END-USER SATISFACTION WITH AN INFORMATION SYSTEM IMPLEMENTATION IN NATALSPRUIT HOSPITAL, GAUTENG PROVINCE

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Research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree

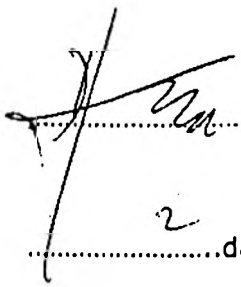
of

Master of Public Health

Johannesburg, 2005

DECLARATION

I, Jaromir Vomacka, declare that this research report is my own work. It is being submitted for the degree of Master of Public Health in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.



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2 day of 6 (month), 2006

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ABSTRACT

The aim of this study was to evaluate user satisfaction with a new hospital information system, Medicom, implemented in Natalspruit hospital.

A sample consisted of 380 full-time employees representing all groups of hospital staff who utilised the software. A cross-sectional survey design was used.

The mean total score for the survey was 40.7 out of possible 60. This was above the middle score of 36 meaning that the users were satisfied with the system. Administrative personnel were most satisfied (mean 43.9). Medicom scored highest for the dimension of Ease of Use. Six variables that were presumed to influence users' satisfaction were analysed; only Availability of the Technical Support was significantly associated with satisfaction in multivariate analysis. Medical doctors were found to be not utilizing the system. Staff complained about training, technical problems and time constraints to exploit the Medicom prospects to its optimum.

Implications for improving the hospital information system are discussed.

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ABBREVIATIONS

HCIS	=	Health Care Information System
HIS	=	Hospital Information System
IS	=	Information System
IT	=	Information Technology
NHIS	=	National Health Information System
NHIS/SA	=	National Health Information System of South Africa

1.0 INTRODUCTION TO THE STUDY

Information technology is defined as the development, installation, and implementation of computer systems and applications (5). In recent years information technology has made significant inroads into the field of health care. The new technology has played a central role in the development of knowledge, skills and tools that enable information to be collected, managed, used and shared and thereby support the delivery of health care and support health (61). As Littlejohn et al. (34) state, though, despite large investments that have gone mainly into computerised hospital information systems, their overall benefits have rarely been assessed.

A recent South African information technology enterprise undertook the computerisation of medical facilities in Gauteng Province. This study is an assessment of the implementation of the new hospital information system from one hospital. The introduction first describes the importance and advantages of information technology in general and those of hospital information systems in particular. It then presents the state of affairs in this area in South Africa and outlines how Gauteng Province has dealt with the matter. The ways of evaluating information systems are reviewed next, focusing primarily on user satisfaction in the hospital environment. The sections that follow present the objectives, methods and results of the research. The last section discusses the results and the implications for hospital information systems in South Africa.

1.1 Information Technology

The various information technology (IT) applications in health care are generally referred to as health care information systems (HCIS) (47). Basic applications of information and communication technologies to the health sector include:

- hospital information systems,
- the set-up of private networks such as Intranets and Extranets for sharing information and collaboration among institutional and individual participants in health sector,
- the use of public networks such as the Internet to distribute information,
- health decision-support expert systems,
- rapid access to shared and remote medical expertise by means of telecommunications and information technologies via telemedicine, and
- community health information systems for local, regional and national health planning (18).

HCISs are an area between two intersecting fields: information systems and health care. Their development is influenced by software and hardware as well as medical innovations/development. A wide range of different sciences, including medicine, nursing, health care, organisational science, statistics and biomedical science, are involved in HCISs. Health care applications can be divided into groups such as diagnostic, treatment, nursing, administrative, support and auxiliary systems (63).

Information technology is increasingly applied in the health sector, and the rate of investments in HCISs is expected to rise as a result of the widespread crisis in health finances, which drives attempts to reduce the overall costs of health care while improving the quality (47). Productivity is meant to increase by the use of much more streamlined computer-based technology.

1.2 Hospital Information Systems

Hospital information systems (HIS) form a cornerstone of modern hospital care. These systems are primarily there to support hospital activities on operational, tactical and strategic levels, generally aiming to lower costs, improve the quality

of patient care, and integrate the hospital's operations. However, they also form an important level in the national health information system to allow relevant aggregated management information flow to appropriate levels of control. In South Africa, for example, there is a system in place to request a standard monthly hospital report form from public and private sector hospitals, which is complementary to the information systems at individual hospitals (1). HIS usually include modules for:

1. electronic medical records, integrated with a document imaging and delivery system that allows the instantaneous scanning, storage and retrieval of both electronically generated and handwritten material from any terminal in the hospital;
2. front office systems including radiology, laboratory, and pharmacy, registration admission, discharge and transfer, and clinic and ward systems;
3. back office systems consisting of all the applications necessary to administer a hospital, from a full-featured accounting system including general ledger, accounts receivable, accounts payable and fixed asset maintenance modules, to purchasing and inventory modules that handle all materials, to a full human resources management and payroll system.

Information gained from captured data enable management to produce statistical reports on hospital performance and disease profiles. Most importantly, it introduces a greater element of confidentiality for patients. HISs promise ready access to integrated health care information that may facilitate treatment. Fears of privacy invasion may be alleviated by a number of security measures such as the institution of a unique patient-identifier, use of user identification names, passwords and menus to control access to computer system functions, use of audit trails to record significant events on a system, and limitations on terminals used for access. By adopting encryption programmes computer pathways can be made a secure communications medium.

A clinical information system that covers patient records, bed-side data, laboratory reports, pharmaceutical receipts, demographics, and that caters for movements between hospitals is required to reduce cost and the waste of resources and to support the needs of a wide range of users. Such a system could have a substantial impact on the cost and quality of service and the health care in the region. Computer-based patient records are becoming vital for doctors, nurses and other health professionals in order to provide an array of hospital, primary care, and other ambulatory and institutional health services. Ideally, patients should have their personal computer-based records that include longitudinal health profiles for those who move frequently and those with complex medical conditions.

The premise is that a well designed, reliable and effective health information system may meet the needs of health service providers, administrators, planners, and decision-makers at all levels leading to more effective health processes and outcomes.

1.3 Health Care Information Systems in South Africa

The National Department of Health inherited a very fragmented paper-based health information system. At the same time, the Department of Health has had a growing need to collect information to derive indicators of equity, service usage and health status for resource allocation and other health management functions. Since 1994 both the Reconstruction and Development Programme (3) and the National Health Plan (2) have identified the necessity of expanding the national health information system/health informatics. Discussions about the development thereof have gained momentum and have placed emphasis on improving data processing and storage resources, their conversion into information for the purpose of improving health management and, ultimately, the health of the population (25,44,45,48,53). These points are elaborated below.

The National Committee for the development of the National Health Information System of South Africa (NHIS/SA) was established in 1994 (10). The committee was chaired by the Director-General, and consisted of representatives from the provinces appointed by each MEC, local experts from the private and public sectors, and consultants from WHO, UNICEF and USAID.

The main points of policy and strategy for NHIS/SA were

- supporting the implementation of the Reconstruction and Development Programme,
- close cooperation between provincial and national institutions to the extent of eventual consensus on all discussed issues, and
- ensuring that main benefits of computerisation will be appreciated by the people on the ground within health districts (3).

Various implementation strategies were established for the NHIS/SA to fulfil its objectives – which include:

- ensuring the availability of information on cost, efficiency, volume and coverage,
- measurement of the South African population's health status,
- collaboration with the private sector,
- accommodating provincial variations,
- establishment of a minimum data ser at the national level, in accordance with international indicators,
- piloting the NHIS/SA nationally on an incremental basis,
- ensuring the system's user-friendliness facilitating the collation, analysis and use of data,
- implementation of National Nutrition Surveillance System as part of the NHIS/SA,

- gathering and publishing of cause-specific mortality and morbidity data (especially for children and women),
- emphasis on the use and feedback of data at all levels, especially at the point of collection,
- appropriate training of health workers, and
- monitoring of timeous and comprehensive reporting (2).

In order to carry out the NHIS/SA vision significant resources in terms of experts, equipment and financial capital were allocated for this purpose. A major policy change in the health care system in 1996 was the decentralisation of certain functions to the provincial level, which had significant implications for the development of the NHIS. As the responsibility for the advancement and operations of the health care services was devolved to the provinces, the NHIS/SA development shifted from a national to a provincial responsibility while retaining the main objective of developing a fully compatible and truly nation-wide health information systems. This multiplied the challenges and the technical workload of coordinating the development of health information systems. Nonetheless, a major consensus and agreement was reached by NHIS/SA implying that each province was free to develop its health information system in its own way and within its own framework, but that nationally agreed-to technical specifications would be respected and adhered to by all (25).

1.4 Health Care Information Systems in Gauteng Province

The Gauteng province has been an active and major contributor to the work of the National Committee for the development of the NHIS (35). The Gauteng Department of Health initiated the formation of the Gauteng Provincial Health Information System that has been commissioned and financed by the department. Abiding by the national specifications, the provincial department

issued an invitation for tenders for a pilot project in 1998. The pilot was for the implementation of a modern management information system in 6 hospitals and 5 clinics, but with a longer-term plan of expanding the package to the whole province. The successful bidder winning a tender was a consortium of five companies known as Rihanyo. Execution in a few chosen medical facilities ranging from primary health care centres to tertiary institutions started on 1 November 1999 and concluded on 31 December 2001. After a technical and managerial evaluation of the pilot sites using the system, its expansion for the whole Gauteng Province has been gradually executed (26,32).

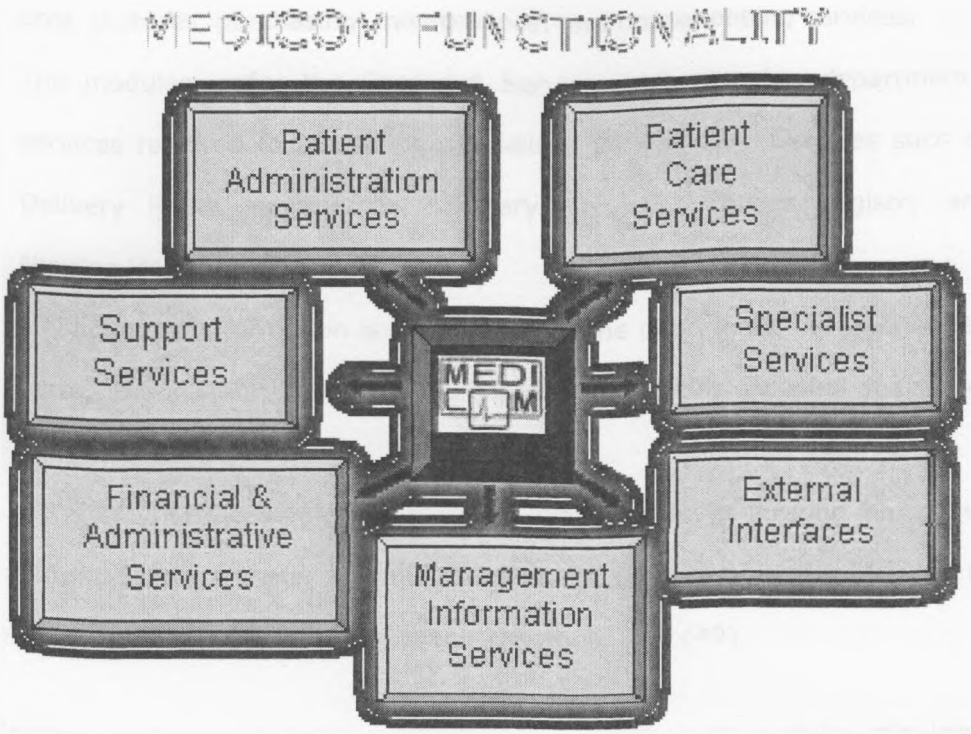
Rihanyo opted for installation of a software system known as Medicom. The package has been the choice of hospitals and other health care facilities across many parts of the world including the Middle East, Southern Africa, South Asia and Far East.

Medicom is a real-time, on-line, integrated management system for healthcare facilities, addressing all critical areas of health care activity. The system is modular and flexible. The various modules are fully integrated (but can also be used alone) to automate functions ranging from patient administration to clinical services. Medicom provides immediate access to clinical and administrative data and streamlines the scheduling and management of clinics visits and admissions. The system aids the dispensing of medications, facilitates management of laboratory functions with interfaces to laboratory equipment and much more. Medicom is scalable for modular implementation in both the Public and the Private Health sector. Medicom product design and philosophy ensures that the product is in line with established and international standards in Health Care Informatics (40).

The functionality of Medicom can be broadly categorised under the types of services shown in Figure 1:

FIGURE 1

Medicom Functionality



Source: (40)

- The Patient Administration Services modules handle the administration of patients with regard to their registration, visits to outpatient clinics and appointments, admittance to wards and associated transfers and discharges, management of wards/ beds, ordering of services by various departments and the maintenance of medical records.
- The modules under Patient Care Services cover departmental services required for providing primary patient care such as Pharmacy, Radiology, Laboratory, Pathology, Blood Transfusion and Operation Theatres.
- The Financial & Administrative suite of modules provide financial management and human resources administration as related to Patient

Billing, Doctors Fees, Receivables, Payables, Fixed Assets and Financial Accounting.

- The Support Services modules provide general logistical support in the area of stores, purchasing, maintenance, and housekeeping services.
- The modules under the Specialist Services suite provide departmental services required for providing specialised Patient Care Services such as Delivery Room Management, Dietary Services, Cancer Registry and Nursing Management.
- Management Information is available from the operational data generated across the system; this could be department specific, hospital specific or consolidated.
- External Interfaces refer to facilities available for generating bar-coded outputs, data transfer via analysers in the laboratory and interfaces to spreadsheets, word processors and electronic mail (40).

The Gauteng strategy entailed the installation of priority core modules stipulated in the contract:

- Patient Administration, Tracking & Management
- Asset and Stock Management Entry
- Pharmacy Management
- Statistical and Strategy Management (32).

The next section reviews the international literature on information systems evaluation.

1.5 Evaluation of Information Systems (IS)

The evaluation of the effectiveness of an IS constitutes one of the key issues in IS research with the purpose of making a contribution to IS practice, policies and

procedures (13,4). An IS is comprised of all of the information processing in an organisation, as well as the involved human and technical players in their information processing roles (65). Therefore, evaluation should be comprehensive and include objects such as hardware and software components, processes and services, but also the persons involved and their interactions with technical components.

In research, well-defined outcome/success measures are needed to ensure that the results from different studies are comparable. While a single measure of IS success or IS effectiveness would certainly be desirable, it seems unlikely that such a measure could be found. Instead, researchers such as DeLone & McLean (13), and Grover et al. (24), have classified success variables, which are applicable for the evaluation of IS in different phases of development and of different aspects of IS. In general, the success of an IS can be evaluated through

- the impact of IS on users' thinking, decisions or actions (individual impact),
- the impact of IS on organisation level costs and benefits (organisational outcome), and
- users' evaluation of the quality of the system (user satisfaction) (62).

1.6 Evaluation of Information Systems in Health Care

On the whole, assessment of IS in health care does not significantly differ from that in other fields. As Turunen & Salmela (60) stated, however, there have been additional challenges in IS evaluation in health care context. These may include the complexity of the evaluation object and environment with its multitude of possible evaluation views and questions, and the possibility that inadequate design and consequent failure of the IS may cause negative effects on staff and patients – staff spending more time with the computer than with the patient, and

IS not positively influencing treatment or contributing to patients' health (11, 28). Therefore, because of the potential impacts on patients' lives, a rigorous evaluation of IS in health care is recommended and of great importance for decision makers and users of future health information systems (66).

All three ways of evaluating IS (user satisfaction, individual impact, and organisational outcome,) have been used in the field of health care. The impact of an information system on decision making, particularly on diagnostic and treatment decisions, has been a common basis for evaluation (62). The assumption is that treatment success as a consequence of positive actions taken by decision-making individuals using an available IS set-up is equivalent to IS success and justifies its extensive utilisation. The value of improved health outcomes should be considered as well, though, to make sure that health resources are used economically in the provision of more advantageous patients' health care. This is where organisational outcome evaluations are utilised and, in fact, cost-benefit studies have been more frequent in the evaluation of IS in health care than in IS evaluation in general (24,63). Because the third IS evaluation choice, that is user satisfaction, has been chosen as the evaluation tool for this study, it is discussed in more detail in the following section.

1.7 User Satisfaction

A user/end-user is considered anybody who is operating the relevant information system.

Due to the difficulty in assessing IS impacts on individuals or organisations, Galetta & Lederer (21) noted that measures based on user perceptions have become prominent within the IS literature. These measures of implementation have looked at user satisfaction, usage, user involvement, and user acceptance

(7,31). The most commonly used measure of IS success is user satisfaction (41). It may be defined as the overall emotive evaluation of end-user regarding their experience related with the information system. The term "experience" can be made more specific to focus upon different aspects related to the information system (e.g., computing, training, etc.). In general, previous studies have focused primarily on the satisfaction measurement of the computing/use aspect of a system. But it may well be satisfaction with components other than system use (e.g., training, participation or involvement in development or selection) that predict subsequent behaviour (e.g. utilisation) or performance. Alternatively, a global measure of the end-user computing experience may equally be of value. Nevertheless, system use remains the focus of most studies (12). A number of attempts have been made to capture the overall satisfaction having by end-users on the topic of the use of an IS system in conjunction with the most immediate precursor factors (those just mentioned above plus the system's reliability, responsiveness, competency, accessibility, etc.) that form this satisfaction (16,29,39,58).

Undoubtedly one of the reasons that user satisfaction is commonly used to assess success is that it is a more convenient measure than performance-related measures. Utilising satisfaction measure, information systems in organisations can be evaluated effectively, with minimal resources, especially with regard to time, and relatively little effort, while large benefits for decision makers can be gained. However, the value of user satisfaction is based largely on two implicit assumptions. The first is that the successful implementation of an IS depends on user adoption. User satisfaction, then, becomes a proxy measure for adoption. The second intuitive argument is that successful implementation depends on how effective the system is in improving work processes. User satisfaction is then a proxy for system effectiveness (41). Since organisational effectiveness measures focus on outcome, some researchers consider user satisfaction as a measure of

organisational outcome (13,24,56). As a result, it can be suggested that user satisfaction may be a surrogate measure of patient outcomes.

Many researchers, though, have drawn attention to the fact that there have been problems with the use of satisfaction as a measure of success (20,21,30,41,57,64). For example, Melone (41) reminds us that the user satisfaction construct has been used to refer to a user's perception of the system in some instances and an assessment of its output goals in others, and Etezadi-Amoli & Farhoomand (20) raise the problem that user satisfaction instruments rely on the affective/cognitive dimension of satisfaction without accounting for the performance-related dimensions. As McGill et al. (38) mention there has been little research attempting to link user satisfaction directly with other measures of user behaviour such as improved productivity, fewer errors or better decision-making. Nevertheless, despite the above-mentioned reservations, it seems that there are more positive than negative aspects with regard to using end-user satisfaction, and it is a widely used surrogate measure for information systems success (23).

A number of standardised tools have been developed to measure user satisfaction. The first user satisfaction instruments by Bailey & Pearson (7) contained a set of 39 factors. The satisfaction of users was calculated as the sum of users' positive and negative attitudes to these factors. This original measure was subsequently applied in the evaluation of HIS in 160 Veterans Administration Medical Centres (6). Other researchers have developed shortened and modified versions of user satisfaction tools (16,31,51) so that in 1989, Miller (42) identified 12 different user satisfaction instruments. However, most of these instrument focus primarily on the effectiveness of organisational IS rather than on the evaluation of user-satisfaction of IS (54).

The initial tool developed by Bailey & Pearson in 1983 remains one of the most widely used user satisfaction tools, followed by Baroudi & Orlikowski's (8), and Doll & Torkzadeh's (16) instruments, both from 1988. The tools differ in the number of items measured, the type of measuring scale (semantic differential vs. Likert-scale type scaling), and have different views on the data processing and end-user computing environment. This project has opted for the Doll & Torkzadeh's instrument for reasons that are detailed in the section 3.4 below.

2.0 RESEARCH QUESTIONS

The overall objective of the project was to evaluate a computerised hospital information system, Medicom, implemented in Natalspruit Hospital. The impetus for the study was the lack of any other known work in this area in South Africa and the need for data on the subject.

The following objectives were set out for the study:

1. to assess the hospital information system's success and/or failure by measuring the satisfaction of end-users (medical doctors and allied medical personnel, nursing staff, administration staff) with its content, accuracy, format, ease of use and timeliness;
2. to identify the hospital group (either nursing staff, or doctors/allied medical personnel, or administration staff) that were most satisfied with the hospital information system;
3. to analyse the user and HIS factors that influenced the satisfaction of end-users with the hospital information system.

3.0 MATERIALS AND METHODS

3.1 Study Site and Time

The research project was carried out in the Natalspruit Hospital, the chief regional hospital of the East Rand, Gauteng Province, South Africa. Natalspruit Hospital was one of those health facilities chosen by the province for implementation of a computerised information system. It has 729 beds and, at the time of the study, employed, among others, 769 members of the nursing staff, 72 medical doctors, 35 allied medical professionals and 159 members of administrative personnel.

End-user satisfaction with the Medicom health information system was assessed over a 2-month period, in October to November 2002. This was 34-35 months after the system has been introduced.

3.2 Medicom

Medicom, a computerised hospital information system, has been in place since January 1999. The cluster of modules accessible largely complies with the requirements stipulated by Gauteng Health Information Systems authorities (32). The list of modules that have been used in Natalspruit Hospital is summarised in Table 1.

The system is involved in most of the procedures that the patient encounters on or after entering the hospital. Ideally, processing of the patient would advance as follows:

- Clerks do registration and admission charge.
- A medical doctor in the outpatient department then takes over the patient setting up a computerised medical record. The diagnosis, its coding, and further follow-up either in the hospital setting or in a primary health care

centre/clinic are entered. Depending on the further management either the Inpatient module or the Outpatient module is used.

- In case of the patient's admission the ward clerk or a ward sister/nurse enters the patient onto the ward's register. During the hospitalisation both medical officers and nursing personnel update the electronic medical record daily with changes in the management. From the ward terminal a doctor can access additions to medical records from allied medical personnel such as speech therapists and social workers, or radiologists, who use the relevant modules from the Patient Care Services set (Figure 1). Unfortunately, the system does not incorporate laboratory results because the software used by the newly restructured National Health Laboratory Service System is not compatible with Medicom.
- Upon discharging or transferring the patient to a different institution, the attending medical officer writes a discharge summary into the electronic medical record.
- The patient is then encouraged to finalise the outstanding billing with clerks at the department where he/she was registered and, following that, can leave the hospital.
- If admission is not indicated, the patient progresses to the pharmacy where prescribed drugs are dispensed. Drug distribution is done without using Medicom (the pharmacy module is not yet operational because the pharmacy office and dispensing unit set-up are unsatisfactory and do not allow for safe record keeping).

Registration of accident and emergency cases by the module differs somewhat from the regular Patient Administration Services due to the limited information that can be provided by the very sick patient. Different billing procedures are involved, too.

TABLE 1

Medicom Modules and their Usage in Natalspruit Hospital

Modules		Used	Used by whom
Core modules			
	Registration (Master Patient Index)	Yes	Admin
	Duplicate Registration	Yes	Admin
	Inpatient Management	Yes	Sisters + Doctors
	OPD Management	Yes	Doctors
	Appointments	No	
	Accident and Emergency	Yes	Admin
	Medical Records	Yes	Sisters + Doctors
	Order Entry	Yes	Admin
	Patient Billing	Yes	Admin
	Statistical and Strategy Management	Yes	Admin
Finance Modules			
	Accounts Receivable	Yes	Admin
	Accounts Payable	Yes	Admin
	General Ledger	No	
	Fixed Assets	No	
Support Modules			
	Clinical Service	Yes	Doctors + Allied
	Pharmacy	No	
	Sterile Stock	Yes	Admin
	Radiology	Yes	Doctors
	Nursing Management	Yes	Sisters
	Operating Theatre	Yes	Sisters
	Dietary Service	Yes	Dieticians
Stock Modules			
	Medical Stock	Yes	Admin
	Inventory	Yes	Admin
	Purchase Order	No	

The Financial & Administrative Services, and Management Information modules (Table 1) are used by administrative staff and hospital management. They provide information about bed occupancy rates, mortality rates, length of patients' stay, etc., which are required by the senior managers in order to correctly manage hospital operations. However, as far as the financial modules are concerned, only two of them, Accounts Receivable and Accounts Payable modules, are currently used. Both the General Ledger and Fixed Assets modules are not operational because they are not compatible with another financial software programme, BAS (Basic Accounting System), which was recently introduced by a different part of the Department of Health.

The Rihanyo consortium provided Medicom training to all members of the staff who were supposed to utilise the new computerised system. The training was divided into two main types:

1. basic training – taught basic computer skills to the very large percentage of staff that had no prior awareness or knowledge of computing;
2. specialised training – provided computing tutorials separately for each Medicom module to the relevant administration, financial, procurement and medical staff.

3.3 Study Population and Study Sample

The study population included all individuals who fulfilled the basic criteria of working in Natalspruit hospital on a full-time basis, and who had had the opportunity to use the system (a Medicom logon id). The names of employees meeting the terms were obtained from the chief administrative clerk. The list revealed 1035 eligible participants.

Multi-stage sampling was used:

- *Stratified sample*: users stratified into 3 groups (according to the different Medicom modules used by each):
    1. Medical staff (107 members) - medical doctors from all departments (paediatrics, medicine, surgery, orthopaedics, casualty/out-patients, obstetrics and gynaecology, anaesthesiology) and representatives of professions allied to medicine (occupational therapy, physiotherapy, speech therapy, nutritional services, social worker services, radiography),
    2. Nursing staff (769 members), and
    3. Administration staff (159 members).
- *Simple random sample* within each stratum:
  every user was given a number and subjects were then randomly chosen to be included in the research by a computer.

A minimum sample size of 76 for each group was calculated using the formula for ANOVA. This allowed distinguishing a difference of 5 units in the means at a power of 80% and a 5% level of significance assuming that the population standard deviation is 11 units.

Additional subjects were recruited for each group proportional to size in order to improve representivity and the power of the study. Individuals from the medical group were allocated 80 questionnaires, representatives of the nursing staff received 200, and 100 were distributed to administration employees, producing a total sample of 380 full-time employees.

For simplification purposes the three groups of hospital staff will be labelled as 'Sisters', 'Medical', and 'Admin' respectively in the rest of this paper.

3.4 Study Design and Tools

A cross-sectional survey design was used in this research. Surveys are an important technique used in human-computer interaction research, and the traditional means of determining user satisfaction (17). The selected survey instrument was the 12-item questionnaire developed by Doll and Torkzadeh (16) as shown in Appendix A. This instrument was selected because of its documented reliability and validity (16,27,58,59), because it assessed parameters that were appropriate for this application, and because it was brief enough to be practical in the hospital environment. Some methodological and conceptual issues have been raised about this instrument (19), but of several tools reviewed, this was the only one that met all of the required criteria. The instrument utilises a five-point Likert-type scale ranging from 1 to 5:

- 1 - almost never
- 2 - some of the time
- 3 - about half of the time
- 4 - most of the time
- 5 - almost always,

to quantify users' perceptions of five system components: Content, Accuracy, Format, Ease of Use, and Timeliness. There are four questions assessing the dimension of Content; two questions assessing Accuracy; two questions assessing Format; two questions assessing Ease of Use, and two questions assessing Timeliness (Appendix A). Consequently the maximum score achieved for Content dimension can be 20, and 10 for each of the remaining dimensions, making a maximum of 60 for the whole questionnaire. The minimum score attainable is 12, while answering the median response of 3 for each question would result in a total of 36.

In addition to the standard part of the questionnaire, the subjects were asked to fill in questions related to demographic data (age and sex) and other variables that were presumed to influence their satisfaction with the computerised system. These covered:

- formal Medicom training
- frequency of Medicom use
- need for a technical support
- availability of technical support
- previous computer literacy
- previous usage of a hospital-computerised system in any other institution.

A space was also provided for the subjects to add any comments relevant to the use of Medicom in the hospital.

The questionnaire took 10-15 minutes to complete. Specific methods to control non-response included a tailored personal approach, a simple questionnaire format, multiple contacts, and confidentiality. The investigator made sure that he personally handed the questionnaires, information sheet and informed consent form to all participants, and also collected the completed forms from the respondents himself.

3.5 Ethics

A study information sheet was provided, and written informed consent was obtained from all respondents. The relevant forms are shown in Appendices B and C respectively. The purpose of the study was explained to all subjects. They were instructed to complete the forms without identifying themselves by name. Participation was entirely voluntary and could be discontinued at any time (even after signing the consent form). It was repeatedly emphasised that the subjects' responses were totally anonymous as no names were recorded on any

questionnaire. There were no risks involved for participants. It was explained that although there may have been no immediate direct benefit to any of them, the study would provide an opportunity to share insights that may improve the effectiveness of using computer technology in the public health system.

Permission for the study was obtained from the Superintendent of the hospital. The Committee for Research on Human Subjects (Medical) of The University of the Witwatersrand, Johannesburg, approved the research unconditionally (Ethical clearance number M02-05-44).

3.6 Statistical Analysis

Data from the returned questionnaires were entered into the computer and the statistical analysis was conducted using Microsoft Excel and InStat software (55).

The first research objective about overall satisfaction was answered by calculating the total average score and standard deviation. A 95% confidence interval was calculated using the standard formula (22). Differences in the satisfaction scores of nursing, medical and administrative staff (the second study objective) were tested by one-way Analysis of Variance (ANOVA) for normal data and the Kruskal-Wallis test for non-normal data. Comparisons were done using total scale scores as well as scores on sub-components of the scale (Content, Accuracy, Format, Ease of Use, Timeliness). Appropriate Multiple Comparisons tests were used to identify the specific differences between groups.

To answer the third research question, six research hypotheses were formulated for exploring the relationships between the response variable (user satisfaction), and the available predictor variables:

I. There is no significant association between age and user satisfaction;

II. There is no significant association between sex and user satisfaction;

III. There is no significant association between computer frequency use and user satisfaction;

IV. There is no significant association between technical support availability and user satisfaction;

V. There is no significant association between previous computer literacy (computer knowledge prior to training for hospital system) and user satisfaction;

VI. There is no significant association between hospital computer training and user satisfaction.

Significant relationships were identified by employing the independent t-test for Literacy; the Mann-Whitney test for Sex, Support Availability and Training; one-way ANOVA for Frequency of Use; and simple linear regression for Age. Multivariate investigation via multiple linear regression analysis was then utilised to adjust for confounding and evaluate the independent effects of the explanatory variables. The output in the form of P values (significant difference/relationship) was always interpreted using a cut-off point of 0.05. Detailed explanations of the results obtained and relevant statistical choices are provided in the next section.

4.0 RESULTS

4.1 Participants' Characteristics

380 users, divided into 3 groups, were invited to participate in the study. Figure 2 illustrates Medicom usage and a breakdown of the responses and return of questionnaires. The overall number of those who responded, i.e. filled in the questionnaire, was 320, giving an overall response rate of 84.2%. The first group

was the group of nursing personnel that is sisters, nurses and matrons. From 200 approached 178 completed the questionnaire (n=200; 178 or 89% response rate). The second group included both physicians and medical allied personnel because they use the same Medicom module (n= 80; 64 or 80% response rate - doctors n=47; 31 or 48.4% response rate, allied n=33; 33 or 100% response rate). The third group consisted of representatives of administration staff, that is clerks and managers (n=100; 78 or 78% response rate). In summary, 89% of Sisters completed the questionnaire in comparison to 80% of the Medical group and 78% of Admin.

Of those participants that completed the questionnaires, 32 replied that they did not use Medicom and left all questions essential to the study unanswered. As a result, only 288 questionnaires were available for analysis. For the Medical group, though, there were significant differences between the responses of medical doctors and allied medical personnel in the usage of Medicom. Of the 31 doctors completing the questionnaire, 23 (74.2%) claimed to be non-users. Overall, doctors formed 71.9% of all 32 Medicom non-users. These facts mean that doctors were under-represented in the final study sample. The implications of this are discussed further in the discussion section.

The itemisation of characteristics of all participants who participated in the survey can be seen in Tables 2 and 3.

Females formed the vast majority in these professions – especially for the Sisters group, and less in Admin. Only in the Medical group males made up the majority.

FIGURE 2

Response Rate and Medicom Usage

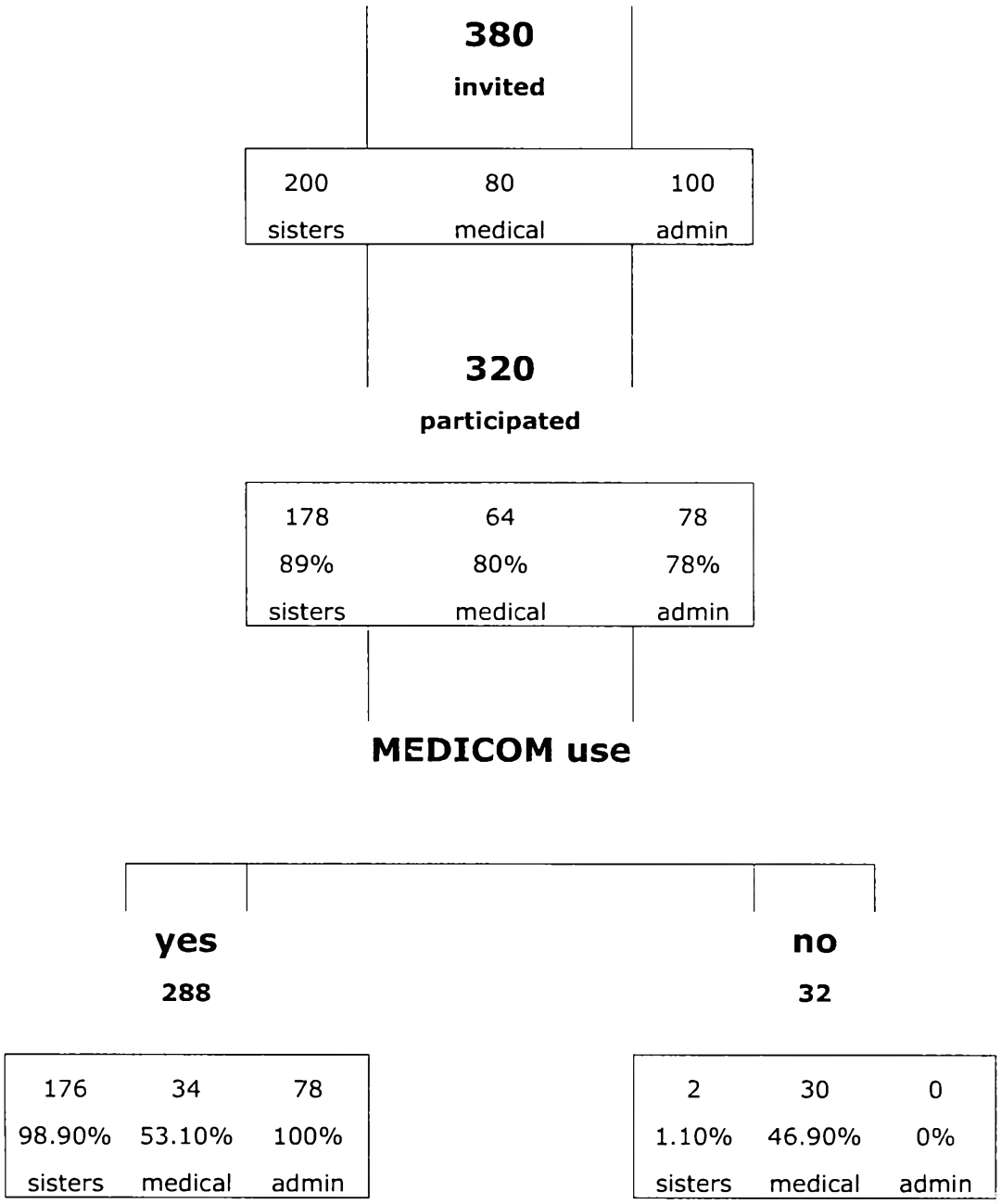


TABLE 2

Subjects' Sex

	Female	Male
Sisters	171 (97.2%)	5 (2.8%)
Medical	15 (44.1%)	19 (55.9%)
Admin	55 (70.5%)	23 (29.5%)

TABLE 3

Subjects' Demographic Characteristics

	Average age (in years)	SD	Average years in position	SD	Average years in Natalspruit	SD
Sisters	40.8	7.3	12.4	7.1	14.3	7
Medical	36.4	10.4	10.7	10	8.6	6.6
Admin	35.1	7.3	7.7	5.7	9.4	6.3

Key: SD – standard deviation

Study contributors' average age ranged between 35.1 in Admin to 40.8 years in Sisters. Sisters had a considerable experience in both their profession and working in the hospital, though the other two groups lagged only slightly behind.

4.2 Analysis of participants' characteristics

TABLE 4

Subjects' Characteristics related to Computers

	Sisters	Medical	Admin	Total
Formal Medicom Training				
Yes	162 (92%)	24 (70.6%)	60 (76.9%)	246 (85.4%)
No	14 (8%)	10 (29.4%)	18 (23.1%)	42 (14.6%)
Medicom Frequency Use				
Every day	64 (36.4%)	4 (11.8%)	53 (67.9%)	121 (42%)
Few times a week	54 (30.7%)	9 (26.5%)	16 (20.5%)	79 (27.4%)
Once a week	18 (10.2%)	6 (17.6%)	8 (10.3%)	32 (11.1%)
Few times a month	18 (10.2%)	12 (35.3%)	1 (1.3%)	31 (10.8%)
Once a month	5 (2.8%)	0	0	5 (1.7%)
Less than once a month	17 (9.7%)	3 (8.8%)	0	20 (6.9%)
Technical Support needed				
Yes	165 (93.8%)	28 (82.4%)	74 (94.9%)	267 (92.7%)
No	11 (6.2%)	6 (17.6%)	4 (5.1%)	21 (7.3%)
Technical Support Availability				
Yes	127 (77%)	24 (86%)	64 (86.5%)	215(80.5%)
No	38 (23%)	4 (14%)	10 (13.5%)	52 (19.5%)
Prior Computer Literacy				
Yes	57 (32.4%)	19 (55.9%)	24 (30.7%)	100 (34.7%)
No	119 (67.6%)	15 (44.1%)	54 (69.3%)	188 (65.3%)
Prior Hospital Information System Use				
Yes	3 (1.7%)	1 (2.9%)	0	4 (1.4%)
No	173 (98.3%)	33 (97.1%)	78 (100%)	284 (98.6%)

The analysis of the participants' characteristics related to a Medicom training, frequency of its use, need for technical support and its availability, as well as general computer literacy and knowledge of any other hospital information system, is shown in Table 4.

The majority of staff underwent the formal Medicom training. 8% of Sisters did not receive training in contrast with 29.4% of Medical and 23.1% of Admin. Sisters, together with Admin, were also heavy users of computers unlike Medical who were using it considerably less frequently. If every-day and few-times-a-week usage are combined, 2/3 of either Admin or Sisters would be included, compared with only 1/3 of Medical utilizing it this often. Technical assistance was needed mostly by Admin and Sisters (94.9% and 93.8% respectively). However, this was not considerably different from Medical users, 82,4% of whom also needed help. With regard to the accessibility of technical support, 23% of Sisters complained that their call for aid was not heard, in comparison with 14% for Medical and 13.5% for Admin. Computer literacy prior to the Medicom use was highest in Medical (55.9%). Only about 1/3 of Sisters and Admin were knowledgeable about computers at the same stage (32.4% and 30.7%, respectively). A negligible number of users had used a Hospital Information System at a different establishment (1.4% for all three groups combined).

As for those who could not be included in the analysis because they were not using Medicom, the main reasons named for the failure to make use of the system are shown in Table 5. By a large amount time constraints were blamed most frequently. The lack of satisfactory capacity to use the scheme was another important factor mentioned. (The total number of reasons given (37) does not equate to the number of Medicom non-users (32) because some participants gave more than one reasons for not using it).

TABLE 5

Reasons for not using Medicom

	Sisters	Medical	Admin
Lack of time/staff shortage	2	17	
Computer illiteracy		2	
Clinical work preference		1	
No Medicom knowledge		6	
No need for computers		3	
Lack of terminals		4	
Double work (paperwork+computer)		1	
Frequent faultiness		1	
Total	2	35	0

4.3 User Satisfaction

This section of the results addresses two of the research questions that is, firstly, the actual end-user satisfaction with Medicom and, secondly, the identification of the most satisfied group. The exact itemisation of how the individual groups contributed to the final results is shown in Table 6 and Figure 3. Admin gave the system the highest approval with a mean of 43.9 (95% confidence interval 41.8 – 46.1). They were trailed by Sisters who scored 40.6 (39 - 42.1) and the Medical with the much lower mean score of 34.1 (30.2 - 38).

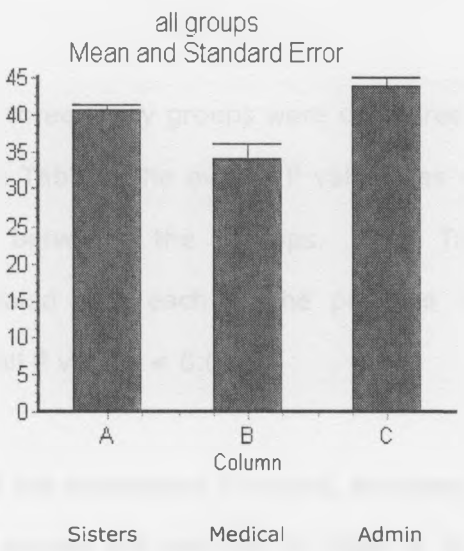
TABLE 6

Satisfaction Mean: Individual Groups

	Users	Mean	SD	Min.	Max.	Median	95% Confidence Interval LCL	UCL
Sisters	176	40.6	10.5	12	60	42	39.0	42.1
Medical	34	34.1	11.2	16	52	37	30.2	38.0
Admin	78	43.9	9.6	19	60	46	41.8	46.1

FIGURE 3

Groups' Satisfaction Mean and Standard Error



The average satisfaction scores for all three groups combined are provided in Table 7. The sample results were weighted to reflect the relative contribution of the three groups in the hospital, but in fact weighting made little difference to the sample estimate (Mann-Whitney Test, P value = 0.6220). The overall user satisfaction score in the survey was 40.7 (95% confidence interval 39.5 – 42.0) out of a possible 60. This is slightly above the middle score of 36 meaning that in general users tended to be satisfied with the system.

TABLE 7

Satisfaction Mean: Groups combined

Users	Mean		SD	Minim.	Maxim.	Median	95% Confidence Interval LCL	UCL
288	**Unweighted:**	39.5	5	34.1	43.9	40.6	27.1	52
288	**Weighted:**	40.7	10.7	12	60	43	39.5	42

The mean scores of the three study groups were compared by a one-way ANOVA test. As indicated in the Table 8 the overall P value was < 0.0001, indicating a significant difference between the groups. The Tukey-Kramer Multiple Comparisons Test revealed that each of the pairwise comparisons was also statistically significant (all P values < 0.05).

Mean ratings for each of the dimensions (Content, Accuracy, Format, Ease of Use, and Timeliness) in the survey are itemised in Table 9. It was obvious that on average Medicom scored highest in the area of Ease of use (7.1), followed by Format (7), Accuracy (6.9), and Content (6.7), and lowest at the area of Timeliness (6.3). (It must be noted that for comparison purposes that the mean

score for Content must be divided by two due to this dimension having twice as many questions in the questionnaire).

TABLE 8

Satisfaction Means: Group Comparison

	P value
All Groups	< 0.0001
Group Comparison (Tukey-Kramer multiple comparisons test)	
Sisters vs. Medical	< 0.01
Sisters vs. Admin	< 0.05
Medical vs. Admin	< 0.001

TABLE 9

Satisfaction Means for each Dimension

	Sisters	Medical	Admin	All groups
All dimensions	6.8	5.8	7.4	6.7
Content	13.5	10.6	14.0	13.3
Accuracy	7.0	6.2	7.0	6.9
Format	6.9	6.2	7.6	7.0
Ease of use	6.9	6.1	8.2	7.1
Timeliness	6.2	5.0	7.3	6.3

Data for the subgroup analysis were not normal so nonparametric tests were used. A synopsis of this analysis is summarised in Table 10. Overall, there were significant differences between the medians of the three groups (P value <0.05) for all dimensions except of Accuracy. Dunn's Multiple Comparisons was calculated to identify significant pairwise comparisons. Timeliness component was found to be significant in all three group comparisons. The significance for Content and Ease of Use was identified on two occasions, and for Format only once. The Medical vs. Admin comparison was the only one that recorded statistical significance for all components.

TABLE 10

Dimensions' Satisfaction Means Comparison: Individual Groups (P value)

	Total	Sisters vs. Medical	Sisters vs. Admin	Medical vs. Admin
Content	< 0.0003	< 0.001	NS	< 0.001
Accuracy	0.1156	N/A	N/A	N/A
Format	0.0121	NS	NS	< 0.05
Ease of use	< 0.0001	NS	< 0.001	< 0.001
Timeliness	< 0.0001	< 0.001	< 0.01	< 0.001

Key: N/A – not applicable

NS – non-significant (P value > 0.05)

Table 11 shows the results of Friedman test used to evaluate the differences between specific dimensions (overall P value < 0.0001, Dunn's Multiple Comparisons Test for individual dimensions). Despite seemingly minor numerical distinctions between particular dimensions (ranging from 7.1 for Ease of Use to

6.3 for Timeliness) statistical differences were identified, mainly with the dimension with the lowest average score, that is Timeliness.

TABLE 11

Dimensions' Satisfaction Means Comparison: All Groups (P value)

	Content	Accuracy	Format	Ease of use	Timeliness
Content		NS	< 0.01	< 0.001	NS
Accuracy			NS	NS	< 0.05
Format				NS	< 0.001
Ease of use					< 0.001
Timeliness					

Key: NS – non-significant (P value > 0.05)

4.4 Explanatory Factors

4.4.1 Bivariate Analysis

The relationship between user satisfaction (the dependent variable) and potential independent variables (Literacy, Sex, Support Availability, Training, Frequency of Use, and Age) were analysed by the appropriate tests. Table 12 shows the results of the bivariate comparisons. For the binary independent variables, an independent t-test was appropriate for Literacy (normally distributed), and the non-parametric Mann-Whitney test was used for Sex, Support Availability and Training variables (non-normal). The Frequency of Use variable has 6 categories, which required a one-way ANOVA, while simple linear regression was used to evaluate the relationship between user satisfaction and Age.

Of all variables tested two of them, namely the Availability of Technical Support and Frequency of Medicom Use, were identified as significantly related to level of satisfaction (with P values of 0.0042 and 0.0012 respectively). Figures 4 and 5 present means and standard deviations for each category of the two significant variables in a graphical form. Users that reported that technical support was available when needed were more likely to be satisfied with the system and, the less frequently a user worked on Medicom the less he/she was satisfied.

A comparison of the means for the other variables indicates the direction of the relationships even though the results were not statistically significant. Regarding Training (P value 0.1367), the relevant means values suggest that trained people were more satisfied with the system than those without any training. The P value for Sex was not significant (P value 0.5774), but females had a higher mean satisfaction score than their male counterparts. Similarly, Literacy (P value 0.3680) and Age (P value 0.757) were not significant predictors of user satisfaction - but the higher mean for those who were computer illiterate might imply that computer literacy might not be such an important factor in Satisfaction.

TABLE 12

Bivariate Analysis Results between Satisfaction and Predictor Variables

(All Groups)

Predictor Variable	Correlation Coefficient	P value
Age	0.01831	0.757

Predictor Variable	Mean	P value
Sex		0.5774
Female	40.88	
Male	39.87	
Frequency Use		0.0012
Every day	43.18	
Few times a week	40.06	
Once a week	41.78	
Few times a month	34.94	
Once a month	36.6	
Less than once a month	36.7	
Support Availability		0.0042
Yes	41.68	
No	36.87	
Literacy		0.368
Yes	39.92	
No	41.12	
Training		0.1367
Yes	41.07	
No	38.64	

FIGURE 4

Support Availability (Mean and Standard Deviation)

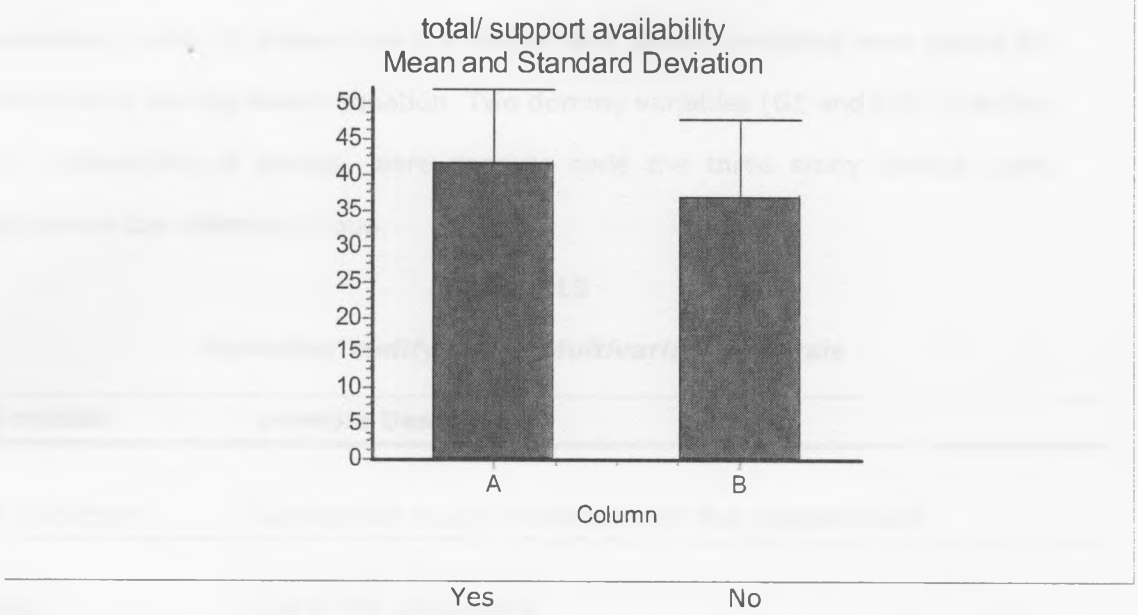
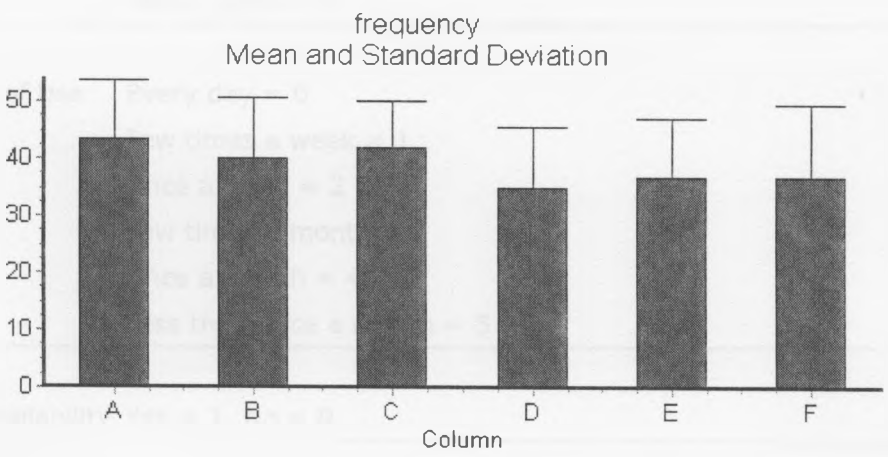


FIGURE 5

Frequency of Use (Mean and Standard Deviation)



Key:
A – Every day
B – Few times a week
C – Once a week
D – Few times a month
E – Once a month
F – Less than once a month

4.4.2 Multivariate Analysis

In this analysis a linear multiple regression model was used to explore the multivariate relationships between satisfaction and the available predictor variables. Table 13 shows how the ordinal and binary variables were coded for inclusion in the regression equation. Two dummy variables (G1 and G2), to adjust for confounding of groups, were used to code the three study Groups using Sisters as the reference group.

TABLE 13

Variables' codifying for Multivariate Analysis

Variable	Variable Description
Satisfaction	Satisfaction value calculated from the questionnaire
Age	Age of the respondent
Sex	Female = 1, Male = 0
Literacy	Yes = 1, No = 0
Training	Yes = 1, No = 0
Frequency of Use	Every day = 0 Few times a week = 1 Once a week = 2 Few times a month = 3 Once a month = 4 Less than once a month = 5
Support Availability	Yes = 1, No = 0
G1	Medical = 1, Sisters = 0
G2	Admin= 1, Sisters = 0

Table 14 summarises the results. Multivariate analysis only includes the cases which have complete data for all the variables included. For that reason, 21 people (11 from Sisters, 6 from Medical, and 4 from Admin) who did not need any support (and thus could not respond to whether or not it was availabile) had to be excluded from this analysis. The R-square of 0.106 suggests that the model did not fit the data very well explaining only 10.6% of the original variability, though the overall P value of 0.00028 indicates that the model is significant. Support Availability (P value 0.005) and G1 (P value 0.009) were the only independent variables found to be statistically significant in relation to Satisfaction (P value 0.005). Other predictor variable revealed non-significant P values. The directions of all coefficients were consistent with the conclusions from the bivariate analysis. Positive correlation for Availability of Technical Support indicates that the satisfaction score would increase with the provision of support. Direction of the negative coefficient in G1 indicates that the Medical score is lower than the score for the reference category of Sisters.

With reference to the study's core questions, on the strength of the above-mentioned results it was only possible to reject null hypothesis number IV whereas the remaining hypotheses (I, II, III, V, and VI) were not rejected.

Table 14

Multivariate Analysis Results between Satisfaction and Predictor Variables (All Groups)

Regression Statistics	
Multiple R	0.326
R Square	0.106
Adjusted R Square	0.078
Standard Error	10.118
Observations	267

Analysis of Variance

	Degrees of Freedom	Sum of Squares	Mean Square
Regression	8	3136.383	392.048
Residual	258	26410.786	102.367
Total	266	29547.169	111.080
F-test			3.830
P-value			0.000283

Ordinary Least Squares

	Unstandardised Coefficient		Standardised Coefficient		
Variable	**B**	**Standard Error**	**Beta**	**t Stat**	**P-value**
Age	-0.021	0.093	-0.016	-0.226	0.821
Sex	0.264	1.980	0.009	0.133	0.894
Literacy	-0.422	1.331	-0.019	-0.317	0.751
Training	1.195	2.222	0.038	0.538	0.591
Frequency of Use	-0.821	0.469	-0.115	-1.749	0.081
Support Availability	4.569	1.615	0.172	2.829	0.005
G1	-6.027	2.290	-0.176	-2.632	0.009
G2	1.766	1.656	0.075	1.067	0.287
(Constant)	37.889	4.379		8.652	0.000

4.5 Participants' Comments

In order to illustrate and clarify the context and conditions under which the research was conducted the quantitative constituent of the study was supplemented by observations related to the hospital computerised system that all subjects were free to put down in an open-ended question on the questionnaire.

Respondents brought up a great deal of remarks. The list of issues mentioned is summarised in Table 15. Sisters (n=85; 48.3% of the group subjects) and Medical (n=16; 47.1%), were the most vocal to express their feelings (compared to only 9 Admin (11.5%) who completed this question). 23 contributors from Sisters commended the system, but unenthusiastic remarks from all groups were in the majority. High on the list of complaints were:

- lack of time to manage computers,
- technical problems with regards to workstations, and
- deficiency of initial training before Medicom implementation.

Training was considered a failure by Medical – they complained about inadequacy of the initial training and about the lack of any follow-up training at all. Allied medical personnel complained about doctors not operating the system in any way, which was hindering their monitoring of patients.

TABLE 15

Quantified List Of Subjects' Comments

	Sisters	Medical	Admin
Inadequate initial training	15	6	3
Computer hardware technical problems	21	2	2
Awkward/unfriendly software	7	4	1
Need for ward clerk	4		
Tailoring to departmental needs		3	
Double work (paperwork + computers)	7	3	
No time for adequate use/staff shortage	17	9	
Poor password acceptance	4		
Non-existing laboratory link	3	1	
Irrelevant diagnoses to local population	1		
Untimely computer shutdowns	1		
Lack of computers		1	1
Under-utilisation by staff (namely doctors)		7	
Management ignorance		2	
Ignorance of user input		1	
Poor implementation in Natalspruit hospital		4	
Need for yearly training		5	
Questionable Medicom necessity		1	
Medicom praise	23		2
Total	103	49	9

5.0 DISCUSSION

This study explored the satisfaction of both medical and administrative personnel with the computerised hospital information system at their workplace. The results are of importance, as they draw attention to which parts of the information system users were satisfied and dissatisfied with. The key findings were that the users were reasonably satisfied with the system favouring specifically the Ease of Use dimension. Administrative staff were satisfied most. Of six variables analysed, the Availability of the Technical Support came up as the only significant predictor of satisfaction.

Eliciting and analysing user attitudes may be an important component of good system design. A comprehensive critique by Melone (41) of the theoretical issues involved in the user satisfaction construct noted that many theoretical and practical issues remain to be resolved. The author cautions that "to the extent that attitudes are held to establish or maintain a positive image of the self, they are less likely to serve the evaluative function implied in IS research". Similarly, another study by Hufnagel (30) suggests that an individual's affective response to a given performance outcome is often highly subjective and in some cases, highly ego-defensive. User satisfaction is an attitude, and attitudes that users hold may play a role in establishing and maintaining self esteem (46). User satisfaction focuses on process, not on actual outcomes. It should be seen as a signal of acceptance of users and, thus, likely to be more useful in finding critical problems of IS implementation or use process than in evaluating the organisational outcomes (39,60,62).

Although user satisfaction measures have become common in the IS science (13), the role of user satisfaction has not been as prominent in health care due to the stricter approach to evaluation of IS in this field. In comparison, studies in the

health care context have used an user satisfaction tool approximately five times less frequently than those in general IS research (24,63). Even though, as suggested above, user satisfaction might be regarded as a substitute measure of patient outcomes, it might overemphasise users' views. Instead, more direct measures of the impacts on patients' health have been used. Surprisingly, user satisfaction measures have also not been used in the evaluation of auxiliary health IS systems (appointment management, document management, financial transactions and personnel information) that influence patient's welfare only indirectly (63).

The response rate in this study was adequate (n=320; 84,2%). 32 (10%) questionnaires could not be added into the study because their respondents were not using the system. 10% of non-users is not high, but what was of the most interest and concern was that medical doctors formed the sizeable majority of this group (n=23; 71.9%). Therefore, because it was not possible to include doctors' perspectives into calculations due to their failure to use the Medicom system, the overall results may be biased. Eventual viewpoints regarding satisfaction were derived from the computer users largely emanating from the other two groups, Admin and Sisters. Results for these two groups are valid. It is presumed that by the inclusion of a larger number of doctors (although they would always form the smallest group) into the study, the overall satisfaction score would be lower.

The mean total score for the survey was 40.7 (details in Table 7). It is safe to say that the overall mean is slightly above the test midpoint of 36 (adjusted for the possible minimum and maximum scores of 12 and 60 respectively), suggesting that the users were generally more satisfied than unsatisfied with the system. Comparisons to other similar studies are not possible because the Medicom software has never been evaluated in this way in any other institution. The

overall results, though, do not support the rather optimistic conclusion of the WHO Evaluation Task Force (35). This group assessed the Health Information System in Gauteng Province in July 2001 through random observations and unstructured interviews and concluded that "on the whole, there was a high level of satisfaction with the new system".

Manifestly the most satisfied hospital group with Medicom was the Administration group with the mean score of 43.9 (Table 6). Sisters followed Admin with the above-average mean 40.6 (median 42, and standard deviation 10.5). Medical Medicom' users expressed their frustration with the below-average mean of 34.1 (median 37, and standard deviation 11.2). The differences between these groups were statistically confirmed (Tables 8 and 14). Reasons for these differences cannot be clearly identified at this stage. Administrative duties are closely linked to computer use, and Admin could have just expressed their happiness with having any computer system at disposal (there was none available before the hospital computerisation). The same could have applied to Sisters whose general positive motivation towards various obligations could have led them to embracing any hospital improvement. On the other hand Medical, known for their aversion towards IT systems that force them to change the way they practice medicine (50), could have given Medicom low marks as they would have to any other system in place.

With regard to the specific dimensions, some statistically significant differences were noted (Table 9 and 11). Ease of Use achieved the highest score (7.1). It was closely followed by Format (7), and further away by Accuracy (6.9) and Content (6.7). The least favourable dimension was considered Timeliness with barely-over-the average 6.3. It might be inaccurate, though, to cluster the dimensions together and produce a total average score. The dimensions assess the Medicom's modules and these do differ in relation to the studied groups. The

statistical differences between the groups were calculated for each dimension (Table 10). Not surprisingly, considering their overall system's assessment, the most profound differences were found when comparing scores between Admin and Medical.

A better picture about the dimensions' performance seems to be gained by looking into the individual groups (Table 9). Admin scored highest, 8.2, for Ease of Use (the system was both user friendly, and easy to use), and lowest, 7.0 (even though still above the mathematical average of 6.0), for Content (informing about the system's provision of either the precise or sufficient information needed, of reports that seem to be just about exactly what needed, and about the information content meeting one's needs) and Accuracy (answering the questions if the system was accurate, and if the users were happy with the accuracy of the system). Both Sisters and Medical staff scored highest for Accuracy (7.0 and 6.2 respectively). Medical put Format (output was presented in a useful format, and information was clear) on the par, 6.2, with Accuracy. On the other hand both groups responded less positively to questions about whether they got information they needed on time, and if the system provided up-to-date information (Timeliness dimension, 6.2 and 5.0 respectively).

It was not possible to pinpoint reasons for differences in performance along different dimensions or the groups' preferences in this study. Detailed one-on-one interviews and close interaction between computer specialists and computer users would be required to shed some light on these issues. The information provided on the weaker points of the system, however, would be of use to policy makers and managers who are involved in a future upgrade of the current information system or its development in any other way. As Lin & Shao (33) proposed, the inclusion of user perspectives is a very important part of ongoing system development bringing benefits that include higher levels of information

system usage, greater user acceptance of systems and increased user satisfaction.

Analytical bivariate analyses suggested that Technical Support Availability (P value 0.004) and Frequency of computer Use (P value 0.001) were predictors of user satisfaction. Both measurements were found to be directly related to the level of satisfaction. In multivariate analysis, of the variables included in the study only the Availability of Technical Support (P value 0.005) was a significant predictor of user satisfaction. As in the ANOVA analysis, significant difference in personnel group (Medical Sisters comparison, P value 0.008) was found after adjustment for all other variables. There are multiple implications arising from these outcomes. In order to improve the hospital information system's performance, both sides, the provider of the hospital information system and its user, should share the responsibility. The management must make sure that timely technical support is available whenever needed by the user. Further, managers should concentrate their effort on motivating users on the usage of the system doing their utmost to find the most effective ways to achieve that. General consideration should be naturally given to all relevant employees, but a particular attention should be paid to the staff from Medical group, mainly doctors, due to their least encouraging results in this study. On the other hand, the users should do their best to meet their employer's demands and realise the simple fact that these systems do improve the hospital's performance and, in due course, patient care.

Owing to the way doctors may have influenced the study, an assessment of the subject may be warranted. This was only a sample of doctors and it is not possible to generalise these results either to all doctors in the hospital, or to all doctors in similar institutions. There is other evidence, though, to suggest that this is a more general pattern, and not confined only to Natalspruit Hospital.

Reports from Ga-Rankuwa Hospital (Pretoria, Gauteng Province) alleged that there were almost no doctors using the Medicom system (32). The paper-based system remains an important feature of health care for now and easier to work with. Any new system has to be at least as simple, user-friendly, satisfying, and flexible, or have considerable new advantages, as the one in place in order to win over doctors. Otherwise it will be ignored irrespective of how good its technical parameters are. The impact on patients' healthcare may be dramatic considering the poor quality of both incomplete data entering the system and information provided by the system. Medicom is not a voluntary system, meaning that doctors are obliged to apply it. The reasons for doctors' non-compliance, as outlined on their questionnaires evolve around two issues – a lack of time related to the severe shortage of personnel, and issues related to computer system itself (illiteracy, training, overall perception or rather misperceptions about informatics concepts, etc.). Apart from the above-mentioned reason of time deficiency, the lack of Medicom knowledge or complete computer illiteracy were reasons worthwhile to note and, certainly, they may have played a role in computer usage. The problem goes much deeper, though. Formal training in general computing or medical informatics should be an integral part of the syllabus during medical school or internship (9). Detmer & Friedman (15) provide evidence that doctors with formal training, when compared to those without formal training, were more knowledgeable about informatics concepts and had a tendency to believe that computers would be more beneficial to health care.

Not a single participant in the study appeared concerned about computers used in the hospital information system potentially resulting in a loss of personal and professional privacy. This fear has been noted previously even in environments where information systems are more mature (49). Either the users may have believed that these concerns were well addressed by the careful format of security features or, which is much more probable, the rather impersonal manner

of working in this hospital with no deep patient-doctor bond development resulted in ignoring the prospective problem. Another potential concern, as noted in the literature, is the belief that computers can have a negative effect on the rapport between physicians and patients (43) (e.g. the way of entering data into the electronic medical record during clinical encounters). This was not mentioned in this study.

Negative attitudes towards computers could be addressed by careful system design as well as targeted educational activities. Deployment of an integrated clinical information system with a provision of electronic access to recent laboratory and radiology reports has to be one of the first most obvious improvements to make to the Medicom system. Further, both hospital information system architects and hospital management must concede to the general perception that self-education and access to up-to-date information are the most beneficial aspects of computers and make relevant software part of the system for academic activities and continuous professional development. If doctors use computers for one reason they may be less likely to be reluctant to use them to perform less desirable tasks such as ordering and data entry. Ongoing computer training with a stepwise approach in the introduction of new user-friendly technologies that would improve the existing work processes and to overcome the fear of users should immediately be instituted. Provision of adequate technical support must also be an essential part of all activities. Further research testing the hypothesis that computerisation encourages or facilitates better practice, and leads to the ultimate goal that is to say, better patient care needs to be done. The leaders, management and relevant authorities, must demonstrate ongoing commitment - it is not enough for the system to be established, it must be sustained as well.

There did not seem to be any problem with usage of Medicom by either Sisters or Admin, which was close to 100%. People do not always adapt immediately to a new environment and get on with new systems that enthusiastically even if they are beneficiaries. Here possible explanations include that Sisters and Admin could have considered the system more beneficial towards their duties, and they could have been more respectful to their own managerial structures. Or, simply, the computer design was experienced as more accommodating than for the Medical group. That should not come as such a surprise considering that original requirements for a hospital information system in South Africa/Gauteng were mostly about improving general administration, less about patient-oriented administration, and least about clinical use (2).

With reference to the subjects' general comments on the questionnaire, it is worth noting on the positive side that a number commended the implementation of Medicom. On the negative side, however, there were a substantial number of complaints related to the insufficient formal computer training, workstation technical problems, and the limited time available to exploit the Medicom possibilities to its optimum due to the staff shortages and the feeling of being overworked. Exactly the same main problems were identified in studies evaluating information systems in both Northern Province and Gauteng (32,36,37).

6.0 CONCLUSION

Electronic health care applications are extremely complex and the hospital environment is uncompromising. It has been confirmed that the methodology and technology chosen for the Health Information System in Gauteng is in full compliance with the standards, set at the national level, for nation-wide

compatibility in health information support (35). If health care computerisation is to be taken forward successfully, with everybody involved making an active contribution to future health care information technology developments, then the satisfaction, attitudes and concerns of both medical and administrative personnel with these developments must be acknowledged. Human-computer interaction studies provide a valuable method to help us understand how hospital staff use computers and how they can be improved.

Based on the results of this study it would appear that the potential benefits of computerisation were not clear to many of hospital personnel and that their satisfaction with the current system and its implementation was just slightly above average. Higher satisfaction levels would be more desirable. Optimal use of Medicom by clinicians is essential if its benefits are to be realised. This suggests that there is much to be done in terms of supporting the staff as they develop their understanding of the benefits that information technology systems may have for themselves and for patient care. Both ongoing monitoring and intermittent evaluation of the system are needed and should form the foundation for further research. Learning from these findings and mistakes of the initial execution, and better reciprocal understanding of all contributors involved should ensure that user satisfaction, and ultimately patient care, will improve considerably over time.

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APPENDIX A

QUESTIONNAIRE /page1/

Do you use the MEDICOM system?

If NO, please state briefly why you do not use the system in the space below and then complete the page 2 (questions 1 to 7, and 14)?

.....

.....

If YES, please answer the questions below by circling the most appropriate answer and then complete the page 2 (questions 1 to 14)?

CONTENT

Does the system provide the precise information you need?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Does the information content meet your needs?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Does the system provide reports that seem to be just about exactly what you need?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Does the system provide sufficient information?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always

ACCURACY

Is the system accurate?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Are you satisfied with the accuracy of the system?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always

FORMAT

Do you think the output is presented in a useful format?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Is the information clear?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always

EASE OF USE

Is the system user friendly?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Is the system easy to use?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always

TIMELINESS

Do you get the information you need in time?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always
Does the system provide up-to-date information?	Almost Never	Some of the Time	About Half of the Time	Most of the Time	Almost Always

1. What is your age? ☐

2. Are you a male or female? ☐ M ☐ F

3. Which department/unit do you work in? ☐ paediatrics ☐ surgery ☐ O + G ☐ OPD ☐ ICU ☐ medicine ☐ orthopaedics ☐ allied medical ☐ administration

4. What is your job title/current position? ☐ intern ☐ community service doctor ☐ medical officer ☐ consultant ☐ matron ☐ sister ☐ nurse ☐ administrative clerk ☐ allied medical ☐ manager

5. How long have you been holding the position? ☐ .....years ☐ .....months

6. How long have you been working at Natalspruit hospital? ☐ .....years ☐ .....months

7. Did you get any formal training on the MEDICOM system? ☐ yes ☐ no

8. How often do you use the MEDICOM system?

☐ every day ☐ a few times a week ☐ once a week ☐ **a few times a month** ☐ once a month ☐ less than once a month

9. Did you need a technical support for the MEDICOM system? ☐ yes ☐ no

10. Was technical support for the MEDICOM system available if you needed it? ☐ yes ☐ no

11. Were you computer literate before you started using the MEDICOM system? ☐ yes ☐ no

12. If YES, how would you rate your computer skills?

☐ poor ☐ fair ☐ good ☐ very good ☐ excellent

13. Have you used any hospital-computerized system anywhere else? ☐ yes ☐ no

14. Would you like to add ANY COMMENTS relevant to the use of the MEDICOM in the hospital?

.....

.....

.....

I would like to thank you and show appreciation for your time and contribution to this research.

APPENDIX B

INFORMED CONSENT FORM

Hello, my name is Dr. Jaromir Vomacka. I am part of a study to investigate the effectiveness of the MEDICOM software currently used in the hospital information system. I am a Master of Public Health student doing research for my project at the Witwatersrand University. You were randomly selected as a possible participant in this study. Would you please consent to assist me in my study?

If you decide to participate, you will be asked to complete a questionnaire concerning your satisfaction with the computer system in the Natalspruit hospital and a few personal details, but no names or any form of information that could identify you personally. This may be helpful for the final statistical analysis. The questionnaire will take approximately 10 minutes to fill out. There are no risks involved for participants. Benefits include the opportunity to share insights that may improve the effectiveness of using computer technology in the public health system.

Any information that is obtained in connection with this study will remain confidential and published as part of my Master's dissertation. Your participation is entirely voluntary and your decision whether or not to participate will involve no penalty or loss of benefits to which you are otherwise entitled. If you decide to participate, you are free to discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled. At no time will you be identified to anyone.

If you have any questions about the research at any time, please call me at (011) 389 0500 or write to me, Natalspruit Hospital, Alrode X01/1451. If you have any questions about your rights as a participant in a research project, please call the Division of Deputy Registrar at Witwatersrand University, (011) 717 1234.

Your signature below indicates that you have read and understand the information provided above and that you willingly agree to participate, you may discontinue participation at any time, and are granting permission for incorporating your information to all data gathered during the research.

Dr. Jaromir Vomacka, MPH Student

I,
(name)_____

Agree o participate in this study. I understand that my views will be kept completely confidential.

Signature_____date_____

APPENDIX C

INFORMATION SHEET FOR SUBJECTS

Title of the project: End-User Satisfaction with an Information System Implementation in Natalspruit Hospital, Gauteng Province

Hospital information systems form a cornerstone of modern hospital care. Computerized forms of these systems are being implemented in an increasing number of hospitals. Natalspruit Hospital has been one of the establishments that has benefited from the formation of the Gauteng Provincial Health Information System under the auspices of the Gauteng Department of Health putting the new computerized version into effect in January 2001.

The evaluation of the effectiveness of an information system constitutes one of the key issues in information systems research. User information satisfaction is probably the most widely used single measure of information system success.

My study will concern evaluating a success/failure of MEDICOM system in Natalspruit hospital through a cross-sectional type of survey research using a questionnaire containing key questions of user satisfaction on system information and its quality. I would like you to volunteer for assisting me in this research project.

I would randomly select representatives of all groups of the hospital staff who have been utilizing the relevant software (doctors, allied medical personnel, nurses, and administrative staff) and ask for their participation.

Every participant will be asked to complete a short questionnaire concerning his/her satisfaction with the computer system in the Natalspruit hospital and a few personal details that may be helpful for the final statistical analysis. Participation is entirely voluntary, and you may discontinue at any time (even after signing the consent form). Your responses are totally anonymous, as no names will be recorded on any questionnaire. There are no risks involved for participants. Please be assured that at no time will individuals be identified to any of the authority and responses to the questionnaire are completely anonymous. Although there may be no direct immediate benefit to you, the study will provide an opportunity to share insights that may improve the effectiveness of using computer technology in the public health system.

The results of the study will be used to meet academic requirements for the Master's degree. At the same time, a concise report without identifying features of participants will also be presented to both the top management of the Natalspruit Hospital and the Health Information Systems section of the Department of Health that may be benefiting from its findings. Please be assured that this format would not allow any individual to be identified.

Dr. Jaromir Vomacka, MPH Student
23/8/2002