The Impact of Electronic Medical Records on Nurse Productivity and Nursing Job Enrichment: An Empirical Study within a South African Hospital

RESEARCH REPORT

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Student:	Matheri Kangethe
Student no:	0213114F
Supervisor:	Professor Jason Cohen
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Declaration

I declare that this research report is my own unaided work, except to the extent indicated in the text, acknowledgements and reference matter. It is being submitted for the 50% research component of a Masters of Commerce degree (by Research and Coursework) at the University of the Witwatersrand, Johannesburg.

It has not been submitted before for any other degree or examination in this or any other institution.

James Matheri Kangethe

28 February 2013

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Costs of data collection were supported in part by funding provided by the National Research Foundation of South Africa for which I am grateful.

My employer, Nedbank Limited is also acknowledged for the support provided to undertake this research.

Finally, my thanks go to my family for their sacrifices and support.

Dedication

This research report is dedicated to my wife Mercy and sons Kangethe, Gathuku, and Ndegwa for making my life purposeful.

I also dedicate the report to my mother for bestowing on me resilience, and for her belief in me.

Abstract

Electronic Medical Record (EMR) Systems hold considerable potential for improving the cost and quality of health care delivery. Yet, little is known about nurses' perceptions of EMR systems and the impacts of EMR system implementations on nursing outcomes in particular, nurse productivity and the nursing job enrichment. This research study therefore examines nurses' satisfaction with EMR use and assesses the impacts of use on individual nurse productivity and how the nurse's role is enriched by this technology. DeLone and McLean (1992) IS Success Model and Bhattacherjee's (2001) Post Acceptance Model form the basis for this assessment.

A structured questionnaire was administered to 172 nurses in a public hospital in the Kwazulu-Natal province of South Africa. The hospital recently upgraded its hospital information system to include full EMR functionality and it was thus a useful context within which to test the study's hypothesised relationships.

Results from the regression analysis show that an EMR that results in user satisfaction will enhance nurse productivity and enrich the nursing job.

Insights derived can promote nurse productivity and help enrich the nursing job in a positive way. For example, managing user expectations beforehand, ensuring records are accurate and always available are fundamental to achieving the individual outcomes of enhanced nurse productivity and an enriched nursing job.

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List of Acronyms

Acronym	Definition
CEO	Chief Executive Officer
CPOE	Computerised Physician Order Entry
ECT	Expectation Confirmation Theory
EHR	Electronic Health Record
EMR	Electronic Medical Record
ENT	Ear Nose and Throat
IS	Information System
KZN	Kwa Zulu Natal
MPI	Master Patient Index
NAHIT	National Alliance for Health Information Technology
PACS	Patient Archive and Communication System
PAM	Past Acceptance Model
PCFA	Principal Components Factor Analysis
PHR	Patient Health Record

CHAPTER 1

1.1 Introduction

An electronic medical record (EMR) system is an information system that enables the electronic collection, storage, and retrieval of information securely on specific patient diagnosis, treatment and other pertinent clinical information (Safran and Goldberg, 2000). Electronic collection of clinical data allows clinicians to provide healthcare to patients without capturing or reviewing information on paper and also allows clinical information to be readily and simultaneously accessible to multiple healthcare professionals. However, changing from paper records to an EMR system has both positive and negative impacts on healthcare professionals and their roles in healthcare provision (Halford, Obstfelder, & Lotherington, 2010) . Positive impacts can include fewer missing pieces of information and fewer messages to pass during nursing handovers (Hertzum and Simonsen, 2008). Negative impacts may include increased documentation time due to slow computer system response and added task complexity brought about by a poor user interface (Kossman, 2006).

EMRs hold considerable potential (Hertzum and Simonsen, 2008) to improve the cost and quality of health care delivery but empirical examination of their impacts is still lacking. Too few studies have demonstrated benefits being realised (Haux, Ammenwerth, Herzog, & Knaup, 2002; Nahm & Poston, 2000). Some research that has shown EMRs not to have improved patient healthcare (Darbyshire, 2004), is associated with an increased likelihood of errors (Ash, Berg, & Coiera, 2004) and even mortality rates (Han et al., 2005). Developing a better understanding of EMR system success and how system success can be influenced could address these challenges.

One promising approach to understanding the use and success of EMR systems is to consider EMRs from the perspective of its users. For this purpose, the work of DeLone and McLean (1992) in Information Systems (IS) Success Model and Bhattacherjee (2001) in Post Acceptance Model (PAM) of IS Continuance provide useful theoretical underpinnings. In the DeLone and McLean model, a user's perceptions of system quality and information quality influence their satisfaction and use of an information system.

These in turn are theorised to influence the individual and organisational net benefits and outcomes of system use (DeLone and McLean, 1992).

This study adopts the DeLone and McLean model and extends it with constructs from Bhattacherjee's post acceptance model. In particular, Bhattacherjee indicated that expectation confirmation has an impact on a user's satisfaction with an information system.

This integrated DeLone and McLean and Bhattacherjee model examines EMR systems from the user perspective and focuses on nurses within a hospital organisation. These nurses are the predominant users of a specific set of core EMR functionalities. User (nurse) perceptions of their EMR system's quality and the corresponding impacts these perceptions have on EMR usage and user satisfaction will be examined. Satisfaction and use will in turn be examined for their impacts on two individual level outcomes, namely individual nurse productivity and the enrichment of the nursing job. Studying individual outcomes is important because organisational outcomes can be inferred from individual outcomes and together these represent the system's net benefits (DeLone and McLean, 2003). Insights derived from this study enhance our understanding of the factors impacting upon EMR usage by nurses, and their satisfaction with these systems. Moreover, by understanding the implications of EMR systems for nurse productivity and the nursing role, hospital decision makers are better positioned to improve usage and user satisfaction and understand their implications for productivity and an enriched nursing job.

1.2 The Research Problem and Overall Objectives

1.2.1 Research Problem

Many studies have found that EMR potential is not realised and in certain instances, adversely impacts on healthcare quality and patient safety (Ash et al., 2004, Darbyshire, 2004, Han et al., 2005, Haux et al., 2002, Nahm and Poston, 2000, Vikkelso, 2005) . This challenge is difficult to address without understanding of factors that influence EMR success. Gaining this understanding will guide actions that lead to improved nurse productivity and a more meaningful nursing job due to EMR use. To help address this problem, this research answers the following questions:

1. To what extent do the attributes of the EMR system and EMR information quality influence user satisfaction?

2. To what extent do the attributes of the EMR system and EMR information quality influence use of the EMR?

3. To what extent is there a relationship between user satisfaction and use of the EMR?

4. To what extent does expectation confirmation influence EMR user satisfaction?

5. To what extent does use of the EMR influence both individual nurse productivity and nursing job enrichment?

6. To what extent does user satisfaction with the EMR influence both individual nurse productivity and nursing job enrichment?

To answers these questions, this study will develop the research model and then test it using a quantitative, survey-based approach. Data will be collected from individual nurses at Addington Hospital in Kwa Zulu Natal, South Africa that has implemented an EMR system. Subsequent statistical analysis will be used to test the hypotheses.

1.2.2 Contribution to the body of knowledge

Answers to the above questions are of both practical and academic significance. An EMR is technology that has wide ramifications in a hospital setting. It impacts on everyone including patients, physicians, nurses and administrators. There is a significant risk that the intended impact on nurses' productivity and their job will be compromised if use and user satisfaction with EMR systems is not achieved. This study examines the relationship between EMR usage and user satisfaction with nurses' productivity and how their role in healthcare provision is enriched. The role of EMR system quality and information quality is also examined. Insights derived from this study can also be applied in hospital settings, by helping healthcare providers to understand and influence the impact of these systems on nurse productivity and the nursing role. Project planners and system developers will also have insights that help them to design a system that is successful.

From an academic perspective, this study addresses three important gaps. Firstly, my review of literature revealed that DeLone and McLean (1992) model has not been validated within the context of an EMR and its impact on individual nurses and this is addressed by the study. Secondly, a new model integrating DeLone and McLean IS Success model with Bhattacherjee's PAM model is presented, and thirdly, the effect of EMR on enrichment of the nursing job is assessed.

1.3 Structure of the report

Chapter 1 - Introduction

This chapter presented the reader with an introduction to the research topic; EMR usage by healthcare providers and its impact on nursing. In addition, it outlined the aim and importance of the research undertaken.

Chapter 2 – Literature Review

Prior research on EMR usage by healthcare providers and its impact on nursing will be discussed. By describing the contributions and shortcomings of prior research, the chapter will also demonstrate that research being undertaken addresses a research gap. The research model and its associated hypotheses will then be developed.

Chapter 3 – Research Methodology

This chapter will articulate the research methodology adopted and justify the approach. The questionnaire, procedure for data collection, including the sample, and limitations of the study will be discussed.

Chapter 4 –Results Analysis

This chapter will test for validity and reliability of the administered questionnaire and also test the formulated hypotheses through multiple regression analysis. Key insights will be brought to the reader's attention.

Chapter 5 –The Research Findings

The research results will be interpreted in this chapter and the significance of the findings be discussed. Outcomes related to each of the hypotheses tested will also be discussed.

Chapter 6 –Conclusion

A summary of the research report will be provided as well as generating conclusions based on the research findings. Limitations of the study and recommendations for future studies will also be discussed.

CHAPTER 2 Literature Review and Research Model

2.1 Introduction

The initial part of this chapter reviews existing literature on EMR systems and in particular the definition, history, and features of EMRs. The impact of EMR use on the nursing profession including advantages and disadvantage is reviewed next and finally, a conceptual model is developed based on DeLone and McLean's IS Success model and Bhattacherjee's Post Acceptance Model (PAM). The two models are integrated and the relationships between the constructs form the basis of the hypotheses to be tested.

Online academic databases namely, EBSCOhost, ProQuest ABI/INFORM Global, ACM Digital Library, Emerald, PubMed Central and Elsevier Science Direct were used to facilitate access to journal articles. Search strings used included "electronic medical records", "electronic patient records", and "electronic health records". These strings were also used in combination with nurse, nursing, and nurses and at times restricted to article titles only. Papers with high citation counts were used to develop an understanding of key concepts. The reference list of these key papers and subsequent research citing the papers were also selectively reviewed. In addition, the *Journal of the American Medical Informatics Association* was specifically searched for articles addressing EMR. This journal was targeted because it has an impact factor of 4.7; placing it at the top of health informatics journal rankings (Thomas-Reuters, 2011).

2.2 Electronic Medical Records

A medical record is an account of a patient with notes from healthcare providers, detailing their observations and discussions had with a patient. It also includes laboratory tests, radiology reports as well as treatment dispensed. The aim of the medical record is to outline chronologically a sequence of clinical events. The medical record also serves as a base to determine whether a patient received appropriate care (Luo, 2006). An EMR is an electronic version of the paper-based record described above but has the ability to efficiently manage and deliver information required for patient care. This electronic record can include patient demographics, problems, medication, vital signs, past medical history, immunisations, laboratory data, progress notes, and radiology reports (McLean, 2006).

The EMR has the ability to integrate this information to provide a complete record of a patient encounter (see Figure 2-1), In addition, the EMR enhances clinical decision making by incorporating features such as decision support tools, thus providing, quality management, and facilitating outcomes reporting. An EMR can also automate and streamline healthcare providers' workflow resulting in increased efficiencies.

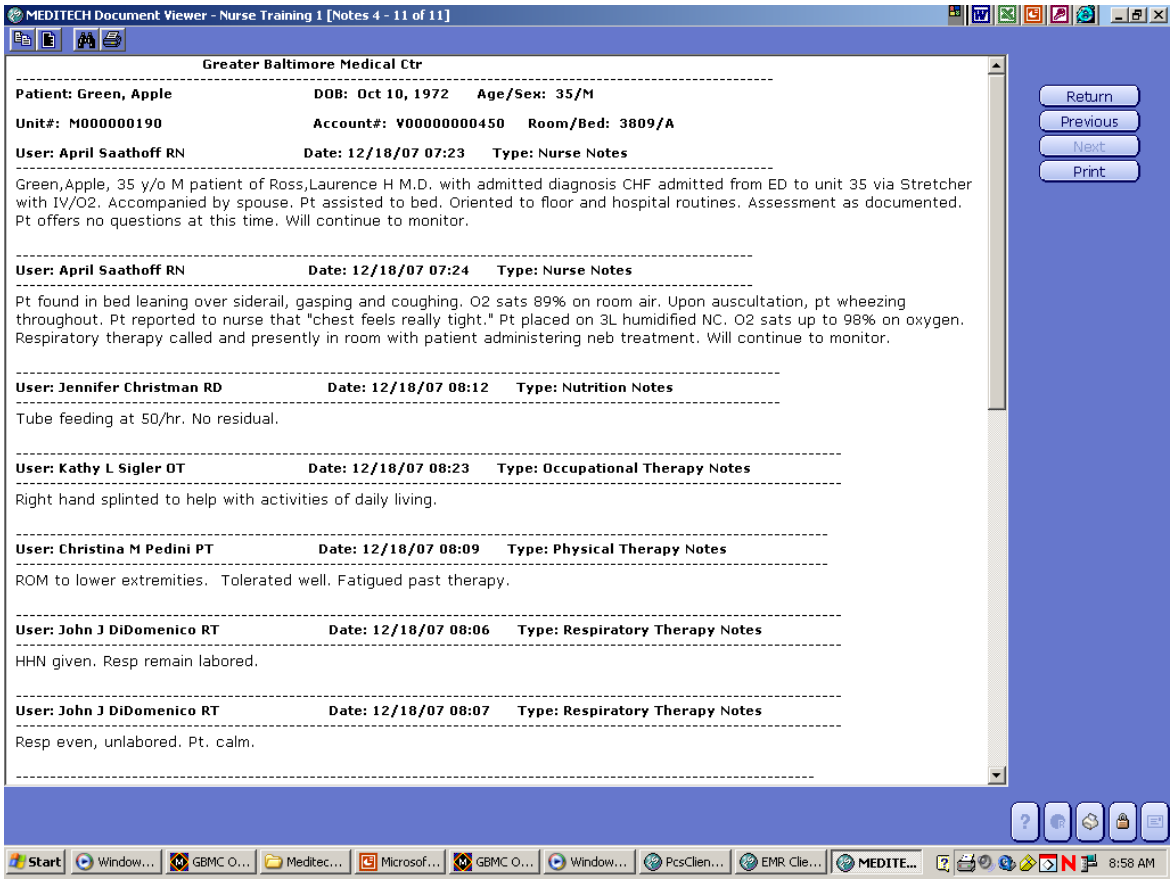

Figure 2-1: Integrated note from an EMR

Source: Meditech EMR Review - Computer Based Tutorial (Meditech, 2006)

The United States National Alliance for Health Information Technology (NAHIT) through broad engagement and extensive review of literature defined an EMR (Morrissey, Horowitz, & Haughom, 2008) as *''an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorised clinicians and staff within one health care organisation.''* An EMR will typically include these features (Thompson, Johnston, & Spurr, 2009):

- electronic clinical documentation capabilities for nurses, doctors and other healthcare providers;
- computerised physician (or provider) order entry (CPOE);
- clinical decision support alerts, reminders, rules, order sets, protocols;
- an integrated electronic patient record, that is linked to administrative, laboratory, radiology and pharmacy systems and data;
- a comprehensive clinical data repository.

NAHIT also sought to reach consensus on the definitions for an Electronic Health Record (EHR) and a Patient Health Record (PHR)[1] to distinguish them from an EMR (Morrissey et al., 2008). An EHR was defined as, *"an electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization"*, while a PHR was defined as *"an electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared, and controlled by the individual."* The main difference between an EMR and an EHR is the latter's ability to access data from more than one healthcare organisation as opposed to an EMR that is limited to one organisation, while a PHR is readily accessible to an individual patient who controls it. This study focusses on the EMR.

2.2.1 History of EMRs

The EMR emerged in the mid to late 1960s and has evolved over four stages (Thompson et al., 2007). The first stage of hospital EMR development began with the work of Lawrence Weed, M.D, which formed the basis for University of Vermont's PROMIS project (Weed, 1968). This resulted in the development of a problem orientated medical record, first used in the Medical Centre Hospital of Vermont in 1970. In addition to the EMR in Medical Centre Hospital of Vermont, researchers at The Mayo Clinic (Mayne,

[1] PHR has also been used as an acronym for Personal Health Record, but the NAHIT definition is used in this report which is an institutional patient record used by health providers

Weksel, & Sholtz, 1968) and Beth Israel Hospital in Boston were also part of the first stage EMR development. By the early 1970s only a few functional hospital EMRs had been developed.

The second stage of EMRs included further development of basic functions such as supplier order entries, automated documentation and decision support capabilities. These were home-grown EMR systems that were highly customised to the organisation's local workflow (Thompson et al., 2007), which were implemented throughout the late 1970s, 1980s and the 1990s. Attempts to generalise and commercialise the use of these systems was unsuccessful, largely due to the high levels of customisation required and technology platform dependency.

The third stage EMR was largely defined by the emergence of commercially viable EMR solutions from vendors such as Cerner, Eclipsys, Epic, IDX, McKesson, Meditech and Siemens (Thompson et al., 2007). These systems were largely based on lessons learned from the academic pioneers involved in stages one and two. Stage three EMRs were not necessarily functionally superior to stage two and complex decision support was not readily available in stage three systems. Thompson et al. (2007) also argue that workflow integration in stage three commercial EMRs was often primitive. However certain organisations were able to customise stage three EMRs to provide a sophisticated decision support capability and integrated workflow specific applications (Raschke et al., 1998). According to Thompson et al. (2007), the fourth stage EMR will be characterised by the broad adoption of commercial EMR systems, increased knowledge of how to use these systems efficiently and the introduction of more sophisticated information processing and delivery capabilities particularly in clinical decision support.

2.2.2 Features of an EMR

Section 2.2 highlighted some EMR features, which are discussed in detail in this section (see Figure 2-2 for a screenshot of EMR functionality)

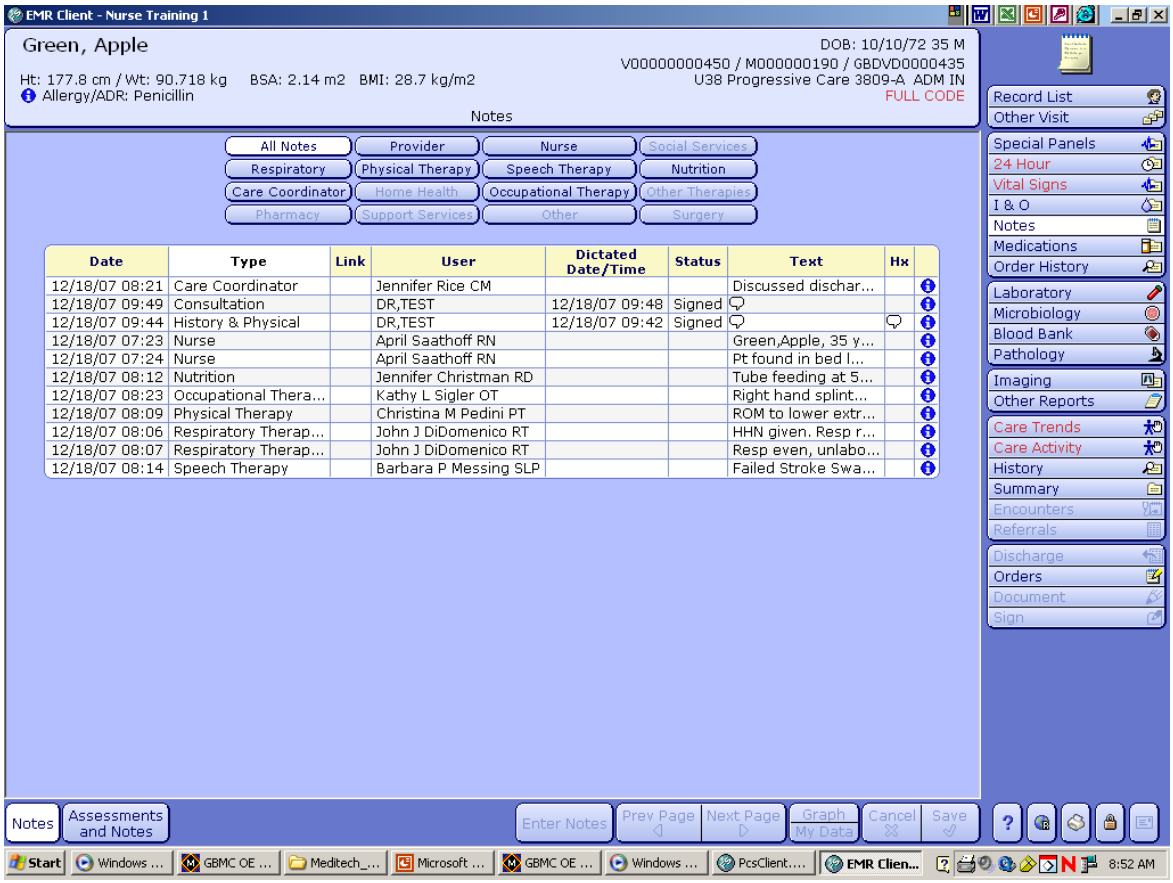

Figure 2-2: Functions of an EMR

Source: Meditech EMR Review - Computer Based Tutorial (Meditech, 2006)

2.2.2.1 Clinical Documentation

EMRs allow for electronic capture of healthcare processes such as clinical notes, patient assessments, diagnosis and treatment (McLean, 2006).

Examples of documentation that can be captured on these systems are:

- Physician, nurse, and other clinician notes;
- Flow sheets (vital signs, input and output, problem lists, MARs);
- Discharge summaries;
- Transcription document management;

- Medical records abstracts;
- Advance directives or living wills;
- Durable powers of attorney for healthcare decisions;
- Consents (procedural);
- Medical record/chart tracking;
- Releases of information (including authorisations).

EMRs are also designed to combine data from other ancillary health systems such as pharmacy, radiology, laboratory, and administration (McLean, 2006).

2.2.2.2 Administrative System

Administrative systems manage patient registration, admission, discharge or transfers. They contain identification and assessment information such as name, demographics, next of kin, main complaints and patient disposition. They have a unique patient identifier that is linked to all aspects of the patient's health care including tests, clinical observations, diagnoses, and treatment procedures (McLean, 2006). This identifier is at times referred to as the medical record number or master patient index (MPI) and is the core of an EMR.

2.2.2.3 Computerised Physician Order Entry

Computerised Physician Order Entry (CPOE) allows healthcare providers to electronically order pharmacy, radiology and laboratory services (McLean, 2006). They offer a range of functionality from ordering capabilities to alerting, customised order sets and test results reporting.

2.2.2.4 Laboratory System

Laboratory information systems are mainly used to integrate orders, results from laboratory equipment, scheduling, billing and other administrative information. The systems are rarely fully integrated with EMRs, but have an interface from which they receive laboratory test orders and to which they submit results (McLean, 2006).

2.2.2.5 Radiology System

Radiology systems contain information pertaining to orders, images, interpretations and patient identification information and at times linked to picture archive and

communication systems (PACS). Radiology systems are interfaced with EMR for order taking purposes and submit results which include interpretations and images (McLean, 2006).

2.2.2.6 Pharmacy System

Pharmacies have well established information systems but they are often standalone systems with interfaces to other systems such as EMRs. Healthcare providers place orders through EMR to the pharmacy which are then processed (McLean, 2006). Alerts are some of the features available on these systems to inform healthcare providers when orders are ready for collection or delivery.

2.2.3 EMR Users

EMR users are different healthcare professionals and administrative staff (Häyrinen, Saranto, & Nykänen, 2008). The healthcare professionals include physicians, nurses, radiologists, pharmacists, and laboratory technicians. Nurses have the key coordinating role (Schmidt and Bannon, 1992) in delivering healthcare to patients and as such, they are predominant users of core EMR functionalities. Therefore, nurses are an attractive target group in EMR studies.

2.3 The Nursing Profession

The nursing practice has evolved due to advances in technology, with nurses being instrumental in making modern, high tech hospitals more hospitable. However, nursing has shifted from creating an environment for patients to heal as defined by Nightingale (1860) to delivering therapies and tending to technologies that monitor patients. (Mason, Isaacs, & Colby, 2011) argue that the worst of a hospital setting loses sight of the patient in the world of modern day medical and technological complexity such as EMRs. The best nursing keeps the patient as the focal point and seeks to integrate various technologies to deliver quality healthcare. In addition, Mason et al also argue that in contemporary terms, the work defined in the nursing practice entails coordination, chronic care management, disease prevention, and health promotion.

Thompson et al. (2009) define nursing tasks in the following way:

- **Direct patient care** – which includes direct contact with a patient, monitoring vital signs, assessing the needs of a patient and medication administration.
- **Indirect patient care** – documentation of care given which includes assessments, medication administration and vital observations, while at the same time co-coordinating care with other healthcare givers.
- **Non-patient care** – accessing equipment, medication and charts, transporting patients and administrative tasks.

The processes around patient healthcare require a significant amount of co-operative activities where nurses, doctors, physiotherapists, dieticians including lab technicians participate (Goorman and Berg, 2001). These activities must be co-ordinated (Schmidt and Bannon, 1992) in order to ensure smooth and effective treatment of patients and nurses are key in co-ordinating these activities (Mason et al., 2011). This coordination role is key in protecting patients from organisational turbulence (Allen, 1997) and keeping a healthcare operation running smoothly (McCloskey, 1995). Therefore, nurses do not only have to be competent practitioners of their own profession but also need to have skills to manage the often turbulent intersection of multiple healthcare professionals providing care to a patient (Goorman and Berg, 2001). In addition, nurses spend a significant amount of time working with documentation pertaining to coordination of care delivery, medication administration admission, discharge and transfer of patients, which also calls for additional skillset of information management.

According to the South African Nursing Council's Scope of Practice (Subedar, 2005), the three categories of nurses are; Professional Nurses, Staff Nurses and Auxiliary Nurses with each category having a defined scope to practice (see Table 2-1).

Table 2-1: South Africa's nursing categories (Subedar, 2005)

Professional (Registered) Nurse	Staff (Enrolled) Nurse	Auxiliary Nurse
The scope of the professional nurse is to provide comprehensive nursing and the primary responsibilities entail: • *The provision of comprehensive nursing treatment and care of persons in all health care settings;* • *Taking responsibility and accountability for the management of nursing care of individuals, groups and communities;* • *Providing emergency care;* • *Ensuring safe implementation of nursing care;* • *Taking responsibility and accountability for the care of persons who have unstable and complicated health conditions;* • *Ensuring that nursing care is only delegated to competent practitioners.*	The scope of the staff nurse is to provide basic nursing care and the primary responsibilities entail: • *The provision of basic nursing care and treatment of persons with stable and uncomplicated health conditions in all settings;* • *Providing basic emergency care;* • *Assessing and developing a plan of nursing care for persons with stable and uncomplicated health conditions;* • *Taking responsibility for the nursing care of persons whose health condition is stable and uncomplicated in a unit of an overall health facility or service;* • *A staff nurse may not take responsibility and accountability for managing overall nursing care in a health facility or service;* • *A staff nurse may provide nursing care and treatment to persons who have complicated health problems or are in an unstable condition under the supervision of a professional nurse.*	The scope of the nursing auxiliary is to provide elementary nursing care and the primary responsibilities entail: • *Providing assistance and support to a person for the activities of daily living and self care;* • *Providing nursing care as prescribed or directed by a professional nurse or staff nurse;* • *Providing nursing care in accordance with a standardised plan of care;* • *Rendering basic first aid.*

2.3.1 Nursing and the use of EMRs

Nursing processes include a complex series of physical and cognitive activities (Potter et al., 2005). Research suggests that 35% of nursing practice time is spent on documentation and 20% on patient care activities (Hendrich, Chow, Skierczynski, & Lu, 2008), while the remaining 45% is spent on medication administration, care co-ordination, and assessment and reading of vital signs. These complexities and chances of errors, including the healthcare coordination role that nurses undertake have served as a motivation for the use of health related technologies to transform nurses work environment (Aspden, Corrigan,

Wolcott, & Erickson, 2004). Health technologies, for example EMRs, have the potential to reduce non-value adding nursing activities and lead to improvement in the quality of healthcare. EMR also has the potential to improve nurses' working conditions leading to higher nurse satisfaction and lower turnover (Bolton, Gassert, & Cipriano, 2008).

Studies show that the role nurses play in a hospital setting and the nature of their tasks has been impacted by the introduction of EMR technologies. In studies by Poissant, Pereira, Tamblyn, & Kawasumi (2005) and Häyrinen et al. (2008), nurses reported using EMR systems for multiple types of patient care documentation including charting, medication administration, treatments, planning for care including admissions and discharges. They also used an EMR to access clinical information such as diagnostic results, notes captured by other healthcare givers, referrals, immunisation, life style, and past history. Shifts and handovers were organised through computerised work lists and medication catalogues. Nurses reported that using an EMR for these activities improved the way they work but they also reported how their performance was hindered. Some of the mixed-ways in which EMR systems impact nurses are (Janols, 2011, Kossman, 2006, Vikkelso, 2005):

- Improved efficiency through improved documentation and ability to access information quickly, communication with different parts of the hospital and automated notification and alerts;
- Better organisation of tasks through computerised work lists, charting, and prompts;
- Decreased time with patients when nurses spend a significant amount of time on computers;
- A tendency to become impersonal while interacting with patients particularly when portable computers are brought to the bedside;
- More flexible decision making as portable devices linked to EMRs allowed for system access at any location.

2.3.2 Existing research on the impact of EMR on the nursing profession

As shown in table 2-2, a number of studies address the impact of EMR systems on the nursing profession. Thompson et al. (2009) reviewed the literature and found that EMRs can save nursing time with proper planning, process improvement planning and focus. Kossman and Scheidenhelm's (2008) study to determine nurses' perceptions of the impact of EMRs on work and patient outcomes revealed that nurses preferred EMRs to paper charts but were concerned that the technology impaired critical thinking, and decreased interdisciplinary communication.

Table 2-2: Prior research on EMRs and nursing

Author (s)	Article Title	Methodology	Approach	Findings
(Goorman and Berg, 2001)	Modelling nursing activities: electronic patient records and their discontents	Qualitative methods. Case study	Drawn on sociological perspectives on healthcare activities	EPRs are not designed according to how physicians and nurses actually practice but how they should practice resulting in dissatisfaction
(Häyrinen et al., 2008)	Definition, structure, content, use and impacts of electronic health records: a review of the research literature	Systematic literature review	A review of 89 previously published papers	In the development of EHRs, nursing information systems and patient's role in producing data for the EHR has not been taken into account
(Hendrich et al., 2008)	A 36-hospital time and motion study: how do medical-surgical nurses spend their time?	Time and motion study	736 nurses from 36 units participated in the research	Documentation, medication administration and care coordination were identified as key to improving the efficiency of nursing care
(Janols, 2011)	The New Clinical Practice: How Nurses and Physicians Experience Electronic Patient Record Systems	Qualitative techniques	Theories on group processes including "Relative deprivation theory"	Both nurses and physicians experienced the same problems with EPR. However nurses felt that documentation had become more visible and could claim importance of their work towards the physicians
(Kossman, 2006)	Perceptions of impact of electronic health records on nurses' work	Quantitative and Qualitative techniques	40 nurses participated in a survey and in-depth interview	Nurses felt that EHR enhanced their work through increased access to information and greater efficiencies. However, they were concerned on the increased documentation time due to slow systems
(Likourezos et al., 2004)	Physician and nurse satisfaction with an electronic medical record system	Quantitative techniques	A survey of emergency department physicians and nurses	Notwithstanding doubts on the benefits of EMR, physicians and nurses still favour its use. Suggestions are made to enhance EMR
(Otieno et al., 2007)	Nurses' views on the use, quality and user satisfaction with electronic medical records: questionnaire development	Quantitative techniques	1666 nurses from 42 hospitals in Japan interviewed	Developed a reliable and validated scale to measure system quality, User satisfaction, and EMR use
(Poissant et al., 2005)	The impact of electronic health records on time efficiency of physicians and nurses: a systematic review	Systematic literature review	23 papers on documentation time of physicians and nurses were reviewed	The goal of reduced documentation time due to EHR is unlikely to be realised. Bedside and central station EHR influences documentation time differently.
(Potter et al., 2005)	Understanding the cognitive work of nursing in the acute care environment	Quantitative and qualitative techniques	Ethnographic study involving 7 nurses	Attention must be given to how care systems and work processes complement or interfere with nurses cognitive work
(Thompson et al., 2009)	The impact of electronic medical records on nursing efficiency	Systematic literature review	23 papers focusing on hospital in patient environment and EMR were reviewed	Achievement of nursing efficiencies with an EMR requires comprehensive understanding of the nursing process and the multidisciplinary and complex nature of patient care.
(Vikkelso, 2005)	Subtle redistribution of work, attention and risks: Electronic patient records and organisational consequences	Qualitative techniques	11 interviews of different categories of healthcare providers	Introduction of EPRs have resulted in redistribution of work, organisational attention and risks

Likourezos et al.'s (2004) study also found that nurses favoured use of EMRs which can improve efficiency, but they expressed concerns that EMRs do not have an impact on patient outcomes. The only study to have used DeLone and McLean IS success model in the context of nurses usage of EMR is Otieno et al. (2007) who developed an instrument to measure nurses perceptions of system quality, EMR use, and user satisfaction. However, they did not address the effect of use and user satisfaction on individual outcomes. These past studies have not addressed nurse perceptions of EMR system and information quality; the resultant impact on their satisfaction and use of these systems; and how this affects their productivity and enrichment of their job as nurses. This study addresses these gaps.

From previous research, EMRs can impact nursing in both positive and negative ways and there is a risk that important nursing outcomes, namely nurse productivity and enrichment of the nursing role could be compromised if the impact of EMR systems is not understood. A conceptual framework to further this understanding is developed in the following section.

2.4 Conceptual Framework and Research Model

The theoretical underpinning for this research is a combination of the DeLone and McLean Information Systems (D&M IS) success model (DeLone and McLean, 1992) and Bhattacherjee's Post Acceptance Model (PAM) of IS Continuance (Bhattacherjee, 2001) as shown in Figures 2-3 and 2-4 respectively.

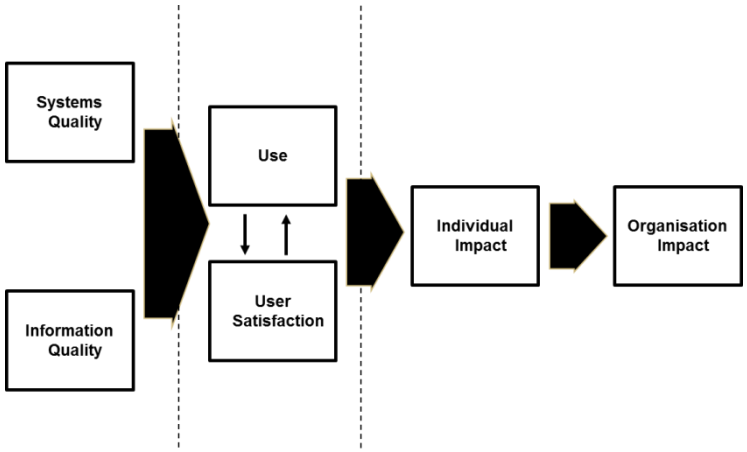

Figure 2-3: DeLone and McLean's IS Success Model

The DeLone and McLean (1992) IS success model proposes that system quality and information quality affect both use and user satisfaction. It further proposes that the extent to which the system is used affects user satisfaction, and vice versa. In the model, the two constructs use and user satisfaction are antecedents to individual impact which in turn has an organisational impact (see Figure 2-3). Having posited the six major dimensions of IS Success, DeLone and McLean (1992) theorised linkages between the dimensions as illustrated by Figure 2-3, based on the information influence theory of Mason (1978) which argues that information flows through a series of stages from its production through its use or consumption to its influence on individual and/or organisational performance.

While the D&M IS success model includes organisational impact, this research study restricts itself to an examination of individual level impacts, namely the extent to which EMR impact nurses' productivity and enrich the nursing job.

In addition, while the D&M IS success model implies a reciprocal relationship, this study focuses only on the flow from satisfaction to use. This is because the study examines users after some period of exposure to the systems has already occurred and attitudinal responses towards the system have thus formed. This study aims to explore whether on-going use and frequency of interactions with the system are determined by these existing attitudinal responses.

Petter, DeLone, & McLean's (2008) qualitative literature review of 180 papers dealing with some aspects of IS success found that in those cases where there was enough data to analyse the relationships, the D&M IS success model is applicable at both individual and organisational levels of analysis. The research also considered different types of IS under different types of conditions and found that there was a sufficient level of support for the model's relationships suggesting that it can be applied in evaluating utilitarian IS such as an EMR.

Bhattacherjee (2001) based his post-acceptance model of IS continuance on expectation-confirmation theory (Oliver, 1980). Bhattacherjee found that user satisfaction is determined mainly by a user's confirmation of the expectations they had of the system and secondarily by their perceptions of the system's usefulness. This confirmation of

expectations leads to user satisfaction, which in turn positively influences more continued usage of the system (see Figure 2-4).

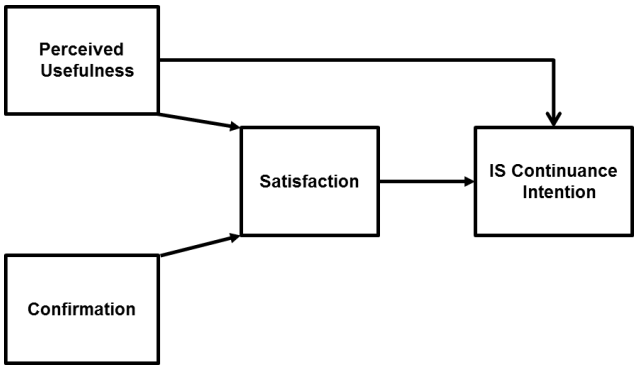

Figure 2-4: Post Acceptance Model of IS Continuance

As evidenced by Figures 2-3 and 2-4, user satisfaction is a common construct to both the PAM and IS Success models. This study therefore integrates the two perspectives. Specifically, confirmation of expectation together with perceived system and information quality are modelled as antecedents to user satisfaction, which in turn leads to increased usage of an information system. This study's integrated research model is illustrated by Figure 2-5.

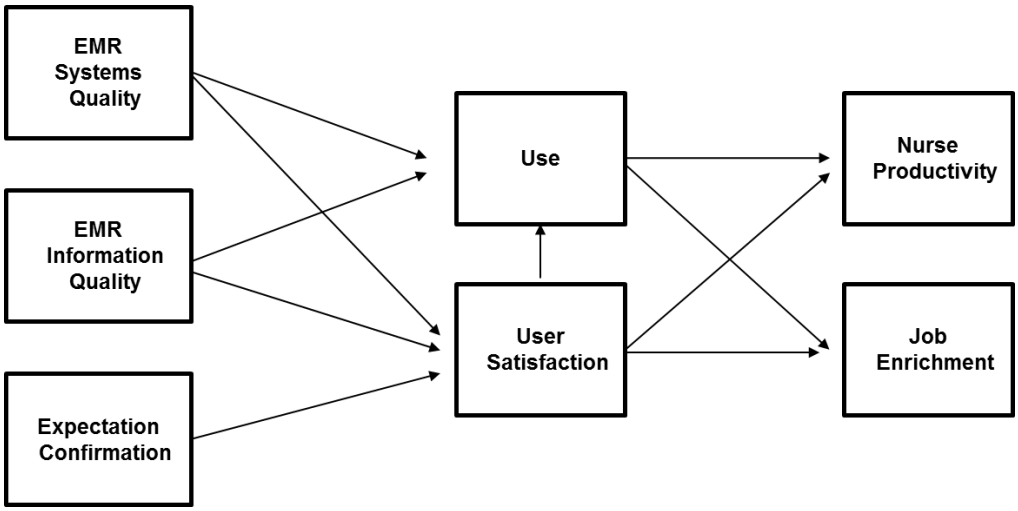

Figure 2-5: Research Model: Integration of IS Success and Expectation-Confirmation Perspectives

The literature used to develop the conceptual framework and the research model is listed on Table 2-3.

Table 2-3: Literature used to develop the conceptual framework and research model

Author (s)	Article Title	Methodology	Approach	Findings
(Bailey and Pearson, 1983)	Development of a tool for measuring and analysing computer user satisfaction	Qualitative	Critical incident interview techniques	Definition of computer user satisfaction was developed and translation of the satisfaction definition into a valid measurement instrument
(Bhattacherjee, 2001)	Understanding information systems continuance: An expectation-confirmation model	Quantitative	Expectation-Confirmation Theory	User satisfaction is determined mainly by a user's confirmation of the expectations they have of a system and their perceptions of the system's usefulness, resulting in more continued usage of a system
(Davis, 1989)	Perceived usefulness, perceived ease of use, and user acceptance of information technology	Quantitative	Longitudinal study of 107 users to predict computer acceptance	Perceived usefulness and ease of use are significantly correlated with system use
(DeLone and McLean, 1992)	Information systems success: the quest for the dependent variable	Systematic literature review	180 articles reviewed to identify the dependent variables within factors that determine IS success	There is not one success measure but many however most of the measures fall into six major categories – *system quality, information quality, use, user satisfaction, individual impact and organisational impact*
(Ein-Dor and Segev, 1978)	Organizational context and the success of management information systems	Systematic literature review	Survey of the scientific, managerial, professional and trade literature	Development of a conceptual framework within which issues of environmental context impacting MIS may be discussed
(Hackman and Oldham, 1980)	Work redesign		Specifies the task conditions under which individuals are predicted to prosper in their work	Proposes ways to redesign work so that it increases the internal motivation of the employees and formulates the Job Characteristics Theory
(Hamilton and Chervany, 1981)	Evaluating information system effectiveness-Part I: Comparing evaluation approaches	Systematic literature review	Examines evaluation of system effectiveness in terms of a conceptual hierarchy of system objectives	Defined system effectiveness and develops and evaluation technique for system effectiveness based on a conceptual hierarchy of system objectives
(Kulik et al., 1987)	Work Design as an Approach to Person-Environment Fit	Systematic literature review	Job Characteristics Theory	Suggest ways in which job characteristics and individual characteristics may influence one another
(Iivari, 2005)	An empirical test of the DeLone-McLean model of information system success	Quantitative	DeLone and McLean IS Success Model	Perceived system quality and perceived information quality are significant predictors of user satisfaction with the system, but not of system use. User satisfaction was found to be a strong predictor of individual impact whereas system use was not
(Oliver, 1980)	A cognitive model of the antecedents and consequences of satisfaction decisions	Quantitative	Expectation Confirmation Theory	Proposed a model in which consumer satisfaction is a function of expectation and expectancy disconfirmation
(Petter et al., 2008)	Measuring information systems success: models, dimensions, measures, and interrelationships	Systematic literature review	DeLone and McLean IS Success Model	In those cases where there was enough data to analyse the relationships, the D&M IS success model is applicable at both individual and organisational levels of analysis

The constructs in the model and hypothesised relationships are discussed next.

2.4.1 EMR Systems Quality

A user's perception of system quality is an antecedent to use and user satisfaction (DeLone and McLean, 1992). Convenience of access to a system such as an EMR, its flexibility, response time, reliability, intuitiveness, ease of use and learning, have been

proposed as measures of system quality (Bailey and Pearson, 1983, Belardo et al., 1982, Srinivasan, 1985, Petter et al., 2008).

Ease of learning and use of a system is fundamental to its technical quality (Davis and Olson, 1985) and design issues such as help facilities, menus, user documentation, screen prompts and support helps a new user become proficient (Burch and Grudnitski, 1989). According to Davis (1989) ease of use is the degree to which using a particular system is free of effort.

System reliability can be measured by how often the system was able to perform its expected function (Weill and Vitale, 1999) which can encompass system response time, uptime, and availability (Alter, 1992).

The extent to which an EMR performs on these measures during chart documentation, care planning, treatments, medical administration, admissions, discharges and also accessing clinical information is an indication of system quality from the perspective of the user.

Therefore, how EMR system quality subsequently impacts on EMR usage by nurses and their satisfaction with EMR will be examined.

2.4.2 EMR Information Quality

Quality of the information that a system generates has been considered by researchers as an antecedent to system use and user satisfaction (DeLone and McLean, 1992). In Bailey and Pearson's (1983) study, some of the key attributes of information quality in descending order of importance were information accuracy, output timeliness, reliability, completeness, relevance, precision, and currency. In addition to these, Otieno et al. (2007) highlighted the importance of information content, clarity, reporting format and usefulness.

Quality of information accessed is critical to healthcare provision. EMR systems provide nurses with access to clinical information such as diagnostic results, notes captured by other healthcare givers, referrals, immunisation, life style, and past history (Kossman and Scheidenhelm, 2008). Shifts are also organised through computerised work lists and

medication catalogues. For nurses to be more effective and ultimately change the way they experience their role, quality of information such as accuracy, reliability and currency is critical in an EMR.

Accuracy is important to healthcare because incorrect information can result in clinical decisions that jeopardise a patient's treatment. It is also important for information to be current to facilitate decisions based on the most recent information regarding a condition. Information also needs to be reliable by being consistent and dependable (Bailey and Pearson, 1983) ensuring it is available when needed and of a standard that allows for quality and timely decision making.

There is evidence that gaining the acceptance of EMR systems by physicians, nurses and other healthcare professionals is often a challenge and the primary reason cited is a general lack of trust in data quality of EMR systems thus exposing a patient's well-being (Orfanidis, Bamidis, & Eaglestone, 2004) to significant risk.

Therefore, the impact of user (nurses) perceptions of information quality on usage and satisfaction with the EMR will be assessed.

2.4.3 Effect of System Quality and Information Quality on EMR User Satisfaction

Satisfaction in the context of job performance was defined by Locke (1969) as "the pleasurable emotional state resulting from the appraisal of one's job as achieving or facilitating the achievement of one's job values". Oliver (1981, p. 29) extended this definition as "the summary psychological state resulting when the emotion surrounding disconfirmed expectations is coupled with the consumer's prior feelings about the consumption experience." Bailey and Pearson (1983) indicate that, satisfaction in a given situation is the sum of one's feelings or attitudes toward a variety of factors affecting that situation. Ives, Olson, & Baroudi (1983) defined user satisfaction as the extent to which users believe the information system available to them meets their information requirements. Otieno et al. (2007) defined user satisfaction as the extent to which nurses believed their EMR system was instrumental in improving their work and attitudinal statements examining work quality improvements and worth of the EMR were used as measures for satisfaction.

According to Chan, Sedera, & Gable (2008), user satisfaction is probably the most used single measure of IS success evaluation (DeLone and McLean, 1992, Doll and Torkzadeh, 1988, Etezadi-Amoli and Farhoomand, 1991, Gatian, 1994, Igbaria and Tan, 1997, Lucas, 1975) and several widely cited studies (Bailey and Pearson, 1983, Baroudi and Orlikowski, 1988, Doll and Torkzadeh, 1988) developed instruments that measure user satisfaction.

Some of the reasons DeLone and McLean (1992) gave as to why user satisfaction is most widely used are:

- It's high degree of face validity and makes a system successful because the users state they like it;
- It is a conceptually strong measure and easy to obtain.

Experience of measures of system quality such as ease of use, reliability and responsiveness (Bailey and Pearson, 1983) result in the positive psychological state of satisfaction as described by Bailey and Pearson (1983), Locke (1969), and Oliver (1981, p. 29) . Based on DeLone and McLean's (1992) argument that a user's perception of system quality is an antecedent to use and user satisfaction, it can be posited that when nurses experience an EMR that is easy to use, reliable, and responsive, they are more likely to perceive satisfaction with the system. Therefore, the following is hypothesised:

Hypothesis 1a: EMR system quality results in greater user satisfaction.

As reported in the previous section, Orfanidis et al. (2004) argue that gaining the acceptance of EMR systems by physicians, nurses and other healthcare professionals is often a challenge and the primary reason cited is a general lack of trust in information quality. It can therefore be put forward that, when nurses experience measures of information quality such as accuracy, clarity, relevance, completeness and currency, it will result in user satisfaction. Therefore, the following is hypothesised:

Hypothesis 1b: EMR information quality results in greater user satisfaction.

2.4.4 Effect of System Quality and Information Quality on EMR Use

In addition to user satisfaction, system use is also a measure of system success, which predicts higher order individual and organisational impacts as highlighted by DeLone and McLean (1992) in 27 empirical studies which they cited. Several IS success frameworks (Lucas, 1973, Hamilton and Chervany, 1981, Ives et al., 1980, Ein-Dor and Segev, 1978) have proposed usage as a measure. Doll and Torkzadeh (1988) argue that usage is dependent on system quality and is a major factor in determining the impact of the technology to users. System use can therefore be both a success measure i.e. a dependant variable, and an antecedent that predicts the downstream impacts of information systems. Klein and Sorra (1996) proposed that use has a continuum that ranged from avoidance of the new system, to partial and reluctant usage, to enthusiastic and committed use. Use is likely to lead to the objectives of a system investment being achieved leading to improved organisational outcomes. Use is an antecedent to achieving overarching organisational goals from IS investment hence a key measure of success.

Based on DeLone and McLean's (1992) argument that a user's perception of system quality is an antecedent to use and user satisfaction, EMR system quality should lead to greater use (i.e. more frequent use) because the ease of use, reliability and responsiveness results in nurses being more likely to want to engage in electronically documenting patient care including, charting, medication administration, treatments, planning for care, and admissions and discharges. Therefore, the following is hypothesised:

Hypothesis 2a: System quality results in more frequent use of an EMR by nurses.

Orfanidis et al. (2004) argument that gaining the acceptance of EMR systems by physicians, nurses and other healthcare professionals is often a challenge and the primary reason cited is a general lack of trust in information quality is also applicable in the context of usage. EMR information quality should also lead to use because content accuracy, clarity, relevance, completeness and currency results in nurses being more willing to use EMR for direction on medication administration, treatments, planning for care including admissions and discharges. Therefore the following is hypothesised:

Hypothesis 2b: Information quality results in more frequent use of an EMR by nurses.

2.4.5 Effect of User Satisfaction on Use

In a study of a medical information system in which use was mandatory, usage was found to be significantly related to user satisfaction (Iivari, 2005). According to Petter et al. (2008), several studies have determined the correlation between system use and user satisfaction. As illustrated by Figure 2-3, there is a reciprocal relationship between system use and user satisfaction. DeLone and McLean (2003) in the enhancement of there IS Success model argued that system use must precede user satisfaction in a process sense, but positive experience with use for example greater user satisfaction will result in more frequent usage behaviour in a causal sense. This increased user satisfaction leads to higher intention to use thereby impacting on usage. Therefore the following is hypothesised:

Hypothesis 3: User satisfaction results in more frequent use of an EMR by nurses.

2.4.6 EMR Expectation Confirmation

Bhattacherjee (2001) study based on Oliver's (1980) expectation-confirmation theory (ECT) found that information systems user satisfaction is determined mainly by users' confirmation of expectations they have of the system during usage. ECT posits that user satisfaction is determined by expectation of the information system and confirmation of that expectation following actual use Bhattacherjee (2001). It is further argued that confirmation is positively related to satisfaction with IS use because it implies benefits expected of the information system have been realised. Wakefield et al. (2007) in their development of a measure of clinical information systems expectations argued that it is important for user expectations of new information systems implementations and their potential impact on work processes be understood and managed to improve chances of success. In a study to determine how well clinical picture, archiving and communication systems (PACS) installations worked, Bauman and Gell (2000) most of the users expectations had been met and would readily recommend PACS to others, an indication that they were satisfied with the system. Therefore, the following is hypothesised:

Hypothesis 4: Confirmation of expectations leads to nurses' satisfaction with EMR.

2.4.7 EMR impact on individual nurses

DeLone and McLean (1992) defined 'individual impact' as the effects of an information system on users in relation to the activity being supported by the system. These effects could include a change of user activity, improved decision-making ability, or transform the role of the user. This research focuses on the effect of EMR on nurse productivity, and also the effect on enriching the nursing role.

2.4.7.1 Nurse Productivity

Productivity, in the context of an IS enabled environment, has been defined as the extent to which an IS application improves the user's output per unit of time (Torkzadeh and Doll, 1999). Braverman, Sweezy & Foster (1974) also argued that organisations automate to improve productivity. Liff (1990) reported in her survey that automation leads to new skills being required of workers leading to greater productivity and more satisfaction (Torkzadeh and Doll, 1999). The potential impact of EMR on nursing efficiency is most evident in reduction of time in activities that are not part of direct patient care (Thompson et al., 2009), such as documentation, information retrieval and coordinating activities. According to Poissant et al. (2005), most of the indirect patient care activities such as documentation can be automated by EMR. Their study reported that nurses using EMRs reported a reduction of 24% of time spent documenting. In successful implementations, nurses have reported that ready access to patient information allows for faster responses to patient needs, clinical decision making and medication administration resulting in improved direct patient care (Kossman and Scheidenhelm, 2008). This usage and satisfaction with the EMR leads to increased productivity of individual nurses. Therefore, the following is hypothesised.

Hypothesis 5a: EMR user satisfaction results in perceived enhancements to nurse productivity.

Hypothesis 5b: Frequent EMR use results in perceived enhancements to nurse productivity.

2.4.7.2 Job Enrichment

EMR has the potential to enrich the nursing job in a positive way to a more meaningful role. The three characteristics of jobs that are especially powerful in influencing the experienced meaningfulness of work (Hackman and Oldham, 1980, Kulik et al., 1987) are *skill variety, task identity,* and *task significance.* Two other characteristics, namely *autonomy,* that leads to experiencing personal responsibility for work outcomes and *job feedback,* which is the degree to which clear information about one's effectiveness is provided also play a role in experiencing meaningfulness of work. In this study, *job feedback* will not be a focus because it is not applicable in this study's context.

Venkatesh, Bala & Sykes (2010) argued that technologies can increase uncertainties in the work place which can result in positive influences on job where employees are forced to develop a variety of skills to handle the new uncertainties. With EMR introduction, records are centrally located thus allowing easy access to records leading to better informed nurses due to information access on their and other healthcare providers' activities. This information increases their knowledge base and enables them to make clinical decisions that are traditionally the preserve of doctors (Poissant et al., 2005). The enhanced knowledge may lead to a nurse assisting physicians during complex medical procedures and the nurse even being authorised to perform some medical activities (Poissant et al., 2005). Thus, the use of the EMR could enrich the nursing role by providing nurses with more decision-making authority thus increasing their autonomy and significance of their role. In addition, by being able to influence the entire patient healthcare process by having an end-to-end view of a patient's record enhances their motivation through increased task identity.

Based on these arguments, the following is hypothesised:

Hypothesis 6a: Satisfaction with an EMR results in an enriched nursing job.

Hypothesis 6b: Frequent use of an EMR results in an enriched nursing job.

2.4.8 Controls

Education level, nursing job level, gender, age, years of service as a nurse, years of working in Addington hospital, and years using the target hospital's EMR will be included in the study as control variables as they may have confounding effects on satisfaction and use. Age and educational level were included because there is a perception that younger and more educated individuals are more receptive to technology (Dutton, Rogers, & Jun, 1987). Morris, Venkatesh & Ackerman (2005) reported that gender differences in technology perceptions became more evident among older workers, but these differences were not apparent in younger workers. In a study by Igbaria, Zinatelli & Cavaye (1998) computer experience was found to be positively correlated with system usage and was included as a control. Years of service as a nurse, years of working in Addington hospital, and nursing job level were included to assess if they have an effect on research outcomes.

2.5 Chapter Summary

This initial part of this chapter reviewed existing literature on EMR systems and in particular the definition, history, and features. The nursing profession within the context of EMR usage and the impact of these technologies on the profession including advantages and disadvantage was also reviewed and a conceptual model based on DeLone and McLean's IS Success model and Bhattacherjee's Post Acceptance Model (PAM) is developed. The relationship between the constructs of the integrated model resulted in the following hypotheses that will be tested by the study.

Hypothesis 1a: EMR system quality results in greater user satisfaction

Hypothesis 1b: EMR information quality results in greater user satisfaction

Hypothesis 2a: System quality results in more frequent use of an EMR by nurses

Hypothesis 2b: Information quality results in more frequent use of an EMR by nurses

Hypothesis 3: User satisfaction results in more frequent use of an EMR by nurses

Hypothesis 4: Confirmation of expectations of the EMR leads to nurses' satisfaction with the system

Hypothesis 5a: EMR user satisfaction results in perceived enhancements to nurse productivity

Hypothesis 5b: Frequent EMR use results in perceived enhancements to nurse productivity

Hypothesis 6a: Satisfaction with an EMR results in an enriched nursing job

Hypothesis 6b: Frequent use of an EMR results in an enriched nursing job

The hypotheses are depicted diagrammatically by Figure 2-6 below.

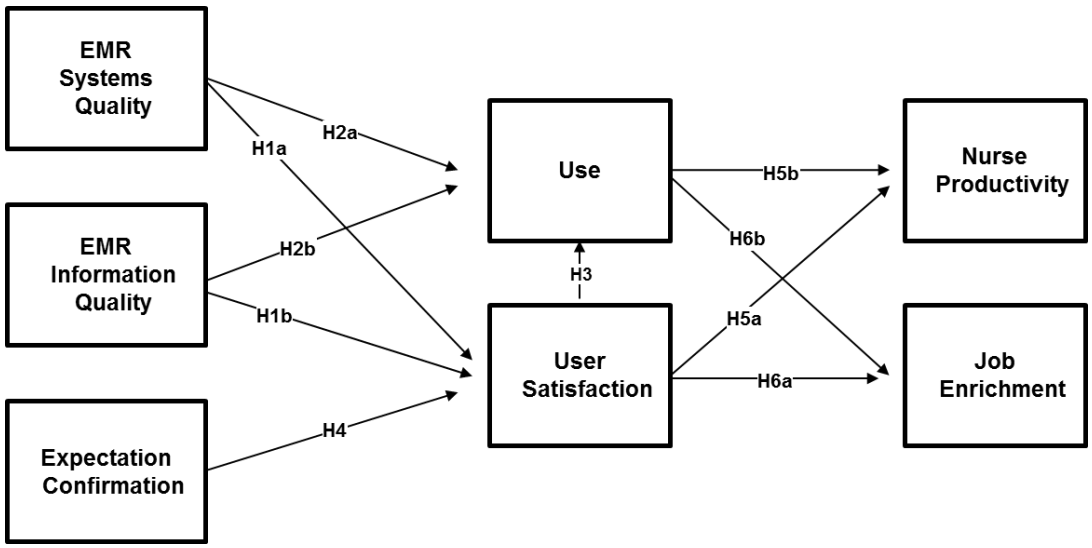

Figure 2-6: Research model including hypotheses

The next chapter of this report articulates the research methods that were used to test the hypotheses.

CHAPTER 3 Research Design

The previous chapter reviewed existing literature on EMR, nurses and their role and usage of EMR and development of a research model that forms the basis for the hypotheses to be tested. The initial part of this chapter examines research methodologies used in information systems research. In addition, the chapter discusses the quantitative approach that was followed by this research, and the research instrument, which is a structured questionnaire. The target hospital and its EMR are then described followed by the sampling approach and procedure for data collection. The final part of the chapter discusses ethical considerations and the approach to hypotheses testing.

3.1 Research methodology

A research methodology is defined as "the general approach the researcher takes in carrying out the research project" (Leedy and Ormrod, 2005). The three broad research methods that have dominated recent social research are quantitative, qualitative and participatory action paradigms. The quantitative approach has been widely linked to positivism. The qualitative approach to interpretivism, and participatory action research to critical studies (Mouton and Babbie, 2001, Orlikowski and Baroudi, 1991). The two common (Orlikowski and Baroudi, 1991) approaches (quantitative and qualitative) in information systems research are discussed further.

Quantitative studies primarily test theory to increase predictive understanding of a phenomenon. The studies usually have formal propositions, quantifiable measures of variables, hypothesis testing and inferring from the sample to a stated population (Orlikowski and Baroudi, 1991). This practice of research emphasises a search for universal laws, quantification in measurement, and objectivity (Mouton and Babbie, 2001). Data collection methods include surveys and experiments and the emphasis is on deductive analytical techniques.

Qualitative studies seek to describe and understand as opposed to explaining and predicting. The emphasis is on methods of observation that stay close to the research subject such as unstructured interviews or participant observation (Mouton and Babbie,

2001). In the analysis on qualitative data, the emphasis is on inductive analytical strategies such as grounded theory.

According to Orlikowski and Baroudi (1991), the quantitative approach is the most dominant in information systems research. Urbach, Smolnik & Riemp (2008) study also established that the majority of studies using the D&M IS Success model adopt a quantitative approach using survey methods where questionnaires are administered. Therefore, a quantification approach is considered useful and appropriate in testing the research model presented in the second chapter.

Survey methods are ideal for acquiring data from a large number of respondents, particularly with limited resources. A survey draws a sample of subjects from a population and studies them to make inferences about the population (Hussey and Hussey, 1997). If a sample is representative, statistical techniques can be used to demonstrate that characteristics found in the sample are also found in the population. Responses to survey questions can be obtained face-to-face, through telephonic interviews or questionnaires. As far as possible participants will be asked the same questions in the same circumstances. The two major types of surveys are descriptive and analytical (Hussey and Hussey, 1997). Descriptive surveys are concerned with identifying and counting variable frequencies in a population. Analytical surveys determine existence of relationships between constructs (variables).

According to Lærum and Faxvaag (2004), analytical survey methods using self-administered questionnaires are frequently used as a quantitative evaluation method in medical informatics. This study will adopt this quantitative, survey-based approach. Responses from the individual nurses will be used on each of the research model's constructs. Thereafter, statistical analysis will be used to test the hypotheses. This will be achieved by examining the relationships between the dependent and independent variables of the research model.

3.2 Data Collection

3.2.1 Research Instrument

All constructs will be measured using multi-item scales ,previously validated and tested for reliability. Only the nursing job enrichment scale is being developed specifically for this study by drawing on existing conceptual definitions and whose validity and reliability will need to be determined during the research. The term EMR will be substituted for Computerised Medical System, the name used by Addington hospital staff.

A seven point Likert-type scale will be used where 1 is *strongly disagree* and 7 is *strongly agree.*

3.2.1.1 Measuring System Quality

Chan et al. (2008) developed an IS impact measurement model but did not assess it for reliability. It will be adapted for this study to measure system quality and information quality.

- The Computerised Medical System is easy to use;
- The Computerised Medical System is easy to learn;
- It is often difficult to get access to the Computerised Medical System;
- Patient records in the Computerised Medical System are always complete;
- The Computerised Medical System is always up and running;
- The Computerised Medical System responds quickly enough;
- Patient records in the Computerised Medical System are never missing;
- Patient records in the Computerised Medical System are always correct;
- The Computerised Medical System includes features and functions necessary for my work.

3.2.1.2 Measuring Information Quality

- The information outputs I get from the Computerised Medical System are relevant to me in my work;
- Information output from the Computerised Medical System is always available to me when I need it;

- Information that I need from the Computerised Medical System is always provided to me in time;
- Information output from the Computerised Medical System is detailed enough;
- Information output from the Computerised Medical System is easy to understand;
- Information output from the Computerised Medical System is easy to read;
- Information from the Computerised Medical System is in a form that is readily usable for my work.

3.2.1.3 Measuring Expectation Confirmation

Bhattacherjee (2001) scale to measure expectation confirmation will be adopted for this study. In Bhattacherjee, the reliability of the scale was good with a Cronbach Alpha of 0.82.

- My experience using the Computerised Medical System is better than what I expected;
- The service level provided by the Computerised Medical System is better than what I expected.

3.2.1.4 Measuring Use

Otieno et al.'s (2007) instrument will be adapted to measure nurse's Use of EMR and user satisfaction. In Otieno et al., use of EMR scale had an acceptable reliability with a Cronbach Alpha of 0.88 and user satisfaction had a Cronbach Alpha of 0.9. The two scales will be adapted for this study.

- Write nursing care plans;
- Enter daily nursing care notes;
- Write nurse care worksheets (Kardex);
- Capture patient observations at the bedside;
- Document physical assessment of patients;
- Document treatment of patients;
- Capture patient discharge information;
- Review the patient's problems;
- Determine patient location in hospital;

- Order test and investigations;
- Obtain the results from tests or investigations;
- Obtain patient personal information.

3.2.1.5 Measuring User Satisfaction

- I am very satisfied with the Computerised Medical System;
- I am very pleased with the Computerised Medical System;
- I am very frustrated with the Computerised Medical System;
- I enjoy using the Computerised Medical System;
- My experience with the Computerised Medical System is favourable;
- I have a positive attitude toward the Computerised Medical System;
- The Computerised Medical System is beneficial;
- Having this Computerised Medical System at Addington Hospital is a good thing;
- Support provided to users of the Computerised Medical System is sufficient;
- I have been provided with the help I need to use the Computerised Medical System;
- Training on the use of the Computerised Medical System is sufficient;
- There is always someone to turn to if we need help with the Computerised Medical System.

3.2.1.6 Measuring impact on Nurse Productivity

Impact of nurse productivity is measured using an adapted scale developed by Torkzadeh and Doll (1999) to measure task productivity in a number of information systems contexts. In past studies, scale reliability has been high and ranged between 0.89 and 0.95 dependending on the context.

- The Computerised Medical System increases my productivity;
- The Computerised Medical System makes my job easier;
- The Computerised Medical System reduces my workload;
- The Computerised Medical System saves me time;
- The Computerised Medical System allows me to accomplish more work than would otherwise be possible;

- The Computerised Medical System enables me to spend more time on productive activities.

3.2.1.7 Measuring Job Enrichment

According to Hackman and Oldham (1980) the three characteristics of jobs that are especially powerful in influencing the experienced meaningfulness of work are skill variety, task identity, and task significance. The characteristic that leads to experiencing personal responsibility for work outcomes is autonomy. From their conceptual discussions, a new measurement scale employing the following items has been developed.

- *Skill variety:* Using Computerised Medical System has created new nursing activities for me;
- *Task significance:* Using Computerised Medical System has made me make clinical decisions normally made by doctors;
- *Task identity:* Using the Computerised Medical System has increased the time I have direct contact with patients;
- *Skill variety:* Using Computerised Medical System has made me develop new skills I did not have before;
- *Task significance:* Using the Computerised Medical System has made my job more important;
- *Task identity:* Using the Computerised Medical System helps me to see how my work contributes to patient outcomes;
- *Skill variety:* Using the Computerised Medical System allows me to apply more of my skills and talents in my job;
- *Autonomy:* Using the Computerised Medical System gives me the chance to be more independent in carrying out my work;
- *Task significance:* Using the Computerised Medical System helps me to have good work relations with the doctors;
- *Task identity:* Using the Computerised Medical Record has helped me be of better service to others.

Table 3-1: Research instrument constructs

Construct	Number of Items	Literature	Type of Variable
System Quality	9	Chan et al. (2008)	Independent
Information Quality	7	Chan et al. (2008)	Independent
Expectation Confirmation	2	Bhattacherjee (2001)	Independent
Use	12	Otieno et al. (2007)	Dependent / Independent
User Satisfaction	12	Otieno et al. (2007)	Dependent / Independent
Nurse Productivity	6	Torkzadeh and Doll (1999)	Dependent
Job Enrichment	10	Hackman and Oldham (1980)	Dependent

3.2.2 Sampling

Sampling makes it possible for a survey to produce generalisable findings without having to collect data from the entire survey population thus saving significant resources. Purposive sampling, which is a non-probability sampling approach, was adopted in the research. In purposive sampling, the researcher decides what needs to be known and sets out to find participants who can and are willing to provide the information by virtue of knowledge or experience (Bernhard, 2002, Lewis and Sheppard, 2006). Multiple EMR research focusing on patients' experience with EMR, quality of data, and implementation (Halford, et al., 2010; Nemeth, Feifer, Stuart, & Ornstein, 2008; Ralston, Revere, Robins, & Goldberg, 2004; Thiru, Hassey, & Sullivan, 2003) have adopted this sampling technique.

In this survey, purposive sampling was used. Nurses using the EMR at the target hospital who were available when data was collected, were included in the study cohort

3.2.3 Target Hospital

The target hospital is Addington Hospital in South Beach, Durban in Kwa Zulu Natal (KZN). This is a district and regional public hospital with 504 beds and staffed by 2500 personnel. Services offered at the hospital include obstetrics and gynaecology, paediatrics,

general surgery, orthopaedics, coronary care, radiotherapy, oncology, ear nose and throat (ENT), and general medicine. The hospital caters for inpatients and outpatients. The hospital also serves as a referral hospital for the region.

3.2.3.1 Addington's EMR System

Addington hospital implemented an EMR system developed by Meditech 1989 (Meditech, 2012). In September 2011, an upgrade to Meditech version 6.0, a Windows based client server system, was implemented. The system has various clinical, administrative, ancillary and financial modules. Nurses have the option of using the clinical and administrative modules in the following way:

- Monitor bed availability, transferring patients to other sections of the hospital including the mortuary, admissions, discharges, and marking beds for cleaning;
- Capture clinical data including height, weight, allergies, diagnosis and medication being administered;
- Order laboratory tests, medication, patient meals, imaging and therapeutic services;
- Capture the matron report, a handover report detailing key issues that occurred during the shift pertaining to the ward and patients.

3.2.4 Procedure for Data Collection

The researcher become aware that Addington hospital in Durban has an EMR through KZN department of health officials. Permission to conduct this study was obtained from both the KZN department of health and the Addington hospital chief executive officer (CEO) (see appendix D and E).

Prior to administering the questionnaire, the nursing manager was informed of the research. Suitable dates were agreed upon to administer the questionnaires (see appendix F). The nursing staff were informed of the study by e-mail and their participation was encouraged by their manager.

Data collection commenced on 14th September 2012 and was completed on the 18th September 2012. The questionnaires were not self-completed, but rather completed in an interview style. The questions and response options were posed to the nurses and their

responses were recorded. All interviews were conducted between 8h00 and 16h00. Nurses who use the EMR were approached by the researcher or his assistants in their respective wards. Each nurse was given the authorisation letter and the participant information sheet for informed consent to be given. Respondents were also allowed to provide any additional qualitative comments. These comments were not however used for purposes of this study, which is focussed only on testing the hypothesized research model. Once all consenting nurses in a specific ward were interviewed, the next available ward was targeted. As a result of this procedure, 172 responses become available.

3.3 Ethical Considerations

Ethics clearance was obtained prior to data collection. The data collection protocol ensured that participation was voluntary. All responses remained anonymous, and respondents could withdraw at any time. Moreover, respondents were informed that all data collected would not be disclosed at an individual level, rather and aggregated view of the results would be reported. The ethics clearance certificate protocol number CINFO/1038 was issued on 31st Aug 2012 by the School of Economics and Business Sciences ethics committee (see appendix C).

3.4 Data Analysis

3.4.1 Reliability and Validity

Data collected was screened for missing values and only completed responses were used. Except for the job enrichment scale that was developed based on literature review, all other instruments adopted validated scales from prior published works with only minor adaptions.

However due to those minor and the development of a new scale, job enrichment; the constructs of the research model were assessed for validity and reliability. Validity is the degree to which a measure accurately represents what it is supposed to (Hair, Black, Babin & Anderson, 2010). Reliability is the extent to which a variable or set of variables is consistent with what it is supposed to measure. This study applied face, content and construct validity tests and also convergent and discriminant validity tests. Reliability is assessed by Cronbach's alpha coefficient.

3.4.1.1 Validity

Hair et al. (2010) state that content validity is an organised review of the research instrument. They also state that it is an assessment of correspondence between items selected to constitute a specific scale. Construct validity should be done by subject matter experts. This separates construct validity from face validity. A review of the research instrument was carried out by a visiting professor from the University of South Florida, Tampa and a professor from the University of the Witwatersrand, IS Division, Johannesburg. Their suggestions were adopted. The two professors are experts in the field of information systems and have published multiple papers.

Face validity refers to whether an item appears to be a reasonable measure of its underlying construct "on its face" (Bhattacherjee, 2012). In this study, face validity was assured by discussing the questionnaire with a senior nurse who was responsible for EMR training. The nursing manager confirmed the relevance of the items in the questionnaire and suggested changes to increase clarity.

Construct validity is based on logical relationships amongst variables (Mouton and Babbie, 2001) and allows items that are highly correlated with each other to form a component or factor. An exploratory factor analysis using principal components as the means of extraction and Varimax as the method of orthogonal rotation can help define the underlying structure among variables in the analysis. Factor analysis provides the tools for analysing correlations among a large number of items and by defining sets of items (factors) that are highly correlated (Hair et al., 2010), while orthogonal rotation is to simplify the rows and columns of a factor matrix to facilitate interpretation. The Varimax orthogonal rotational method has proved successful as an analytic approach to obtaining a rotation of factors (Hair et al., 2010).

Convergent analysis reveals if a relationship exists between measures that should have relationships (John and Benet-Martinez, 2000). Discriminant analysis determines if unrelated measures are indeed unrelated (John and Benet-Martinez, 2000). These were assessed by reviewing the factor loadings from the principal component factor analysis. Questionnaire items that were expected to load on their respective factors did so thus

determining convergent validity and those that were not expected did not thus determining discriminant validity.

3.4.1.2 Reliability

One of the most popular reliability statistics in use today is Cronbach's alpha coefficient. It is used to determine the internal consistency or average correlation of items in a survey instrument. This then determines the reliability of the survey (Santos, 1999). Cronbach alpha coefficient ranges in value from 0 to 1. The closer the score is to 1 the more reliable the scale is. Nunnally (1978) indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used. All constructs will be examined to ensure evidence of acceptable scale reliability.

3.4.2 Hypothesis testing

Hypothesis testing will be through multiple regression. If the beta co-efficient is statistically significant at the $P < 0.05$ or better, the hypotheses are confirmed. The following regression tests[2] will be run to test the hypotheses:

$US = f^{3}\ IQ + SQ$
$US = f\ EC$
$US = f\ IQ + SQ + EC$
$US = f\ NP$
$US = f\ JE$

Other relationships will be tested by the following regression tests[4]:

$NP = f\ US + IQ + SQ + EC$

$JE = f\ US + IQ + SQ + EC + NP$

[2] EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

[3] *f represents "a function of"*

[4] EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

3.5 Limitations of the study

A number of limitations associated with the methodology for the study should be noted. First, the sampling approach will result in findings based on nurses working in one hospital with a specific EMR in place. These results may therefore not be generalisable to all nurses and all EMR implementations. Moreover, additional sampling bias results because only nurses working on specific day shifts will be interviewed. Second, the data collected is via a cross-sectional survey. Thus temporal precedence cannot be established by the research design and causality cannot therefore be inferred.

Third, surveys are subject to methods biases including for example a social desirability response bias. For example, nurses may report greater satisfaction than actually experienced.

3.6 Chapter Summary

This chapter examines research methodologies used in information systems research. Furthermore it discusses the quantitative, survey-based approach that was followed in this research. The target hospital and the EMR used are introduced. The instrument measures are defined. The sampling approach and procedure followed for data collection are also described. The final part of the chapter discusses ethical considerations and the approach to hypothesis testing.

The next chapter analyses the data collected and presents the results of the study.

CHAPTER 4 RESULTS

The previous chapter discussed the research methodology and approach used for data collection and analysis. This chapter presents the results of this study. The collected data is prepared for analysis by screening out missing values and outliers, and where necessary, questionnaire items are reverse scored. The respondent profile is then presented followed by reliability and validity tests. A revised research model is also presented due to dropping of items associated with one of the model's construct. The final section tests the hypotheses using correlations and linear regression analysis to assess the effect of the independent variables on the dependent variables.

4.1 Data screening, missing value and outliers

Following the data collection strategy as attested in the previous chapter, 172 questionnaires were obtained from the sampled nursing staff. To prepare the data for analysis, data was first checked for missing values, examined for outliers, and two of the questionnaire items reverse scored.

4.1.1 Missing values

The most direct means of assessing the extent of missing data is determining the number of missing questionnaire responses for each case, and the number of missing case responses for each questionnaire item (Hair et al., 2010).

4.1.1.1 Questionnaire items with missing data

Table 4-1 shows that 18 questionnaire items (27%) had no missing cases, 38 (58%) have one to three missing cases and 10 (15%) have four to seven missing cases. Since no questionnaire item are missing from more than 5% of the cases, none are eliminated.

Table 4-1: Questionnaire items with missing data

Item	Missing Cases	Item	Missing Cases	Item	Missing Cases
Total number of years working as a nurse	0	Q 15	3	Q 37	2
Years working at Addington Hospital	0	Q 16	1	Q 38	4
Education	0	Q 17	0	Q 39	1
Job Level	1	Q 18	0	Q 40	1
Hospital Unit	0	Q 19	0	Q 41	2
Gender	2	Q 20	0	Q 42	1
Age	1	Q 21	3	Q 43	3
Years using Addington's System	2	Q 22	1	Q 44	3
Q 1	0	Q 23	0	Q 45	3
Q 2	0	Q 24	2	Q 46	4
Q 3	1	Q 25	0	Q 47	3
Q 4	7	Q 26	0	Q 48	3
Q 5	0	Q 27	0	Q 49	3
Q 6	2	Q 28	3	Q 50	3
Q 7	5	Q 29	1	Q 51	5
Q 8	3	Q 30	2	Q 52	3
Q 9	2	Q 31	3	Q 53	6
Q 10	0	Q 32	2	Q 54	5
Q 11	0	Q 33	1	Q 55	3
Q 12	1	Q 34	1	Q 56	5
Q 13	2	Q 35	4	Q 57	3
Q 14	0	Q 36	1	Q 58	4

4.1.1.2 Cases with missing data

Table 4-2 shows that 115 (67%) non of the cases has missing item responses. Thirty eight (22%) have one missing item, and 12 (7%) have two missing items. Seven cases are missing three or more item responses. Hair et al. (2010) suggested a rule of thumb in which cases missing 10% of required data may be retained and cases missing 15% or more of the data are candidates for deletion. Cases 2, 71 and 134 which are missing 31%, 27% and 27% of item responses have been deleted and not are not used for further analysis.

Table 4-2: Cases with missing data

Case	Missing Data	Case	Missing Data	Case	Missing Data	Case	Missing Data
1	1	44	0	87	0	130	1
2	18	45	0	88	0	131	1
3	1	46	2	89	0	132	0
4	0	47	0	90	0	133	0
5	0	48	0	91	0	134	16
6	0	49	0	92	0	135	0
7	0	50	0	93	0	136	0
8	0	51	1	94	0	137	0
9	0	52	0	95	0	138	0
10	1	53	1	96	2	139	1
11	0	54	0	97	1	140	2
12	0	55	1	98	5	141	0
13	1	56	0	99	0	142	0
14	0	57	1	100	1	143	0
15	0	58	0	101	1	144	0
16	0	59	0	102	1	145	0
17	1	60	0	103	1	146	0
18	4	61	1	104	0	147	2
19	0	62	0	105	0	148	3
20	0	63	2	106	0	149	1
21	0	64	0	107	0	150	1
22	0	65	0	108	2	151	2
23	0	66	0	109	1	152	1
24	0	67	0	110	0	153	0
25	0	68	0	111	0	154	0
26	0	69	0	112	1	155	0
27	1	70	1	113	0	156	0
28	1	71	16	114	0	157	1
29	1	72	1	115	0	158	2
30	1	73	0	116	0	159	0
31	3	74	1	117	0	160	0
32	0	75	2	118	0	161	0
33	1	76	0	119	1	162	0
34	1	77	0	120	2	163	0
35	0	78	0	121	1	164	0
36	0	79	1	122	0	165	0
37	0	80	1	123	0	166	0
38	0	81	0	124	0	167	1
39	0	82	0	125	0	168	0
40	0	83	0	126	0	169	2
41	2	84	0	127	0	170	0
42	0	85	0	128	0	171	0
43	0	86	0	129	0	172	0

The remaining cases are assumed to have data missing at random and an imputation approach has been applied in which the series mean is calculated and is used as a substitute for the missing information. Mean substitution is one of the most widely used methods and the rational for this approach is that mean is the best single replacement value (Hair et al., 2010). However, missing demographic data is not replaced in any of the cases.

4.1.2 Reverse scoring

This is the process of reversing the scores of an item phrased in the negative while retaining its distribution characteristics (Hair et al., 2010), to align their correlations with other items measuring the same variable. Two items listed below are reverse scored:

- Questionnaire item 3 - It is often difficult to get access to the Computerised Medical System
- Questionnaire item 4 - I am very frustrated with the Computerised Medical System

4.1.3 Outliers

According to Hair et al. (2010) outliers are observations with characteristics identifiable as distinctly different from the other observations. Univariate outlier detection will be sed to examine the distribution of observations for each item and select as outliers those cases at the outer ranges of the distribution. For sample sizes larger than 80, the threshold value of standardised score is 4.0 (Hair et al., 2010). This study has a sample size of 169 thus this threshold is adopted.

Eleven cases have standard scores above 4 for a number of their responses and were excluded in further analyses. The final sample used is 158 cases.

4.2 Respondent Profile

Eighty nine percent of the respondents have a diploma in nursing. Ninety five percent of the respondents are registered nurses as shown in Table 4-3. To be registered as a nurse, a diploma in nursing or other higher tertiary qualification is a key requirement, and 90% of the respondents have this profile. It was by exception that enrolled or auxiliary nurses are allowed to use the EMR.

Nearly ninty two percent (91.8%) of the respondents are female. This is not surprising given that nursing has been stereotyped as female dominated profession (McLaughlin, Muldoon & Moutray, 2010) since the time of Florence Nightingale. Loughrey (2008) argues that males tend to avoid careers such as nursing due to this stereotypical association with females.

The average age of the nurses is 38 years [give the range]. Fourty four percent of nurses are between the ages of 31 and 40 years, while nurses in the age categories of 23 to 30 and

41 to 50 constitute 22% and 25% of total respondents respectively. Only 8% of nurses are above the age of 50.

Table 4-3: Respondent Profile

Education Level	Number	%
Diploma in Nursing	140	88.6%
Higher Certificate in Nursing	11	7.0%
Bachelors in Degree in Nursing	5	3.2%
Postgraduate Degree	2	1.3%
Total	158	100.0%

Job Level	Number	%
Registered Nurse	150	94.9%
Enrolled Nurse/Staff Nurse	5	3.2%
Auxiliary Nurse/Nursing Assistant	3	1.9%
Grand Total	158	100.0%

Gender	Number	%
Female	145	91.8%
Male	12	7.6%
Missing data	1	0.6%
Total	158	100.0%

Age	Number	%
23 to 30	35	22.2%
31 to 40	69	43.7%
41 to 50	40	25.3%
51 to 59	13	8.2%
Missing data	1	0.6%
Total	158	100.0%

Years practising as a nurse	Number	%
0 to 5	17	10.2%
6 to 10	57	32.8%
11 to 20	58	36.5%
21 to 30	22	16.2%
31 to 40	4	4.2%
Total	158	100.0%

Years in Addington Hospital	Number	%
0 to 5	36	22.8%
6 to 10	55	34.8%
11 to 20	51	32.3%
21 to 30	15	9.5%
31 to 38	1	0.6%
Total	158	100.0%

Years using Addington's EMR	Number	%
0 to 5	51	32.3%
6 to 10	57	36.1%
11 to 20	43	27.2%
21 to 30	5	3.2%
Missing data	2	1.3%
Total	158	100.0%

The average experience of the nurses is 14 years with 73% of the nurses having practiced the nursing profession between 6 to 20 years. A significant number of nurses (17%) have experience that exceeds 20 years.

The respondents have worked for an average of 11 years at Addington hospital, with 67% of the nurses working for a period ranging between 6 to 20 years, and only 23% for less than 6 years.

Sixty three percent of the nurses have 6 to 20 years of experience in using Addington's EMR with the average experience being 9 years. This experience spans the use of the

older system MediTech MAGIC originally implemented in 1989 [5] and MediTech Client Server 6.0 system which was implemented in September 2011.

4.3 Validity and Reliability

Due to the adaptations made to previously validated scales and the development of a new scale, Job Enrichment, the constructs of the research model will be assessed for validity through principal components factor analysis (PCFA) and for reliability using Cronbach's alpha coefficient.

4.3.1 Principal Component Factor Analysis

An exploratory factor analysis was conducted using principal components as the means of extraction and Varimax as the method of orthogonal rotation.

Prior to conducting the principal components analysis, a correlation matrix of all 58 questionnaire items Q1 to Q58 (see questionnaire in appendix A) was examined to assess if they were suitable for factor analysis. Two items Q3, Q33 had all their correlations below 0.3 and were excluded from the analysis. Questionnaire items Q34, Q36, Q37, Q38, Q39, Q40, Q41, and Q42 were also removed as they were not incorporated into the instrument to measure variables in the research model but were included for purposes of a broader study into respondents' overall attitudes toward the EMR and perceptions of support they are receiving.

All items in the use construct (Q17 to Q28) were also removed because it became clear over the course of the data collection process that usage of Addington's EMR is mandatory. This was observable because of the lack of variation and skewed responses to most of the usage questions. Based on the responses to the use construct (see Table 4-4), the three most used functions in descending order were obtaining results from tests or investigations, Obtain patient personal information (95% of users), and reviewing the patient's problems (95% of users), and Order tests and investigations (94% of users).

[5] Meditech 30 Years : 30 Stories available at http://www.meditech.co.za/stories/

Table 4-4: EMR Feature Usage

Questionnaire Item	Never Use	Sometimes Use	Frequent Use	Always Use
Obtain the results from tests or investigations	0%	1%	4%	95%
Obtain patient personal information	0%	0%	5%	95%
Order tests and investigations	0%	0%	6%	94%
Determine patient location in hospital	3%	2%	8%	88%
Capture patient discharge information	15%	1%	7%	77%
Review the patient's problems	15%	3%	6%	76%
Document treatment of patients	22%	4%	9%	65%
Document physical assessment of patients	41%	1%	8%	51%
Capture patient observations at the bedside	66%	3%	8%	23%
Write nurse care worksheets (Kardex)	82%	4%	1%	12%
Enter daily nursing care notes	87%	1%	1%	11%
Write nursing care plans	89%	2%	2%	7%

As a result of dropping the use construct questionnaire items, Hypotheses 2a, 2b, 3, 5b, and 6b have been dropped and the new research model is illustrated by Figure 4-1.

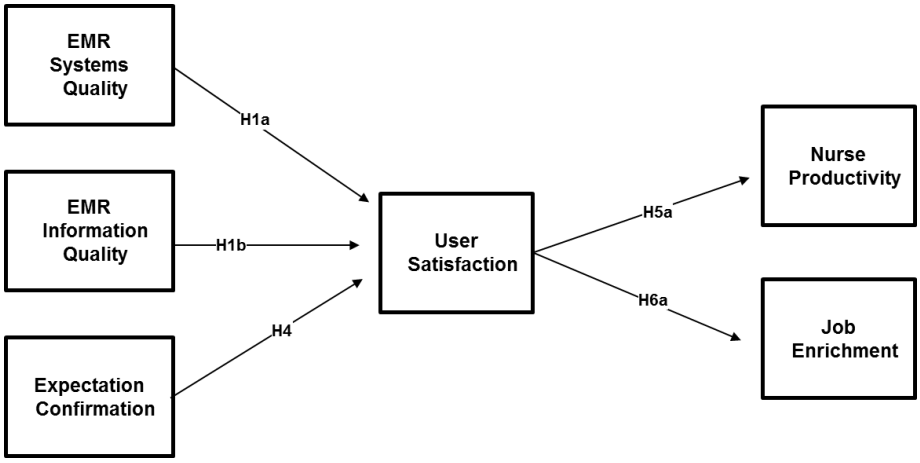

Figure 4-1: Revised research model

PCFA was run using the remaining 36 items to extract factors with eigenvalues greater than 1. All non-significant loadings of less than 0.4 were suppressed. KMO and Bartlett's test were conducted and the items were determined to be factorable and also that of PCA was appropriate (see Table 4-5).

Table 4-5: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.879
Bartlett's Test of Sphericity	Approx. Chi-Square	2659.958
	df	630
	Sig.	.000

Items were loaded on nine factors after the orthogonal rotation as shown in Table 4-6. The table formed the basis for selected questionnaire items that load on their likely factors, leading to 14 items being dropped.

Table 4-6: Rotated component matrix 1

	Component								
	1	2	3	4	5	6	7	8	9
JE_Q58	.756								
JE_Q56	.728								
JE_Q55	.707								
JE_Q57	.637					.449			
JE_Q54	.572								
JE_Q53	.464								
JE_Q52	.455								
NP_Q47		.761							
NP_Q45		.679							
NP_Q46		.592							
NP_Q48		.556							
US_Q35			.604						
US_Q32			.550						
IQ_Q11			.545		.535				
IQ_Q15			.544						
US_Q31			.512						
IQ_Q13			.452						
EC_Q29				.694					
NP_Q44				.670					
SQ_Q4				.537				.467	
SQ_Q2				.516					
EC_Q30				.515					
IQ_Q12					.789				
SQ_Q6					.696				
SQ_Q5					.601			.506	
JE_Q50						.678			
JE_Q49						.589			
JE_Q51	.494					.560			
IQ_Q16						.529			
SQ_Q1							.798		
IQ_Q10							.754		
IQ_Q14							.466		
SQ_Q7								.813	
SQ_Q9							.401	.508	
NP_Q43									.621
SQ_Q8									.555

EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

A second PCFA was conducted using the remaining items. The number of factors was fixed to six based on the number of constructs on the revised research model (see Figure 4-1) and all non-significant loadings of less than 0.4 were suppressed. The items loaded in their likely factors as demonstrated by Table 4-7. These items were adopted as the measures.

Table 4-7: Rotated component matrix 2 and scale reliability

		Component						Cronbach's Alpha
		1	2	3	4	5	6	
Job Enrichment	JE_Q55	.738						.838
	JE_Q58	.724						
	JE_Q56	.720						
	JE_Q54	.647						
	JE_Q52	.534						
	JE_Q53	.508						
Nurse Productivity	NP_Q47		.801					.791
	NP_Q45		.666					
	NP_Q46		.649					
	NP_Q48		.645					
System Quality	SQ_Q5			.821				.701
	SQ_Q7			.688				
	SQ_Q6			.644				
	SQ_Q8			.485				
User Satisfaction	US_Q32				.621			.755
	US_Q31				.602			
	US_Q35				.518			
Information Quality	IQ_Q10					.746		.669
	IQ_Q14					.614		
	IQ_Q15				.455	.587		
Expectation Confirmation	EC_Q29						.779	.563
	EC_Q30						.664	

EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

4.3.2 Reliability Test

The scale reliability tests were carried out using Cronbach Alpha. All constructs have evidence of acceptable scale reliability for a study undertaken for exploratory purposes as shown by the Cronbach's Alphas on Table 4-7.

Satisfied as to the reliability and validity of the measures, a composite score for each construct was then calculated based on the arithmetic average of the questionnaire items that has survived the PCFA. The descriptive statistics including skewness and kurtosis are illustrated by Table 4-8

Table 4-8: Composite Score Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Composite JE	158	5.00	2.00	7.00	5.5502	.97770	-1.045	.193	1.192	.384
Composite NP	158	3.75	3.25	7.00	5.9190	.79077	-1.072	.193	1.204	.384
Composite SQ	158	4.75	2.00	6.75	5.5393	.90508	-1.308	.193	2.728	.384
Composite US	158	4.67	2.33	7.00	5.6890	.89348	-.694	.193	.569	.384
Composite IQ	158	2.67	4.33	7.00	5.9428	.57216	-.259	.193	.159	.384
Composite EC	158	4.50	2.50	7.00	5.5930	.79818	-.713	.193	1.920	.384

EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

The composite scores were tested for correlation using Pearson's correlation analysis. All the relationships were significant at $p < 0.01$ as seen on Table 4-9. This indicates that hypotheses 1a, 1b, 4, 5a, 6a might be supported, and regression analysis could proceed.

Table 4-9: Correlation Matrix of Composite Score

		Composite JE	Composite NP	Composite SQ	Composite US	Composite IQ	Composite EC
Composite JE	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	158					
Composite NP	Pearson Correlation	.553**	1				
	Sig. (2-tailed)	.000					
	N	158	158				
Composite SQ	Pearson Correlation	.542**	.435**	1			
	Sig. (2-tailed)	.000	.000				
	N	158	158	158			
Composite US	Pearson Correlation	.614**	.571**	.380**	1		
	Sig. (2-tailed)	.000	.000	.000			
	N	158	158	158	158		
Composite IQ	Pearson Correlation	.307**	.330**	.276**	.506**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		
	N	158	158	158	158	158	
Composite EC	Pearson Correlation	.488**	.501**	.348**	.489**	.351**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	158	158	158	158	158	158

**. Correlation is significant at the 0.01 level (2-tailed).

EC - Expectation Confirmation, IQ - Information Quality, JE - Job Enrichment, NP - Nurse Productivity, SQ - System Quality, US - User Satisfaction

4.4 Hypothesis Testing

Based on the revised research model (Figure 4-1) resulting in the dropping of hypotheses 2a, 2b, 3, 5b, and 6b only hypotheses 1a, 1b, 4, 5a, 6a and the effect of controls will be tested. Regression analysis is conducted to determine the effect of independent variables on the dependent variables.

4.4.1 Hypothesis 1a and 1b testing

Hypothesis 1a: EMR system quality results in greater user satisfaction

Hypothesis 1b: EMR information quality results in greater user satisfaction

The R^2 in the model explains 33.3% of the variance in user satisfaction (Table 4-10). This is significant at the $p < 0.001$ level. The independent variables, information quality and system quality are statistically significant in terms of their effects on satisfaction. Information quality has the largest significant effect ($p < 0.001$) on user satisfaction with a standardised beta coefficient of .420. System quality has a standardised beta coefficient of .241, which is also significant at $P < 0.001$. These results support hypothesis 1a and 1b. In addition, these results suggest that controls have no effect on the dependent variable.

Table 4-10: Output for hypothesis 1a and 1b testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.577	.333	.306	.74753

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite IQ, Composite SQ

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	41.313	6	6.885	12.322	.000
	Residual	82.703	148	.559		
	Total	124.016	154			

Dependent Variable: Composite US

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite IQ, Composite SQ

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-.025	.767		-.033	.974
	Years working as a nurse	-.015	.019	-.136	-.826	.410
	Years of service at Addington Hospital	-.005	.020	-.038	-.240	.811
	Age	.021	.013	.192	1.571	.118
	Years using Addington's System	-.011	.021	-.072	-.515	.607
	Composite SQ	.250	.075	.241	3.319	.001
	Composite IQ	.657	.113	.420	5.834	.000

Dependent Variable: Composite US

IQ - Information Quality, SQ - System Quality, US - User Satisfaction

4.4.2 Hypothesis 4 testing

Hypothesis 4: Confirmation of expectations of the EMR leads to nurses' satisfaction with the system

The R^2 in the model explains 26.7% of the variance in user satisfaction (Table 4-11). This is significant at the $p < 0.001$ level. The standardised beta coefficient for independent variable confirmation of expectation is .458, which is significant at $P < .001$ level. The results support hypothesis 4, and suggest that controls had not effect on the dependent variable.

Table 4-11: Output for hypothesis 4 testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.516	.267	.242	.78123

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite EC

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	33.077	5	6.615	10.839	.000
	Residual	90.939	149	.610		
	Total	124.016	154			

Dependent Variable: Composite US

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite EC

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	2.379	.567		4.192	.000
	Years working as a nurse	-.024	.019	-.215	-1.261	.209
	Years of service at Addington Hospital	-.009	.021	-.071	-.434	.665
	Age	.024	.014	.226	1.796	.074
	Years using Addington's System	-.004	.022	-.024	-.165	.869
	Composite EC	.510	.080	.458	6.367	.000

Dependent Variable: Composite US

EC - Expectation Confirmation, US - User Satisfaction

4.4.3 Hypothesis 1a, 1b and 4 testing

Hypothesis 1a: EMR system quality results in greater user satisfaction

Hypothesis 1b: EMR information quality results in greater user satisfaction

Hypothesis 4: Confirmation of expectations of the EMR leads to nurses' satisfaction with the system

The R^2 in the model explains 37.6% of the variance in user satisfaction (Table 4-12) and is significant at the $p < 0.001$ level.

Table 4-12: Output for hypothesis 1a, 1b and 4 testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.636	.404	.376	.70908

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite EC, Composite IQ,

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	50.105	7	7.158	14.236	.000
	Residual	73.911	147	.503		
	Total	124.016	154			

Dependent Variable: Composite US

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite EC, Composite IQ,

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	-0.697	.745		-0.937	.351
	Years working as a nurse	-.012	.018	-.103	-.659	.511
	Years of service at Addington Hospital	.000	.019	.003	.017	.986
	Age	.018	.012	.169	1.454	.148
	Years using Addington's System	-.016	.020	-.107	-0.800	.425
	Composite SQ	.170	.074	.164	2.302	.023
	Composite IQ	.537	.111	.343	4.861	.000
	Composite EC	.332	.079	.298	4.182	.000

Dependent Variable: Composite US

EC - Expectation Confirmation, IQ - Information Quality, SQ - System Quality, US - User Satisfaction

The independent variables information quality and expectation confirmation have statistically significant effects on user satisfaction. Information quality has the largest significant effect on user satisfaction with a standardised beta coefficient of .343, which is significant at $P < 0.001$ level. Expectation confirmation has a standardised beta coefficient of .298, which is significant at $P < 0.001$ level. System quality has a beta coefficient of 0.164 significant at $P < 0.05$ level. The results support hypothesis 1a, 1b, and 4.

Information quality, system quality, and expectation confirmation are all independent predictors of user satisfaction. The diminished influence of system quality on user satisfaction may suggest that expectation confirmation partially mediates the effects of system quality on user satisfaction.

For the above analysis, multiple regression assumption tests were carried out and are shown in Appendix G1. The tests show some collinearity amongst the demographic variables. Appendix G1 illustrates regressions results if all demographics were removed except "number of years using Addington's System". This subsequent tests did not change

the conclusions regarding the effects of information quality, system quality and expectation confirmation on user satisfaction.

4.4.4 Hypothesis 5a testing

Hypothesis5a: EMR user satisfaction results in perceived enhancements to nurse productivity

The R^2 in the model (which includes both demographic and main effects variables) explains 34.4% of the variance in nurse productivity (Table 4-13**Error! Reference source not found.**). This is significant at the $p < 0.001$ level. The standardised beta coefficient for independent variable user satisfaction is .563, which is significant at $P < .001$ level. The results support hypothesis 5a, and also suggest that controls have no effect on the dependent variable.

Table 4-13: Output for hypothesis 5a testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.586	.344	.322	.64483

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite US

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	32.449	5	6.490	15.608	.000
	Residual	61.955	149	.416		
	Total	94.403	154			

Dependent Variable: Composite NP

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite US

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	2.959	.435		6.799	.000
	Years working as a nurse	.006	.016	.064	.397	.692
	Years of service at Addington Hospital	-.032	.017	-.287	-1.863	.064
	Age	.004	.011	.040	.331	.741
	Years using Addington's System	.034	.018	.259	1.901	.059
	Composite US	.491	.060	.563	8.189	.000

Dependent Variable: Composite NP

NP- Nurse Productivity, US – User Satisfaction

4.4.5 Hypothesis 6a testing

Hypothesis 6a: Satisfaction with an EMR results in an enriched nursing job

The R^2 in the model explains 39.5% of the variance in nurse productivity (Table 4-14). This is significant at the $p < 0.001$ level. The standardised beta coefficient for independent variable user satisfaction is .631, which is significant at $P < .001$ level. The results support for hypothesis 6a, and also suggest that controls have no effect on the dependent variable.

Table 4-14: Output for hypothesis 6a testing

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.628	.395	.374	.77314

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite US

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	58.096	5	11.619	19.439	.000
	Residual	89.064	149	.598		
	Total	147.160	154			

Dependent Variable: Composite JE

Predictors: (Constant), Years using Addington's System, Age, Years of service at Addington Hospital, Years working as a nurse, Composite US

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	1.531	.522		2.934	.004
	Years working as a nurse	.014	.019	.118	.755	.451
	Years of service at Addington Hospital	-.018	.021	-.131	-.883	.379
	Age	-.003	.014	-.026	-.221	.825
	Years using Addington's System	.025	.022	.154	1.177	.241
	Composite US	.687	.072	.631	9.564	.000

Dependent Variable: Composite JE

JE- Job Enrichment, US – User Satisfaction

4.4.6 Other relationships with nurse productivity and job enrichment

To determine which additional independent predictors of nurse productivity and job enrichment, two additional regression analyses were carried out.

$NP = f\,US + IQ + SQ + EC$ and $JE = f\,US + IQ + SQ + EC + NP$

In the first regression model, the R^2 in the model explains 42.2% of the variance in nurse productivity (Table 4-15), which is significant at the $p < 0.001$ level.

Table 4-15: Outputs for NP = f US + IQ +SQ + EC

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.649	.422	.390	.61146

Predictors: (Constant), Years using Addingtons System, Age, Years of service working at Addington Hospital, Number of years working as a nurse, Composite EC,

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	39.817	8	4.977	13.312	.000
	Residual	54.586	146	.374		
	Total	94.403	154			

Dependent Variable: Composite NP

Predictors: (Constant), Years using Addingtons System, Age, Years of service working at Addington Hospital, Number of years working as a nurse, Composite EC,

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	1.735	.644		2.693	.008
	Number of years working as a nurse	.011	.015	.108	.699	.486
	Years of service at Addington Hospital	-.021	.017	-.182	-1.225	.223
	Age	-.001	.011	-.006	-.053	.958
	Years using Addingtons System	.019	.017	.146	1.107	.270
	Composite US	.340	.071	.389	4.774	.000
	Composite IQ	.010	.103	.007	0.095	.924
	Composite SQ	.136	.065	.150	2.101	.037
	Composite EC	0.246	0.072	0.253	3.397	0.001

Dependent Variable: Composite NP

EC - Expectation Confirmation, IQ - Information Quality, SQ - System Quality, NP- Nurse Productivity, US – User Satisfaction

The standardised beta coefficients for all independent variables, with the exception of information quality, is significant at $P < 0.05$ level, suggesting system quality, expectation confirmation and user satisfaction are all independent predictors of nurse productivity.

In the second regression model, the R^2 in the model explains 54.1% of the variance in nurse productivity (Table 4-16), which is significant at the $p < 0.001$ level.

Table 4-16: Outputs for JE = f US + IQ +SQ + EC + NP

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.736	.541	.513	.68216

Predictors: (Constant), Years using Addingtons System, Age, Years of service working at Addington Hospital, Number of years working as a nurse, Composite EC,

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	79.686	9	8.854	19.027	.000
	Residual	67.474	145	.465		
	Total	147.160	154			

Dependent Variable: Composite JE

Predictors: (Constant), Years using Addingtons System, Age, Years of service working at Addington Hospital, Number of years working as a nurse, Composite EC,

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-0.241	.736		-0.327	.744
	Number of years working as a nurse	.018	.017	.148	1.070	.286
	Years of service at Addington Hospital	.008	.019	.057	.425	.671
	Age	-.013	.012	-.114	-1.108	.270
	Years using Addingtons System	-.005	.020	-.028	-0.238	.812
	Composite US	.428	.085	.393	5.013	.000
	Composite IQ	-.092	.115	-.054	-0.806	.421
	Composite SQ	.351	.073	.311	4.783	.000
	Composite CE	.181	.084	.149	2.150	.033
	Composite NP	.195	.092	.156	2.115	.036

Dependent Variable: Composite JE

EC - Expectation Confirmation, IQ - Information Quality, SQ - System Quality, NP- Nurse Productivity, US – User Satisfaction JE – Job Enrichment

In the second regression, the standardised beta coefficients for all independent variables, with the exception of information quality, are significant at $P < 0.05$ level, suggesting system quality, expectation confirmation, user satisfaction, and nurse productivity are all independent predictors of job enrichment.

Multiple regression assumptions tests carried out for NP = f US + IQ +SQ + EC and JE = f US + IQ +SQ + EC + NP in Appendix G2 and G3 present results where all demographic variables except "number of years using Addington's System" were removed. These tests did not change the conclusions.

4.4.7 Outcomes of hypotheses tests

As illustrated in Table 4-17, all hypotheses tested are supported. This means that system quality, information quality, and expectation confirmation predict user satisfaction. User satisfaction is a predictor of individual outcomes (perceived nurse productivity and job enrichment). The model confirms DeLone and McLean (1992) model in a hospital EMR

context in which nurses are the users. The model also confirms aspects of Bhattacherjee's (2001) PAM model of IS continuance by demonstrating that EMR expectation confirmation is a predictor of nurses satisfaction with the system.

Table 4-17: Summary of findings

	Hypothesis	Outcome
Hypothesis 1a:	System quality results in greater user satisfaction	Hypothesis supported
Hypothesis 1b:	Information quality results in greater user satisfaction	Hypothesis supported
Hypothesis 2a:	System quality results in more frequent use of an EMR by nurses	Hypothesis not tested due to low variation in data
Hypothesis 2b:	Information quality results in more frequent use of an EMR by nurses	Hypothesis not tested due to low variation in data
Hypothesis 3:	User satisfaction results in more frequent use of an EMR by nurses	Hypothesis not tested due to low variation in data
Hypothesis 4:	Confirmation of expectations of the EMR leads to nurses' satisfaction with the system	Hypothesis supported
Hypothesis 5a:	EMR user satisfaction results in perceived enhancements to nurse productivity	Hypothesis supported
Hypothesis 5b:	Frequent EMR use results in perceived enhancements to nurse productivity	Hypothesis not tested due to low variation in data
Hypothesis 6a:	Satisfaction with an EMR results in an enriched nursing job	Hypothesis supported
Hypothesis 6b:	Frequent use of an EMR results in an enriched nursing job	Hypothesis not tested due to low variation in data

4.5 Chapter Summary

This chapter tested hypotheses using Pearson correlation and regression analysis. It was established that system use is mandatory due to lack of variation in the data, resulting in the construct being dropped, and a revised research model. Acceptable reliability and validity tests were obtained and hypotheses were tested to assess the effect of the independent variables on the dependent variables.

Each hypothesis tested was supported leading to the conclusion that EMR information quality and system quality predicts nurses' satisfaction with the system. In addition, the extent to which nurses expectations of the system were confirmed predicts their satisfaction with it, and satisfaction in turn predicts changes in their productivity and the extent to which their nursing role is enriched.

In the next chapter, these results will be discussed in light of the literature presented in chapter 2.

Chapter 5 – Discussions and Interpretations

The previous chapter presented the analysis of data collected and answered the following research questions:

1. To what extent do the attributes of the EMR system and EMR information quality influence user satisfaction?
2. To what extent does confirmation of expectations influence EMR user satisfaction?
3. To what extent does user satisfaction with the EMR influence both individual nurse productivity and nursing job enrichment?

Both EMR information quality and system quality was found to influence nurses' satisfaction with the system. In addition, the extent to which nurses' expectations of the system were met also influenced their satisfaction. Finally, satisfaction with EMR was in turn found to have an effect on individual nurse productivity and also on the nature of the nursing role.

The research model built based on DeLone and McLean's (1992) IS Success model and Bhattacherjee's (2001) Post Acceptance Model of IS Continuance was later revised by dropping the use factor. This was because minimal data variation of the used items was lacking. This lack of variation was likely due to the mandatory usage of EMR in the target hospital. Factors other than system quality, information quality, and user satisfaction would be more likely to explain which functions were accessed by whom (see Table 4-4 on page 49).

Examining the research model in the context of EMR is particularly important because many studies (Ash et al., 2004, Darbyshire, 2004, Han et al., 2005, Haux et al., 2002, Nahm and Poston, 2000, Vikkelso, 2005) found that EMR potential is not realised. In many instances this impacts on healthcare quality and patient safety adversely. The insights will better position hospital administrators not only to avoid these adverse impacts but also enrich nurses' jobs and improve their productivity.

Results for each of the hypotheses tested in the research model are discussed next:

Hypothesis 1a: EMR system quality results in greater user satisfaction

Hypothesis 1a was supported. According to DeLone and McLean (2003) several studies have indicated that user satisfaction occurs when a system has qualities that include ease of use, adequate functionality, is reliable, flexible, and has good data quality. Nurses reported that the Addington hospital EMR system quality was good. They were also satisfied with the EMR itself. Comments by some of the nurses that the system is easy to navigate, convenient, and simple, attests to their perception of the system's quality. They also reported that records were more likely to be accurate and were never missing. System quality's ability to predict user satisfaction in the context of nurses' use of an EMR has been confirmed thus providing further support to DeLone and McLean (1992) IS Success Model.

Hypothesis 1b: EMR information quality results in greater user satisfaction

Hypothesis 1b was also supported. DeLone and McLean (2003) argued that the DeLone and McLean IS Success Model, systems quality measures technical success, and information quality measures semantic success such as accuracy, timeliness, completeness, relevance, and consistency. Users experience of these measures result in satisfaction with the system. Quality of healthcare information is critical in an EMR systems as it provides nurses with access to clinical information such as diagnostic results and notes captured by other healthcare givers (Kossman and Scheidenhelm, 2008). The nurses reported the information to be relevant to their work, easy to understand, and easy to read, which are some of Bailey and Pearson's (1983) and Otieno et al. (2007) measures of information quality. They however reported in their anecdotal comments that the space provided for ward handover report (matron report) was limited, resulting in capturing of abbreviated reports. This perception of good EMR information quality in turn predicted the satisfaction perceived by nurses providing additional support to DeLone and McLean (1992) IS Success Model in the EMR system context.

Hypothesis 2a: System quality results in more frequent use of an EMR by nurses

Hypothesis 2b: Information quality results in more frequent use of an EMR by nurses

Hypothesis 3: User satisfaction results in more frequent use of an EMR by nurses

Hypothesis 5b: Frequent EMR use results in perceived enhancements to nurse productivity

Hypothesis 6b: Frequent use of an EMR results in an enriched nursing job

Hypotheses 2a, 2b, 3, 5b, and 6b were not tested because it became clear over the course of the data collection process that usage of Addington's EMR is mandatory and there was little variation to the usage questions. It was however indicated that most users engage with functions that order and obtain tests or investigations, obtain patient personal information, review patients problems, document treatment of patients, and to determine patient location in hospital (see Table 4-4 on page 49). Other functions such as writing nursing care plans, entering daily nursing care notes, and writing nurse care worksheets were used by a handful of nurses. Results of this study are thus mostly representative of nurses' perceptions as they relate to their use and experiences of EMRs for those functions commonly used.

Hypothesis 4: Confirmation of expectations of the EMR leads to nurses' satisfaction with the system

Hypothesis 4 was supported. Consumers tend to form an initial expectation of a specific product such as EMR and after experiencing the product, they form perceptions about its performance (Bhattacherjee, 2001). This performance is then benchmarked against the original expectation, and if it confirms the expectation, user satisfaction has been achieved. Nurses at Addington hospital perceived use of the EMR better than what they expected. This led to greater satisfaction levels. Nurses also reported that service levels were better than what they expected. This provides additional support to Bhattacherjee's (2001) PAM model based on Oliver's (1980)

Hypothesis 5a: EMR user satisfaction results in perceived enhancements to nurse productivity

Hypothesis 5a was also supported. Thompson et al. (2009) posited that the potential impact of EMR on nursing efficiency is most evident in reduction of time in activities that are not part of direct patient care. These activities would include patient care, documentation, medication administration, treatments, planning for care including admissions and discharges and coordinating activities. Nurses reported that information was of good quality and that the system was easy to use. It is evident that the measure of user satisfaction as defined by Etezadi-Amoli and Farhoomand (1996) resulted in nurses reporting that Addington's EMR reduced their workload, helped them save time, and allowed them to spend time on more productive activities. These increased efficiencies are evidenced by some nurses commenting that additional and faster EMR computer terminals are needed to further enhance productivity. The results support DeLone and McLean's (1992) IS success model's relationship of user satisfaction having an effect on individual outcomes as evidenced by increased nurse productivity.

Hypothesis 6a: Satisfaction with an EMR results in an enriched nursing job

Hypothesis 6a was also supported. Hackman and Oldham (1980) and Kulik et al. (1987) posited that the three characteristics of jobs that are especially powerful in influencing the experienced meaningfulness of work thus enriching it are *skill variety, task identity,* and *task significance* and the characteristic that leads to experiencing personal responsibility for work outcomes is *autonomy.* User satisfaction, evidenced by nurses reporting that the EMR information is of good quality and easy to use, led to nurses feeling that EMR use allowed them to develop skills they did not have, made their job more important, and allowed them to see how their work contributes to patient outcomes. They also reported that they applied more of their skills and talents on the job due to EMR, and the chance to be more independent in carrying out their tasks. These outcomes result in a more meaningful and enriching role. The results also support DeLone and McLean's (1992) model in which user satisfaction can lead to an individual outcome such as job enrichment in an EMR usage context.

5.1 Chapter Summary

The research results were interpreted in this chapter and the significance of the findings discussed. Outcomes related to each of the hypotheses tested were also discussed.

The next chapter is a summary of the study and highlights the contribution to the body of knowledge. Limitations of the study and recommendations for future research are also discussed.

Chapter 6

This chapter provides a summary of the study and highlights the contribution to the body of knowledge. Limitations of the study and recommendations for future research are also discussed.

6.1 Summary of the study

Nursing processes which include a complex series of physical and cognitive activities (Potter et al., 2005) serve as a motivation for the use of health related technologies to transform nurses work environment (Aspden et al., 2004). Health technologies, such as EMRs have the potential to reduce non-value adding nursing activities. However, many studies have found that EMR potential is not realised and in certain instances. Limited understanding of factors that influence EMR success impact adversely on healthcare quality and patient safety (Ash et al., 2004, Darbyshire, 2004, Han et al., 2005, Haux et al., 2002, Nahm and Poston, 2000, Vikkelso, 2005). This study increases this understanding by determining the extent to which system quality, information quality, expectation confirmation and satisfaction affects nurse productivity and enrichment of the nursing job.

The study initially examined how nurses use EMR for patient care, benefits and challenges presented by this usage and a conceptual model was later developed to provide a framework for the study. The research methodology was defined prior to data collection.

The collected data was prepared for analysis by screening out missing values and outliers. Where necessary, questionnaire items were reverse scored. Reliability and validity tests were found to be acceptable and hypotheses were tested using correlation and regression analysis.

System quality, information quality and expectation confirmation were found to have an effect on user satisfaction. It was also found that user satisfaction had an effect on nurse productivity and enrichment of the nursing role.

Findings also re-affirmed that variables of DeLone & McLean IS success model and Bhattacherjee's PAM model were predictors of user satisfaction with a system that lead to higher order perceptions of nurse productivity and job enrichment.

6.2 Practical contribution

Implementing and successfully using information systems such as EMR in organisations is prone to many barriers and often, many systems only achieve part of their desired objectives. Poor design of interfaces and unresponsive technology are some of the barriers to success that result in significant costs being incurred without benefits being realised. There is a pressing need for managers to have the necessary tools to ensure that systems are well designed and properly implemented to achieve organisational goals. This study provides hospital managers with some of these tools by highlighting aspects that need close attention if nurse productivity is to increase and the nursing role enriched by EMR.

Firstly, managers have to ensure that nurses' expectations with respect to the capabilities of EMR are realistic to enhance the levels of satisfaction with the system. They will need to understand what nurses expect and what their needs are in an EMR context then actively reshape expectations based on these insights.

Secondly, nurses expect EMR to allow some of the tasks such as documentation and information retrieval to be done more efficiently. This would allow nurses more time to engage in more productive work such as direct patient care. To achieve this, managers should highlight to system designers, project managers and nurses that information availability and accuracy of information should not be compromised. In addition, managers should pay close attention to and ensure that the technical solution being purchased has a reputation for reliability and responsiveness. This is critical for an EMR to be considered a success.

Thirdly, managers should monitor the impact of EMRs on nurses with respect to increased variety in their skillset, perceptions of their role as more significant, and their contributions becoming more visible due to EMR reporting capabilities. These effects on nurses serve as key performance indicators of the EMR, and enhancements to the system should be considered if the indicators are not being achieved.

6.3 Academic contribution

DeLone and McLean (1992) IS success model had not been validated within the context of EMR and its impact on individual nurses. The validation by this study has once more re-affirmed the model's variables predictive abilities. The impact of PAM's expectation confirmation on satisfaction was also confirmed within this study's context.

Secondly, this study presents and validates a new model integrating DeLone and McLean (1992) with Bhattacherjee's (2001) PAM model. The two models are complementary because expectation confirmation, system quality and information quality all had independent effects on user satisfaction in this study's context.

Thirdly, this study demonstrates a relationship between user satisfaction and job enrichment in which user satisfaction results in a job that has increased skill variety, creates a great sense of identity with the tasks undertaken, and enhances the significance of the tasks. Satisfaction with a system can also result in the user experiencing greater autonomy with their role. Job enrichment is an individual benefit that in new to our understanding of IS success.

Fourthly, the study was able to establish additional relationships not defined by the research model. System quality and expectation confirmation were found to be independent predictors of nurse productivity. In addition, system quality, expectation confirmation, and nurse productivity were also found to be independent predictors of job enrichment.

6.4 Limitations of the study

The use of EMR in Addington hospital is mandatory and it was not possible to test the effect of system quality, information quality, and satisfaction on usage. This also resulted in the use construct being dropped hence limiting the extent to which DeLone & McLean IS success model was validated.

The results of the study should be interpreted with caution because the findings are based on nurses working in one hospital with a specific EMR and should not be generalised to all nurses and all EMR implementations.

Many of the nurses experienced the change when the EMR was upgraded in September 2011, and the study does not examine nurses' perceptions and responses of the older system.

The data collected is cross-sectional and causality cannot be inferred.

There may be a social desirability response bias, for example nurses reporting greater satisfaction than actually experienced and a sampling bias since only nurses in day shifts were interviewed.

6.5 Recommendations for future research

There are various avenues that future studies can follow to explore the impact of EMR on individual outcomes within an organisation.

Future studies can test the research model proposed in chapter 2 in a voluntary usage context.

In addition, IS continuance variable in the PAM model can be tested by answering the question "To what extent does user satisfaction influence IS continuance intention?"

This study was conducted in a single hospital setting which had a Meditech EMR implementation. To make the results more generalisable, future studies can broaden the sample to include more hospitals and also examine EMR implementations from different vendors.

Future research may also extend past individual benefits to explore the impacts of EMR use on an organisational level such as patient satisfaction levels and health care outcomes.

This study focussed on nurses but EMR is used by different healthcare professionals including physicians, laboratory technicians and pharmacists. Future studies can examine the effect of EMRs on other healthcare professionals with respect to productivity and job enrichment to provide insights that can support a more holistic EMR structure and design.

6.6 Conclusion

EMRs have the potential to transform healthcare provision by increasing efficiencies in documentation and retrieval of information. EMRs also improve the coordination of

healthcare for an individual patient. Thus, there is a potential to change the way healthcare workers experience their jobs through the introduction of new tools that replace traditional patient-healthcare provider practices.

This potential has not as yet been realised in certain instances, partly due to limited understanding of factors that influence EMR. This study has increased this understanding by determining the extent to which system quality, information quality, expectation confirmation and satisfaction affects nurse productivity and enrichment of the nursing job.

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Appendices

Appendix A – Survey Instrument Administered at Addington Hospital

This questionnaire contains 58 questions. It should take about 10 minutes to complete. The questions ask about your experiences and your perceptions of Addington Hospital's Computerised Medical System **(Meditech).** There are no right or wrong answers and your honest response is appreciated. You are not asked to identify your name anywhere on the questionnaire, all responses are completely anonymous and all data will be strictly confidential.

Total years of service as a Nurse: _____ years

Years of service working in Addington Hospital:_____ years

Education: Higher Certificate in Nursing ☐ Diploma in Nursing ☐ Bachelors degree in Nursing ☐

Postgraduate Degree ☐ Other:_____

Job Level: Auxiliary Nurse/Nursing Assistance ☐ Enrolled Nurse/Staff Nurse ☐

Registered Nurse/Sister ☐ Other_____

Unit where you currently work: CCU ☐ Theatre ☐ Trauma/Casualty ☐ Outpatient ☐

Other_____

Gender: Female ☐ Male ☐

Age: _____

How many years have you been a user of Addington's Computerised Medical System: _____years

		Strongly disagree						**Strongly agree**
	Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	The Computerised Medical System is easy to use							
2	The Computerised Medical System is easy to learn							
3	It is often difficult to get access to the Computerised Medical System							
4	Patient records in the Computerised Medical System are always complete							
5	The Computerised Medical System is always up and running							
6	The Computerised Medical System responds quickly enough							
7	Patient records in the Computerised Medical System are never missing							
8	Patient records in the Computerised Medical System are always correct							
9	The Computerised Medical System includes features and functions necessary for my work							
		Strongly disagree						**Strongly agree**
	Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**

10	The information outputs I get from the Computerised Medical System are relevant to me in my work							
11	Information output from the Computerised Medical System is always available to me when I need it							
12	Information that I need from the Computerised Medical System is always provided to me in time							
13	Information output from the Computerised Medical System is detailed enough							
14	Information output from the Computerised Medical System is easy to understand							
15	Information output from the Computerised Medical System is easy to read							
16	Information from the Computerised Medical System is in a form that is readily usable for my work							

	Question				
	How often do you use the Computerised Medical System to perform each of the following tasks?	**never use**	**sometimes use**	**frequent use**	**always use**
17	Write nursing care plans				
18	Enter daily nursing care notes				
19	Write nurse care worksheets (Kardex)				
20	Capture patient observations at the bedside				
21	Document physical assessment of patients				
22	Document treatment of patients				
23	Capture patient discharge information				
24	Review the patient's problems				
25	Determine patient location in hospital				
26	Order test and investigations				
27	Obtain the results from tests or investigations				
28	Obtain patient personal information				

		Strongly disagree						**Strongly agree**
	Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**
29	My experience using the Computerised Medical System is better than what I expected							
30	The service level provided by the Computerised Medical System is better than what I expected							
31	I am very satisfied with the Computerised Medical System							
32	I am very pleased with the Computerised Medical System							
33	I am very frustrated with the Computerised Medical System							
34	I enjoy using the Computerised Medical System							

35	My experience with the Computerised Medical System has been favourable							
36	I have a positive attitude toward the Computerised Medical System							
37	The Computerised Medical System is beneficial							
38	Having this Computerised Medical System at Addington Hospital is a good thing							
39	Support provided to users of the Computerised Medical System has been sufficient							
40	I have been provided with the help I need to use the Computerised Medical System							
41	Training on the use of the Computerised Medical System has been sufficient							
42	There is always someone to turn to if we need help with the Computerised Medical System							
		Strongly disagree						**Strongly agree**
	Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**
43	The Computerised Medical System increases my productivity							
44	The Computerised Medical System makes my job easier							
45	The Computerised Medical System reduces my workload							
46	The Computerised Medical System saves me time							
47	The Computerised Medical System allows me to accomplish more work than would otherwise be possible.							
48	The Computerised Medical System enables me to spend more time on productive activities							
		Strongly disagree						**Strongly agree**
	Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**
49	Using Computerised Medical System has created new nursing activities for me							
50	Using Computerised Medical System has made me make clinical decisions normally made by doctors							
51	Using the Computerised Medical System has increased the time I have direct contact with patients							
52	Using Computerised Medical System has made me develop new skills I did not have before							
53	Using the Computerised Medical System has made my job more important							
54	Using the Computerised Medical System helps me to see how my work contributes to patient outcomes							
55	Using the Computerised Medical System allows me to apply more of my skills and talents in my job							
56	Using the Computerised Medical System gives me the chance to be more independent in carrying out my work							
57	Using the Computerised Medical System helps me to have good work relations with the doctors							
58	Using the Computerised Medical System has helped to me be of better service to others							

Appendix B – Participant Information Sheet

Good-day, you are being invited to participate in a research study

STUDY INFORMATION

Study Title:

The Impact of Electronic Medical Records on Nurse Productivity and Nursing Job enrichment: *An Empirical Study within a South African Hospital*

Researcher:

James Matheri Kangethe

0824510965
Matheri@telkomsa.net

School of Economic and Business Sciences
Faculty of Commerce, Law and Management
University of The Witwatersrand, Johannesburg

Supervisor:

Professor Jason Cohen

PURPOSE OF THE RESEARCH STUDY

You are being invited to participate in a research study of how the use of Electronic Medical Records system in your hospital impact on your work and role as a nurse.

You are invited to participate because as a nurse who has worked with both paper records and Electronic Medical Records, you can respond to questions regarding the system, the extent to which you use the system, your satisfaction with it, and how the system has affected your work.

Your participation in this study is entirely voluntary. Your participation is anonymous and you not asked to provide your name or other identifying details. Information collected for this study will be kept confidential. Your responses will not be made available to any other party and will be destroyed once the research is complete. Results will be reported only in the aggregate and you cannot be identified. Whether you participate or not, you will not be subjected to any form of prejudice or loss of benefits. You are also free to withdraw and discontinue your participation at any time.

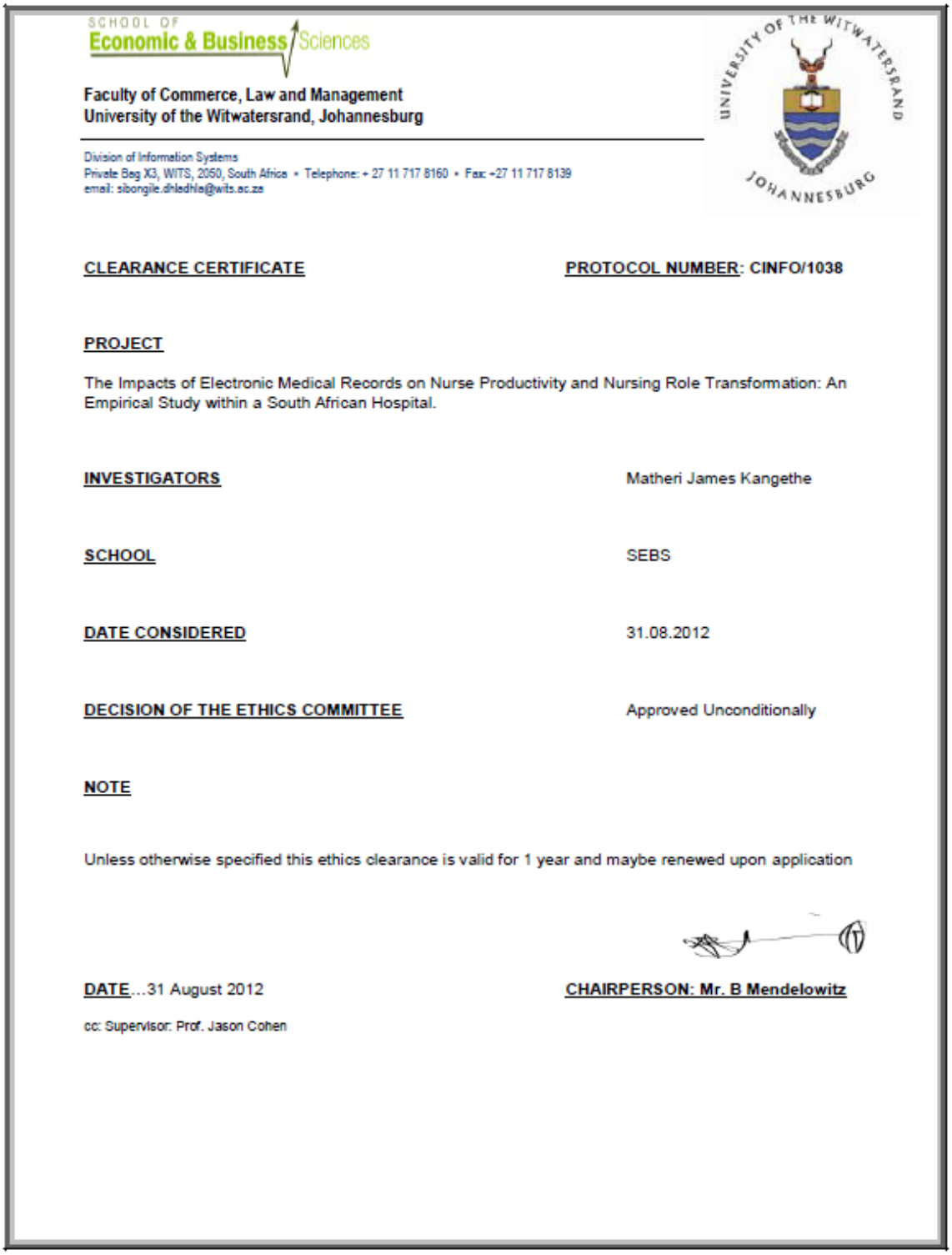
If you consent to participate, please complete the attached questionnaire. The questionnaire contains 58 questions which you are asked to rate on a scale. The questionnaire should take approximately 10 minutes to complete.

The completed questionnaire can be returned researcher the next day when he will come to collect from you at your workstation.

WHO TO CONTACT IF YOU HAVE QUESTIONS

If you have questions about this research study, you may contact the researcher James Matheri Kangethe at telephone number 0824510965 or e-mail matheri@telkomsa.net . You may also contact the study supervisor, Professor Jason Cohen at telephone number 0117178164 or e-mail jason.cohen@wits.ac.za

Appendix C – Ethics Clearance Certificate



SCHOOL OF
Economic & Business Sciences

Faculty of Commerce, Law and Management
University of the Witwatersrand, Johannesburg

Division of Information Systems
Private Bag X3, WITS, 2050, South Africa • Telephone: + 27 11 717 8160 • Fax: +27 11 717 8139
email: sibongile.dhladhla@wits.ac.za

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: CINFO/1038**

PROJECT

The Impacts of Electronic Medical Records on Nurse Productivity and Nursing Role Transformation: An Empirical Study within a South African Hospital.

INVESTIGATORS Matheri James Kangethe

SCHOOL SEBS

DATE CONSIDERED 31.08.2012

DECISION OF THE ETHICS COMMITTEE Approved Unconditionally

NOTE

Unless otherwise specified this ethics clearance is valid for 1 year and maybe renewed upon application

DATE...31 August 2012 **CHAIRPERSON: Mr. B Mendelowitz**

cc: Supervisor: Prof. Jason Cohen

Appendix D – KZN Department of Health Authorisation

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM 89/12
Enquiries : Mr X Xaba
Tel : 033 – 395 2805

Dear Mr M Kangethe

Subject: Approval of a Research Proposal

1. The research proposal titled **'The impact of electronic medical records (EMR) on nurse productivity and nursing role transformation: an empirical study within a South African hospital'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at Addington hospital.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

Dr E Lutge
Chairperson, Health Research Committee
KwaZulu-Natal Department of Health
Date: 21/08/2012

Appendix E – Addington Hospital Management Authorisation 1

HEALTH
KwaZulu-Natal

ADDINGTON HOSPITAL
OFFICE OF THE HOSPITAL MANAGER
Postal Address: P.O. Box 977, DURBAN, 4000
Physical Address: 16 Erskine Terrace, South Beach
Tel:: (031) 327-2970, Fax.:(031) 368-3300
Email.: addington.management@kznhealth.gov.za
www.kznhealth.gov.za

AD/9/2/3/R

Enquiries: Dr R N Mokoena
Extension: 2970/2568

15 August 2012

Principal Investigators:
- **Mr. M. KANGETHE**

PERMISSION TO CONDUCT RESEARCH AT ADDINGTON HOSPITAL: "THE IMPACT OF ELECTRONIC MEDICAL RECORDS ON NURSE PRODUCTIVITY AND NURSING ROLE TRANSFORMATION. "

I have pleasure in informing you that permission has been granted to you by Addington Management to conduct research on "the impact of electronic medical records on nurse productivity and nursing role transformation."

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. Addington Hospital will not provide any resources for this research.
5. Your will be expected to provide feedback on your findings to Addington Hospital.

HOSPITAL MANAGER
DR ER MASILELA
ADDINGTON HOSPITAL

Appendix F – Addington Hospital Management Authorisation 2

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

ADDINGTON HOSPITAL
PO Box 977, Durban, 4000
16 Erskine Terrace, South Beach, Durban, 4001
Tel: 031-327 2000, Fax: 031-327 2453
Email: www.kznhealth.gov.za

14 September 2012

TO WHOM IT MAY CONCERN

This is to confirm that **Mr. James Matheri Kangethe ID. NO. 671207587086,** has been granted permission by Head Office and Addington Hospital Management to conduct research on The Impact of Electronic Medical Records on Nurse Productivity and Nursing Role Transformation in Addington Hospital. He will be assisted by two qualified researchers:

- **Ms. Precious Shangase – ID. No. 7407190372086**
- **Ms. Thembisile Mnyandu – ID. No. 7707070429082**

The duration of the research will be: 14 September 2012 to 20 September 2012

Regards

Mr. T.P. Zondi
Acting Deputy Nursing Manager

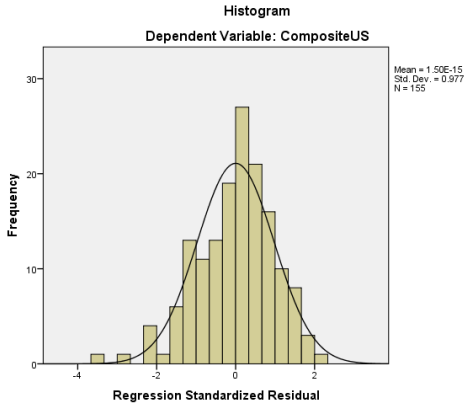
Appendix G – Testing of Multiple Regression Assumptions

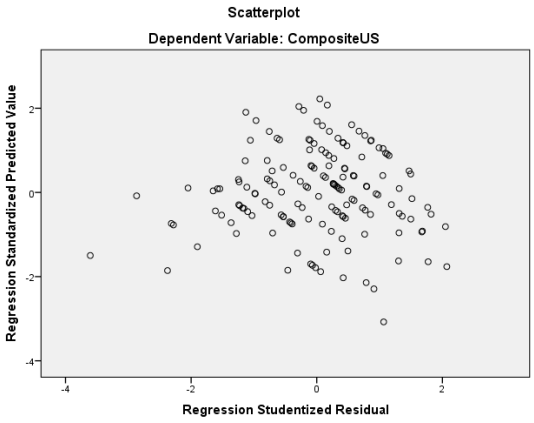
Appendix G1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.697	.745		-.937	.351		
	Total number of years working as a nurse	-.012	.018	-.103	-.659	.511	.167	6.003
	Years of service working at Addington Hospital	.000	.019	.003	.017	.986	.179	5.583
	Age	.018	.012	.169	1.454	.148	.302	3.314
	Years using Addington's System	-.016	.020	-.107	-.800	.425	.228	4.394
	Composite SQ	.170	.074	.164	2.302	.023	.800	1.249
	Composite IQ	.537	.111	.343	4.861	.000	.812	1.231
	Composite EC	.332	.079	.298	4.182	.000	.799	1.252

a. Dependent Variable: Composite US





Collinearity diagnostics suggest that demographic variables are quite highly correlated. The model was rerun using only years using system, results as follows:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.632[a]	.399	.383	.70533

ANOVA[a]

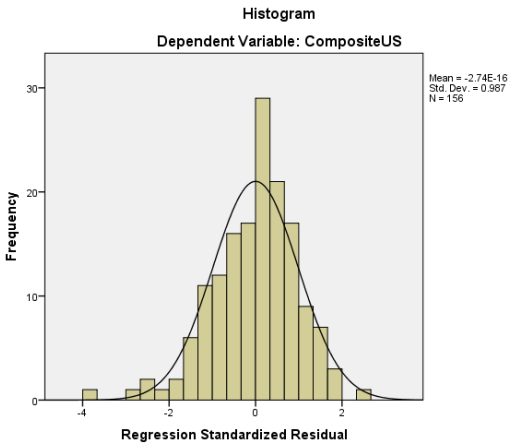
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49.956	4	12.489	25.104	.000[b]
	Residual	75.121	151	.497		
	Total	125.077	155			

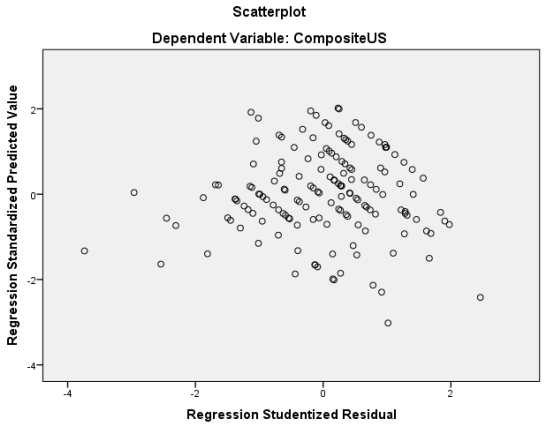
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.223	.658		-.339	.735		
	Years using Addington's System	-.013	.010	-.085	-1.323	.188	.966	1.035
	Composite SQ	.184	.068	.187	2.712	.007	.841	1.190
	Composite IQ	.526	.108	.336	4.852	.000	.830	1.205
	Composite EC	.336	.079	.300	4.277	.000	.807	1.239

a. Dependent Variable: Composite US

Conclusions do not change, and results show that SQ, IQ and EC are all significant predictors of US.



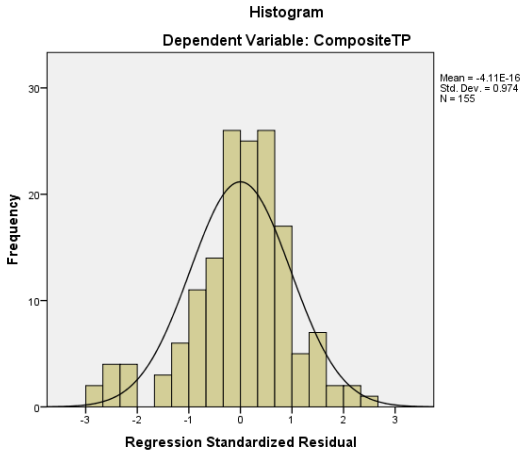


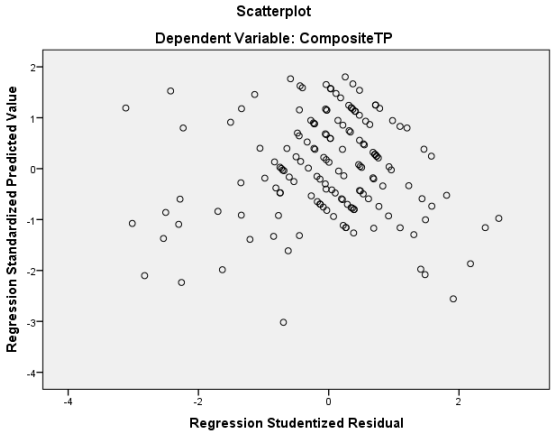
Appendix G2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.735	.644		2.693	.008		
	Years using Addington's System	.019	.017	.146	1.107	.270	.227	4.413
	Total number of years working as a nurse	.011	.015	.108	.699	.486	.166	6.020
	Years of service working at Addington Hospital	-.021	.017	-.182	-1.225	.223	.179	5.583
	Age	-.001	.011	-.006	-.053	.958	.297	3.362
	Composite SQ	.136	.065	.150	2.101	.037	.772	1.295
	Composite US	.340	.071	.389	4.774	.000	.596	1.678
	Composite IQ	.010	.103	.007	.095	.924	.700	1.429
	Composite EC	.246	.072	.253	3.397	.001	.714	1.401

a. Dependent Variable: Composite NP





Collinearity diagnostics also suggest that demographic variables are quite highly correlated. The model was rerun using only years using system, results as follows:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.656[a]	.430	.411	.61036

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.237	5	8.447	22.675	.000[b]
	Residual	55.881	150	.373		
	Total	98.118	155			

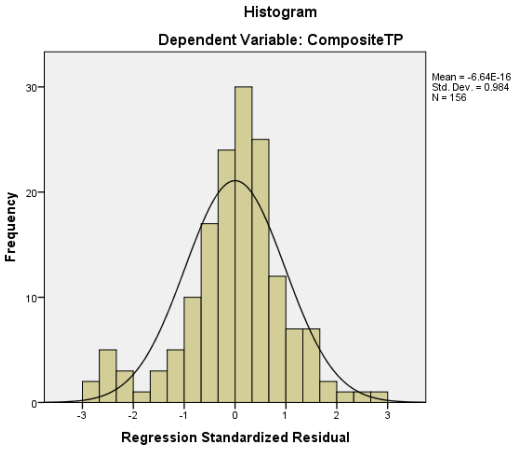
a. Dependent Variable: Composite NP

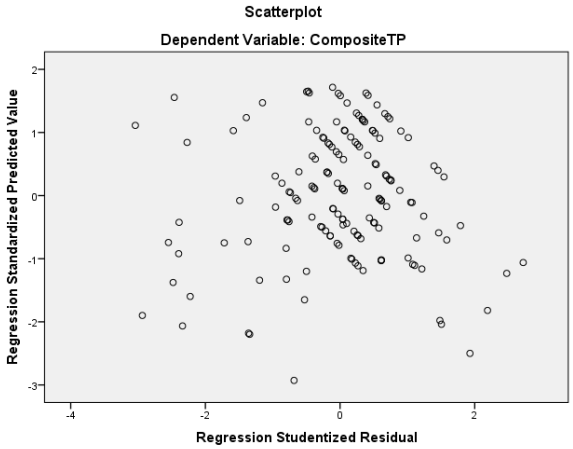
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.543	.570		2.709	.008		
	Years using Addington's System	.009	.008	.067	1.055	.293	.955	1.047
	Composite SQ	.174	.060	.199	2.888	.004	.802	1.248
	Composite US	.338	.070	.382	4.806	.000	.601	1.665
	Composite IQ	.006	.101	.004	.062	.951	.718	1.393
	Composite EC	.245	.072	.247	3.406	.001	.720	1.389

a. Dependent Variable: Composite NP

Conclusions do not change, and results still show that SQ, EC and US are all significant predictors of NP.



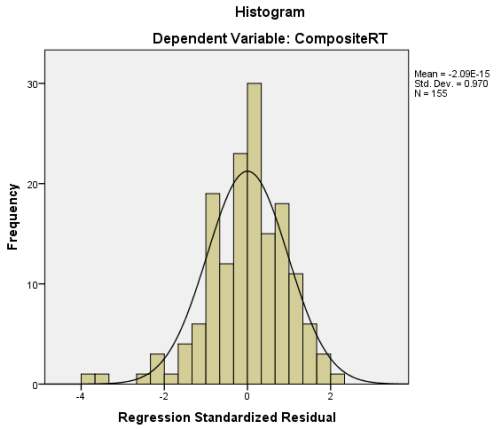


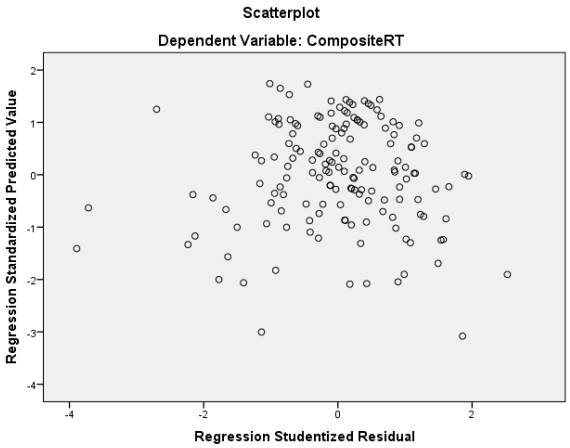
Appendix G3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.241	.736		-.327	.744		
	Years using Addington's System	-.005	.020	-.028	-.238	.812	.225	4.450
	Composite SQ	.351	.073	.311	4.783	.000	.750	1.334
	Composite US	.428	.085	.393	5.013	.000	.516	1.940
	Composite IQ	-.092	.115	-.054	-.806	.421	.700	1.429
	Composite EC	.181	.084	.149	2.150	.033	.662	1.511
	Composite NP	.195	.092	.156	2.115	.036	.578	1.729
	Total number of years working as a nurse	.018	.017	.148	1.070	.286	.166	6.040
	Years of service working at Addington Hospital	.008	.019	.057	.425	.671	.177	5.640
	Age	-.013	.012	-.114	-1.108	.270	.297	3.362

a. Dependent Variable: Composite JE





Collinearity diagnostics also suggest that demographic variables are quite highly correlated. The model was rerun using only years using system, results as follows:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.736[a]	.541	.523	.67859

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80.948	6	13.491	29.299	.000[b]
	Residual	68.611	149	.460		
	Total	149.559	155			

a. Dependent Variable: Composite JE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-.244	.649		-.376	.707		
	Years using Addington's System	.011	.009	.065	1.132	.260	.948	1.055
	Composite SQ	.321	.069	.297	4.666	.000	.759	1.317
	Composite US	.424	.084	.387	5.036	.000	.520	1.921
	Composite IQ	-.101	.112	-.059	-.903	.368	.718	1.393
	Composite EC	.179	.083	.146	2.154	.033	.668	1.497
	Composite NP	.187	.091	.151	2.055	.042	.570	1.756

a. Dependent Variable: Composite JE

Also in this case, conclusions do not change and results still show that SQ, US, EC, and NP are all significant predictors of JE.