow; the impact of automation in terms of cost and strategic value in healthcare facilities; and the degree to which organizational culture influences the implementation of new workflows and processes within the hospital. The third section of the questionnaire consists of seven open-ended questions used to assess the qualitative factors associated with automated workflow and perceived benefits or pitfalls.

The interviews were conducted face-to-face with respondents in February 2011 and captured using a mobile phone-based research software application for data collection and recordings. Ordinal data obtained from the respondents was classified and subjected to analysis according to a Likert scale consisting of seven response categories plus a category for responses where the answer was not known. A distribution-fitting approach as developed by Stacey (2005) was applied in order to analyze the collected data and categorize the various criteria. When analyzing the results of the distribution-fitting analysis performed on the survey data, Stacey's (2005) statistical methodology implies that the following interpretations needed to be made to identify factors as very important, important and less important in order to interpret the data meaningfully:

- If the mean for a factor response was appreciably greater than zero (μ as determined by the hypothesis test) then that factor is statistically significantly more important than the overall average importance of all the factors and can hence be interpreted as being very important relative to other factors.

- If the mean for a factor response was very close to zero (μ as determined by the hypothesis test) then that factor is statistically no more and no less important than the overall average importance of all the factors and can hence simply be interpreted as being important (the average) relative to other factors.
- If the mean for a factor response was appreciably less than zero (μ as determined by the hypothesis test) then that factor is statistically significantly less important than the overall average importance of all the factors and can hence be interpreted as being less important relative to other factors.

Steps taken to improve external validity during the study consisted of drawing a large pool of respondents who had adapted to an information system-based workflow for at least one year. The healthcare professionals employed at the chosen hospital sites were expected to be familiar with the challenges and limitations of healthcare delivery in the public sector. Respondents were drawn from at least two provinces, Gauteng and KwaZulu-Natal, but were limited to healthcare facilities where components of information systems had been implemented. To further ensure consistency, a mixed method approach was followed to consolidate qualitative feedback with the quantitative survey data. To ensure that internal validity was preserved, respondents were considered according to three population groupings: doctors, nurses and administrators. A pilot study was conducted to ensure that the research instrument questionnaire was easy to understand and elicited the intended information from respondents. The research instrument was standardized and consistent for each group of respondents.

3.1 Case studies: Inkosi Albert Luthuli Central Hospital and Sebokeng Hospital

Significant data variants were observed at the two hospitals. The reasons for this variance relate to the nature of the IT project (extent to which the system had been implemented, the timing of the project and user experience) and political forces in each province. The profiles of each hospital are described below.

3.1.1 Hospital profile: Inkosi Albert Luthuli Central Hospital (IALCH)

IALCH is an 840-bed tertiary facility in the city of Durban, South Africa, and is one of the few digital hospitals in the country. This has been assisted by a public private partnership, whereby in 2001 the Impilo Consortium was awarded the contract for the provision of medical equipment service (Siemens Systems), IT systems (AME), and facilities management (Drake and Scull). The contract is for 15 years and is worth more than R5 billion.

AME International is responsible for implementing the complete HIS at IALCH, which consists of:

- Electronic Medical Record;
- Picture Archiving and Communication System;
- Radiological Information System;
- Laboratory Information System;
- Pharmacy Information System;
- Critical Care System;
- Administration and Financial Systems; and

- Human Resource Management System.

IALCH is in its tenth year of its 15-year Public Private Partnership contract, and hospital staff at IALCH are subject to continuous training of the HIS, with the result that most clinical staff are now computer literate. In addition, the most recent annual report confirms that surveys are conducted on a monthly basis with clinical staff to ensure that the quality of service levels regarding the IT systems and training is acceptable.

3.1.2 Hospital profile: Sebokeng Hospital

Sebokeng Hospital is a 704-bed regional hospital in Gauteng Province, with three associated clinics. In August 2008, Sebokeng Hospital completed a proof of concept for a planned provincial implementation of an HIS.

The Baoki Consortium (AME International is part of the consortium) was awarded the Gauteng provincial contract (valued at $120 million) for supplying an HIS to 37 provincial hospitals and 400 community clinics. The scope of this implementation includes:

- Patient Management and Scheduling;
- Electronic Medical Record System;
- Clinical Documentation;
- Pharmacy Information System;
- Visit Summaries and Discharge Summaries; and
- Statistics and Reporting.

4 Presentation and discussion of results

The two hospitals that participated in the study were at different stages of their respective HIS implementation life cycles. Respondents from both hospitals agreed that the HIS has the potential to impact positively on information security, workflow optimization, cost reduction and patient care. This is further unpacked below.

4.1 Perceived reasons that influence the investment of automated systems within the hospital

4.1.1 Perceptions of manual processes

The research data confirms that for hospital staff conditioned to working in non-automated environments, the perceptions of inefficiency relating to paper-driven processes are not significant. The majority of doctors disagreed with the statement that paper processes resulted in more than 20% of their time being dedicated to administrative activities. This is likely attributable to the fact that doctors did not perceive the urgency of making detailed clinical notes as they are less under threat of being sued for medical liability than their global colleagues. This is because, while the notion of punitive damages for medical liability in South Africa exists, in general these damages are not recoverable. Thus, it could be expected that it would be nurses and staff who are delegated a high administrative workload that would hold this perception. In addition, 71% of the nursing sample group recognized the need for duplicate data entries, which is to be expected, given that nurses are tasked with recording multiple aspects of patient data on a frequent basis, e.g. patient history, medication, observations, and laboratory results.

The observations suggest that paper processes are not as inefficient as is suggested by the literature (Goldzweig et al. 2009). Rather, the physician resistance to adoption was demonstrated (with 55% of doctors believing that paper processes were efficient) through the unwillingness to adopt new workflow processes that required data to be accessed and entered onto a computer system. This is in keeping with the findings of Poon et al. (2004), which suggested that the number one barrier to adoption resides in the change management function, which needs to be addressed in order to shift perceptions towards acceptance of HIS. It can be inferred from the results of the current study that doctors, nurses and administrators integrate manual processes into their daily workflow without questioning the impact of these processes on job function efficiencies. It is only when automation is introduced that healthcare providers realize the shortcomings of manual processes in comparison to the automated ones. This aligns with the findings of Poissant et al. (2005), which confirm clinician perceptions regarding the value of IT investment in hospitals.

4.1.2 Perceptions of hospital information systems

Respondents considered administrative tasks and patient interaction workflow separately. This suggests that while respondents recognize that there are benefits to be gained from automation, the direct impact on their daily business processes is not well understood. Some staff also perceived the introduction of hospital systems as disruptive to patient care, with one nurse from Sebokeng Hospital commenting that "concerning patient care on the nursing side, more time is now taken to sit in front of a computer instead of taking care of the patient". Thus, obtaining buy-in and acceptance for the implementation of a computerized system from hospital staff should not rely on broad promises of potential optimization benefits, but should rather target processes specific to the various user groups within their daily workflow that are genuinely perceived as inefficient. Table 2 describes the data relating to the impact of automation and the perceived barriers to adoption for doctors, nurses and hospital administrators, respectively. Using the Stacey (2005) distribution fitting algorithm (discussed in the methodology section) a positive and statistically significant t-value indicates that the factor is statistically more important relative to the other factors and that there is more agreement with the factor or statement, a negative and significant t-value indicates the factor is less important and that there is less agreement with the factor.

For all three sample groups (doctors, nurses and administrators) that had experience using the HIS, there was consensus that it was easier to work with electronic systems compared to paper records. This was a statistically significant factor and is in keeping with the literature review discussion as evidenced by Poon et al. (2004); Westbrook et al. (2008); and Devine et al. (2010). There is no doubt that the perceived benefits of investing in an HIS are not as well understood by potential users, compared to those users who have had some exposure to working with the system. The data also revealed a belief across all three sample groups (doctors, nurses and administrators) that the cost of learning the new system was worth the benefits, that the HIS was preferred to the previous paper-based system, and that hospital staff would like to move to the HIS for all functions as soon as possible. A nurse from Sebokeng Hospital alluded to the excitement amongst the hospital staff attributed to moving to an automated system: "Personally I think it's a great thing. I love technology and the fact that it can help people. I didn't have exposure to technology before, and now I can use email and the internet." Thus, the perceived value of the hospital IT investment would benefit from exposing the potential user population to hands-on usage models, i.e. live system demonstrations that would allow users to internalize the impact on workflow. This exposure would be likely to have a more positive effect than trying to identify inefficiencies in the existing manual system.

4.1.3 Information security and patient confidentiality

Over 75% of nursing staff and hospital administrators were confident that information is more secure and confidential in electronic format compared to a paper-based system. While this was

a statistically significant factor for these sample groups, 58% of doctors surveyed disagreed. This was probably because paper-based records are accessible to all hospital staff while the electronic system requires a log on with a password. Qualitative data provided some insight, with one doctor at IALCH confirming that staff can access data of patients that are not directly in their care and that "people who don't work in that department should not be able to access records of patients in other departments". As described in the literature review, privacy and confidentiality of data are fundamental concerns with international HIS implementations (Simon et al. 2007; Angst and Agarwal 2009; Miller and Tucker 2009). There is currently no protocol or guidance in South Africa as to the exact measures that should be implemented to protect patient confidentiality effectively. The Patient Right Charter and Medical Schemes Act merely state that all patients have the right to privacy. It can be inferred that electronic records have the ability to offer password-restricted access to electronic patient information; however, hospital staff was discouraged by the fact that once a user logs onto the system, that person has complete access to all patient records regardless of who the treating doctor is, or which ward the patient is allocated to. Going forward, measures should be taken to ensure that security and privacy of information are included in the system security and design architecture in accordance with the hospital risk management function.

4.1.4 Lowering costs

As to the perceived cost benefits of implementing the new system, the statement "I believe the hospital will save costs as a result of moving to the new system" was identified as statistically significant by nurses and administrators but not by doctors. From the qualitative interviews, it was clear that while nurses and administrators believed that IT would reduce costs, both sample groups did not understand how this would be achieved. When asked "Do you see cost savings as a result of the system?", one nurse at IALCH replied "Yes, it saves time; more patients are admitted because it is faster than writing." One possible explanation is that the positive attitude towards the IT system within these two sample groups translated into a logical association of workflow efficiencies with cost reduction. One doctor felt: "It's costing the hospital as well as provincial government a lot of money. The cost of running a computer system is expensive. You need to have someone to maintain the system on call 24 hours a day." Another clinician was of the opinion that "The hospital will save money as they don't have to buy as much paper. Information will be accessed more efficiently and patients will be treated more efficiently, so there's a faster turnaround time. For example, to discharge a patient, it's all done on the system and the patient just goes to one place and all paperwork is done there."

The research suggests that there is an opportunity to include the IT value proposition specific to cost reduction in the change management process during system implementation (and education of doctors, nurses and administrators) in order to gain further support for system adoption and usage.

In summary, the perceived reasons that influence the investment of automated systems within a hospital are the ability to reduce administrative workload associated with data capture; the optimization of workflow; the potential to enhance patient data security; and the potential for lower overall costs. Factors that are not well understood present an opportunity for inclusion in the change management process. Suggested actions would be:

1. Identify and target usage models for workflow optimization specific to each user group as user experience differs from doctors to nurses to administrators.
2. Provide potential users with exposure to the HIS or demonstrations to assist with internalizing automation benefits and thereby driving system adoption.
3. Enhance patient confidentially within the system.
4. Develop a value proposition specific to each user group to encourage support, adoption and usage of the new system.

4.2 Outcomes experienced from automating systems in hospital departments

Following the implementation of the hospital system, respondents were asked about their perceptions relating to the impact of automation in terms of cost and strategic value of the system. The results provided insight into the impact of automation on service delivery and hospital reputation perceptions; patient record management; and HIS user experience (see Table 3).

4.2.1 Impact on service delivery and hospital reputation perceptions

As was to be expected, the overall perceptions relating to the impact on patient experience were overtly positive. For example, at IALCH 86% of respondents stated that patient waiting times to be seen by a doctor or nurse had decreased, whilst 66% maintained that at Sebokeng. Significant statistical factors were observed with nursing and administrator respondents regarding patient waiting times for admission and discharge, and overall patient satisfaction with care received. It stands to reason that as nursing staff and administrators are involved in the administrative tasks relating to patient admission and discharge, the perception of these two sample groups would hold a higher level of significance concerning where automation can replace manual processes. Doctors on the other hand did not identify these factors relating to patient workflow as significant, as they are not involved in patient administrative tasks and the system was not perceived to enhance the doctors' ability to treat patients more effectively.

Given that patients spend more time with nurses and administrators during the admission, waiting and discharge processes compared to the time spent with the doctor for consultation and treatment, it is likely that the nurses and administrators perceive the hospital to have experienced a higher level of service delivery to patients as a result of the automated system. One nurse at Sebokeng Hospital commented: "waiting time decreased ... You don't have to look for papers to file, staple or punch." Research findings were consistent with those of Poon et al.'s (2004) confirming that positive patient experience and hospital reputation perceptions are supported through IT investment.

The image of public sector tertiary hospitals in South Africa has been an emotive issue. Public opinion considers these facilities to be antiquated, under resourced and associated with poor service delivery. The results of this study suggest not only that IT has a role to play in modernizing state hospitals in terms of automation but that there is a real belief that automated systems are an important component to improving health service delivery, patient experience and the overall public perception of state healthcare services. IT systems also have a role to play in the reputational management of internal stakeholders, as evidenced by the perceived increased satisfaction in overall working conditions within the hospital, particularly for 87% of nurses and 86% of administrators surveyed.

4.2.2 Patient record management

The majority of hospital staff was in agreement as to the benefits of EMRs (see Table 4).

Doctors, nurses and administrators all identified the statement "I have superior access to patient record information when compared to paper based systems" as being very important relative to other factors with t-values of 3.66, 4.64 and 3.16 respectively. A doctor from IALCH confirmed "Patient care is improved because access to results are easier and don't get lost. Results are logged and you can prove that you ordered them." The perceived advantages of EMRs were shared by the nursing respondents. As a nurse from IALCH commented: "The system is user friendly, very fast, and saves money because the doctors are able to read the scans from the rural hospitals without the patient, the decision is made on the phone, results are posted through the computer, multidisciplinary teams are able to work fast with the system and patient care is improved." The research suggests a unanimous recognition of the value of HIS and raises questions as to how this capability will enhance the clinician's ability to improve healthcare delivery. Nurses and administrators believe that the HIS

results in fewer records lost, improved record management, and the reduction of duplication of information. A nurse at IALCH confirmed: "Record keeping is good as the history of the patient is written on the computer and is well kept and can be retrieved easily."

The study results suggest that paper patient records are cumbersome and costly to manage and that there are efficiencies to be gained by moving from paper to electronic format. The results from this study suggest that the HIS offers cost savings to be achieved by optimizing the manual processes required to maintain manual record management systems.

4.2.3 Hospital information system user experience

The HIS user experience varied between the three sample groups. Doctors, nurses and administrators inferred that the system was easy to use with 87% disagreeing with the statement that they found the system difficult to use. But only nurses and administrators believed the statement "I find the computerized system is faster and easier to use compared to handwritten notes" to be very important relative to other factors (78% of nurses and 80% of administrators believed that the fact that computerized systems were faster than handwritten notes was an important factor while only 55% of doctors agreed with this statement to varying degrees). Opinion as to whether the users perceived the system as slow varied, with doctors emerging as the most sensitive to system performance. The reasons relating to system usability and performance were not well understood, and while infrastructure and system design considerations are not evaluated in this study, it can be inferred that these factors have the potential to define the user experience and hence the user attitude towards system adoption and usage.

4.3 Organizational factors that influence the sustained successful adoption of healthcare systems

4.3.1 Executive sponsorship

Sixty-eight per cent of doctors, 100% of nurses and 82% of administrators maintained that management encouraged staff to use the computer systems. This was also demonstrated by Poon et al. (2004), who identified the role of management as critical for successful business process reengineering. Management's involvement in supporting and encouraging staff to adopt the new HIS was identified as an important factor of success. Merely implementing a new system and then providing training to hospital staff do not guarantee adoption. The hospital management team needs to encourage adoption continuously through change management programs that actively endorse system usage, and include the HIS as an important factor that promotes professionalism with staff at the hospital.

4.3.2 Training perceptions

While doctors, nurses and administrators generally agreed that the training provided was sufficient, perceptions of the need for continuous training amongst doctors differed from those of nursing and administration staff. Seventy per cent of doctors agreed that further training on the system was not required, while nurses and administrators disagreed with the statement. Some respondents were not satisfied with the training provided. One doctor at Sebokeng discussed how inadequate training indirectly impacted on daily workflow: "Sometimes we have a lot of patients and we are short staffed, we have to go to the computer and some of us are slow." The nurses echoed some of the doctor's sentiments that training was insufficient. Said one nurse at Sebokeng, "Because they [the nurses] don't have basic training on how to use the computer, and proper training wasn't given to begin with, when I arrived here I wasn't given any training on how to use the computer except for the sister who showed me what to do when you order and that was it, and that was less than an hour." When asked what she would change with the system, another nurse replied, "Because the system

is an unknown obviously it's going to be difficult, so I say basically let's start with training people, showing them the basics of what they are doing, see what is it, what is it for and then after that we can improve. We don't know really what the system is about to begin with. I'm sure we could use it more for actually seeing patient records, but I didn't know that. I only knew that you can use it for ordering patients' medication and things like that." Another nurse further related the frustrations associated with the need for continuous training: "My computer at the moment is not functioning and I become frustrated because it's better if you use the computer everyday so you don't forget some of the things you learned since when we started using the computer when they were introduced to the hospital. It was our first encounter with a computer so we're still learning."

Intuitiveness of the system was not recognized as a significant factor, which was offset by the level of training provided. Barriers to adoption did not reside in an unwillingness to learn the new system, but were rather based on the need to adapt current workflow to accommodate interacting with IT. There was consensus amongst nurses and administrators about the need for continuous training. This may be as a result of the frequent reallocation of nurses to various areas within the hospital, but this would require further investigation to confirm.

4.3.3 Willingness to adopt new systems

Respondents indicated that they were eager to use the new system, were comfortable using a computer, and believed that they could not get by without having to learn a computer system. However, their responses indicating their willingness to use the computer; the impact of the system on morale; and their perceptions of how computers convey professionalism in the hospital environment varied (see Table 5).

Respondents were asked about their perceptions regarding the impact of the new computer system on morale in the workplace. While doctors did not see a correlation between hospital morale and the new computer system, 64% of nurses agreed that there was a positive relationship, and administrators perceived the relationship as statistically significant with a t-value of 3.63. The results are likely a reflection of the degree to which the three sample groups depend on computer systems for their job functions. There were, however, varying opinions, with one of the doctors at IALCH expressing the opinion that the system "lifts morale because you are living in a very modern environment; access to patient information is quick, less work and saves time; there is improved communication between departments".

As to the ability of systems to increase individual levels of professionalism, nurses and administrators identified this factor as being very important relative to other factors, while doctors did not find this statement of statistical importance – t-values of 3.42, 2.85 and -0.08 respectively. A nurse at Sebokeng Hospital commented: "I think the presence of the electronics in our work has improved confidence and morale, and it puts the hospital at a certain level; once you come in and see your information has been computerized you will quickly develop that confidence in the future."

5 Conclusion

The role of technology in public sector tertiary health facilities in developing countries is widely recognized as an important consideration in reducing costs and enabling improved access to health services. In South Africa, while Gauteng and KwaZulu-Natal have embarked on a path of implementing HIS, these two provinces are at different stages of their implementation life cycles, with various components in design and/or operational phase. The challenges of implementing system automation are as a much a function of technology as they are of understanding the impact on business processes within the hospital ecosystem. While HIMSS recommends a staged-progression approach to implementation that takes into account infrastructure, connectivity, people and culture (HIMSS Analytics 2010), results from the research suggest that the benefits of the system are only fully understood and appreciated once all components are implemented and holistic change management

support has been applied. Doctors, nurses and administrators were surveyed to understand differences in perceptions about what benefits the HIS offers, and how the system is used. The results provide some insight into the reasons for investing in automated systems; the outcomes experienced as a result of automation; and the organizational factors that are critical to the successful adoption of IT systems.

Research Question 1: Perceived reasons that influence the investment of automated systems within the hospital

Hospital staff conditioned to working in non-automated environments was accustomed to the inefficiencies of manual paper-driven processes. There was general consensus amongst doctors, nurses and administrators that system automation is a required investment, but the direct impact on workflow and job function efficiencies was only understood once staff had migrated to the automated system. All respondents believed that the hospital would ultimately save costs as a result of automated processes, but the mechanisms for saving costs within the hospital were poorly understood. All respondents, however, supported the investment in IT systems, and indicated an overall willingness to learn the new systems and a desire to move off manual processes. Information security and confidentiality was one area that was identified as a function that could be more effectively enforced through IT systems. South Africa is ready to invest in IT in healthcare, but the business case for investment is not clear. In addition, concerns around patient data security are not being adequately addressed.

Research Question 2: Outcomes experienced from automating systems in hospital departments

The ability of the system to impact metrics such as patient waiting times, patient satisfaction and ease of use (compared to paper processes) directly was more positively perceived by nurses and administrators, who are more involved in administrative tasks as part of patient care/handling. There is little doubt from both the literature review and the research conducted that the management of patient records is made more efficient via automated systems as compared to paper processes. Interestingly, the role of the HIS has evolved from being a support function to providing a capability that has the potential to enhance the reputation of the facility to both patients and staff alike.

Research Question 3: Organizational factors that influence the sustained successful adoption of healthcare systems

The role of management to champion the use of IT systems is critical to the long-term adoption by end users. The need for continuous training was identified by nurses and administrators, suggesting that there is the potential for further productivity improvements to be gained (through additional training programs). Finally, respondents were generally keen to adapt to the new system and perceived the HIS as a component of their overall professionalism. The success of IT projects depends not only on the IT department, but also on the broader management team as a whole. In South Africa, hospital staff comprises a diverse user base, with varying workflow perceptions, and the change management function must be fully considered to ensure successful system implementation and user adoption.

Given the challenges facing the public healthcare sector in developing countries relating to resource allocation and utilization, access to healthcare services, and efficient management of patient encounters at tertiary public health facilities, the research has demonstrated the impact of IT in these regards. Automation of systems and processes complements the evolution of patient treatment protocols, medical record management, and back office administrative functions while enabling time and cost savings within the healthcare system. Health systems have the opportunity to alleviate some of their resource constraints and reduce transactional costs by investing in technology to help better co-ordinate care and move all functions of public health management into the service economy.

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Table 1: Profile of respondents

Description of respondent type	Number sampled
Doctors	21
Nurses	41
Hospital administrators	31
EMR implementation managers	1

Table 2: Perceptions of Hospital Information Systems – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I find it easier to work with electronic system than with paper records	0	0	2	4	4	6	4	20	2.8881	0.0098	+
I have confidence that information is more secure and confidential in electronic compared to paper	1	4	6	1	0	6	1	19	-0.4984	0.6246	
I believe the computer systems will save the hospital money	1	2	2	3	3	5	1	17	0.4029	0.6927	
I believe the cost of learning new computer systems is not worth the benefits	4	7	4	0	3	1	0	19	-4.2001	0.0006	-
I prefer using a paper based system	4	7	4	2	2	1	0	20	-4.6680	0.0002	-
I would like to move to a paperless system as soon as possible	1	1	1	3	2	3	9	20	2.9370	0.0088	+
Nurses											
I find it easier to work with electronic system than with paper records	1	2	2	1	9	15	10	40	3.6251	0.0008	+
I have confidence that information is more secure and confidential in electronic compared to paper	3	1	3	3	4	18	8	40	2.0762	0.0447	+
I believe the computer systems will save the hospital money	1	1	1	3	10	11	4	31	1.5837	0.1241	
I believe the cost of learning new computer systems is not worth the benefits	9	14	4	2	3	5	0	37	-5.9191	0.0000	-
I prefer using a paper based system	13	14	4	3	2	1	3	40	-4.9693	0.0000	-
I would like to move to a paperless system as soon as possible	1	2	0	2	4	18	13	40	4.7026	0.0000	+
Administrators											
I find it easier to work with electronic system than with paper records	1	1	0	1	0	17	10	30	3.6777	0.0010	+
I have confidence that information is more secure and confidential in electronic compared to paper	1	3	0	2	2	12	10	30	3.1072	0.0043	+
I believe the computer systems will save the hospital money	0	2	1	5	3	9	7	27	2.5319	0.0180	+
I believe the cost of learning new computer systems is not worth the benefits	7	14	1	3	1	2	2	30	-4.5328	0.0001	-
I prefer using a paper based system	13	16	0	1	0	0	0	30	-16.0300	0.0000	-
I would like to move to a paperless system as soon as possible	4	0	0	0	2	12	12	30	2.0536	0.0495	+

Table 3: Service delivery and hospital reputation perceptions – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Patient waiting times for admissions have decreased	2	3	1	3	3	6	0	18	-0.0914	0.9283	
Patient waiting times to be seen by a doctor or nurse are decreased	1	4	2	0	6	4	0	17	-0.4756	0.6412	
Patient overall satisfaction with care received is higher	1	2	1	3	4	5	2	18	0.9382	0.3621	
I am treating more patients per shift in the outpatient/ward/where I work	2	4	2	3	4	4	1	20	-0.7749	0.4484	
There is increased satisfaction with the overall working conditions in the hospital	1	1	1	3	5	6	3	20	1.7130	0.1039	
The hospital has enjoyed improved service delivery	1	2	1	3	1	9	2	19	1.6998	0.1074	
Nurses											
Patient waiting times for admissions have decreased	0	4	3	3	4	15	8	37	2.7761	0.0088	+
Patient waiting times to be seen by a doctor or nurse are decreased	1	0	1	5	10	17	4	38	1.9725	0.0563	
Patient overall satisfaction with care received is higher	1	0	1	1	12	18	6	39	2.9657	0.0053	+
I am treating more patients per shift in the outpatient/ward/where I work	0	3	2	6	8	10	8	37	2.1513	0.0384	+
There is increased satisfaction with the overall working conditions in the hospital	0	1	7	2	9	14	7	40	2.2247	0.0321	+
The hospital has enjoyed improved service delivery	1	1	2	1	12	15	6	38	2.6109	0.0131	+
Administrators											
Patient waiting times for admissions have decreased	1	1	1	2	2	10	8	25	2.6938	0.0130	+
Patient waiting times to be seen by a doctor or nurse are decreased	0	1	1	2	3	11	5	23	3.3013	0.0034	+
Patient overall satisfaction with care received is higher	0	0	0	5	5	10	2	22	2.1914	0.0404	+
I believe more patients are treated per shift as a result of the system	0	1	0	2	2	9	10	24	4.8093	0.0001	+
There is increased satisfaction with the overall working conditions in the hospital	0	3	0	1	4	10	10	28	3.5554	0.0015	+
The hospital has enjoyed improved service delivery	0	1	0	2	2	18	6	29	5.3258	0.0000	+

Table 4: Electronic Health Record perceptions – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I have superior access to patient record information when compared to paper based systems	0	2	1	1	2	3	11	20	3.6665	0.0018	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	2	1	4	0	3	8	2	20	0.7483	0.4640	
Patient information is more disorganised with the computer system compared to the paper system	4	9	2	1	1	2	1	20	-3.1743	0.0053	-
Fewer records are lost and record management has improved	0	0	0	0	6	6	8	20	5.9135	0.0000	+
Nurses											
I have superior access to patient record information when compared to paper based systems	1	0	0	0	8	16	13	38	4.6403	0.0000	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	2	0	1	2	12	15	7	39	2.0770	0.0448	+
Patient information is more disorganised with the computer system compared to the paper system	10	19	6	2	1	0	2	40	-5.8010	0.0000	-
Fewer records are lost and record management has improved	2	4	1	0	4	18	10	39	2.9957	0.0049	+
Administrators											
I have superior access to patient record information when compared to paper based systems	1	0	0	1	3	16	8	29	3.1605	0.0039	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	1	3	2	2	3	14	5	30	1.6292	0.1145	
Patient information is more disorganised with the computer system compared to the paper system	10	11	3	2	1	2	1	30	-5.8357	0.0000	-
Fewer records are lost and record management has improved	0	2	1	4	3	10	9	29	3.3449	0.0024	+

Table 5: Willingness to adopt new systems – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Staff are eager to learn the new system	1	2	3	2	1	7	3	19	1.3622	0.1909	
Initially I did not want to move to the computer system	6	6	2	4	2	0	0	20	-4.8408	0.0001	-
Initially the hospital staff did not want to move to the computer system	0	2	1	3	5	2	0	13	-0.1996	0.8454	
As a result of the computer systems, I see improved moral in the workplace	2	2	0	6	4	1	2	17	-0.3466	0.7337	
As a result of the computer systems, my overall level of professionalism is increased	2	2	1	5	5	3	2	20	-0.0862	0.9322	
I have a fear of having to use a computer instead of paper	9	8	0	3	0	0	0	20	-7.0867	0.0000	-
I can get by without having to learn the computer system	5	7	1	0	2	1	0	16	-4.3597	0.0007	-
Nurses											
Staff are eager to learn the new system	3	0	3	1	10	14	9	40	1.9387	0.0600	
Initially I did not want to move to the computer system	7	15	2	0	4	6	6	40	-2.3553	0.0238	-
Initially the hospital staff did not want to move to the computer system	0	6	4	3	4	9	4	30	0.2093	0.8357	
As a result of the computer systems, I see improved moral in the workplace	2	1	6	5	7	14	4	39	0.5032	0.6178	
As a result of the computer systems, my overall level of professionalism is increased	0	2	5	1	8	13	11	40	3.4205	0.0015	+
I have a fear of having to use a computer instead of paper	14	20	1	1	3	1	0	40	-11.2977	0.0000	-
I can get by without having to learn the computer system	15	16	4	0	1	3	1	40	-7.2398	0.0000	-
Administrators											
Staff are eager to learn the new system	0	3	0	2	2	16	7	30	3.6346	0.0011	+
Initially I did not want to move to the computer system	5	17	0	1	0	3	2	28	-4.2944	0.0002	-
Initially the hospital staff did not want to move to the computer system	0	10	1	2	1	3	3	20	-1.6708	0.1121	
As a result of the computer systems, I see improved moral in the workplace	1	2	1	1	4	11	10	30	3.0791	0.0046	+
As a result of the computer systems, my overall level of professionalism is increased	2	0	0	2	4	10	12	30	2.8525	0.0081	+
I have a fear of having to use a computer instead of paper	10	19	0	1	0	0	0	30	-16.8528	0.0000	-
I can get by without having to learn the computer system	13	12	1	0	1	1	0	28	-9.2708	0.0000	-