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Computer Network System for University Hospitals in Saudi Arabia

By

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A Doctoral Thesis

Submitted in partial fulfilment of the requirements

for the award of

Doctor of Philosophy

of the

Loughborough University

2001

Supervisor: Professor Ron Summers BSc MSc PhD CEng MInstMC SMIEEE

Faculty of Science

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Abstract

The use of computer networks is set to become an essential part of the ICT infrastructure in Saudi Arabia. They have the potential to be used in all aspects of society. As an example of an application domain, this study will investigate the likely system requirements for computer networks in Saudi University Hospitals. The principal aim of this study is to investigate the provision of a computer network system to link Saudi University Hospitals electronically in order to exchange medical information.

To draw appropriate conclusions and make recommendations that are both systemically desirable and culturally feasible, empirical data have been collected via document analysis, direct observation, interviews and questionnaires, using a sample of 900 clinicians and computer staff from three University Hospitals. To obtain a rich picture of the current use of computers and communication technologies in Saudi University Hospitals, Checkland's Soft Systems Methodology (SSM) has been used to investigate the existing problem situation and to identify change to improve it. This work examines the issues that affect the planning and implementation of computer network systems. As a result of comparing the conceptual model of the SSM to the real world (depicted by a rich picture) there is a lack of a steering group charged with responsibilities of planning, monitoring and co-ordinating the required activities among Saudi Universities. Further findings of this study show that clinicians and computer staff have already got the basic competencies and skills required to adopt computer-based technology. Saudi Universities are working independently to establish their own computer network system, thus not taking advantage of the synergies that co-operation would bring. One conclusion from the study is that, as indicated in discussions with change agents, it is accepted that the time has come not just to implement a computer network system for Saudi University Hospitals, but also to plan and implement a nationwide computer health information system for Saudi Arabia. As a result of this research, a novel information system has been proposed. This is termed 'Saudi University Hospitals Network System' (SUHNS). The proposed system will enable Saudi University Hospitals to exchange medical information, knowledge, and expertise for better health services provision. SUHNS will link all Saudi University Hospitals together. It should form part of a proposed Saudi National Health Network System (SNHNS).

Dedications

I dedicate this work to the soul and spirit of my parents (may Allah redeem them). I wish that they could have lived to see this work.

To my beloved wife, Hussah A Al-Zahrani for her support, encouragement and many sacrifices during the hard times I have encountered while undertaking this work. She has always stood by and given me encouragement to continue. I am extremely grateful to her for her continued-shared responsibility and her devotion and time taking care of our children.

To my sons, Mansour and Khaled, and my daughters, Aseel and Ruba, for the inconvenience I put them through, especially in regard to the constant change of education and schools. They have been extraordinary children, and I am very proud of them. There have been times when I wanted to spend more time with them, but I promise to do so in the future.

Special thank you

I strongly believe that there are some people that have had a special impact on my education, career, and indeed, my life. Truly, I can never repay a fraction of what they have done for me. These people are as follows:

- HRH Prince / Professor Dr. Mansour bin Mutab bin AbdulAziz Al-Saud
- Dr. Mohammed Saeed Al-Ahmed Al-Kahtani
- My brother, Hizam Ghormallah Al-Zahrani
- My beloved wife, Hussah, and my children, Mansour, Khaled, Aseel and Ruba.

Acknowledgements

All thanks and praise are to Allah for his great help, knowledge, health, patience and guidance through my life; without his support I would achieve nothing. Also, I would like to thank everyone who contributed to my intellectual performance during my life.

I wish to express my sincere thanks and appreciation to a number of people without whose support and encouragement this work would not have been achieved.

First and foremost, my grateful thanks to my supervisor and Head of the Department, Professor Ron Summers, for being intellectually challenging. His friendly supervision made my doctoral research process an enjoyable, challenging and fulfilling experience. I greatly appreciate his generous assistance, guidance, encouragement, constructive criticism and invaluable suggestions throughout my study.

I am indebted for the assistance and support of all staff members of the Department of Information Science. In particular, Dr Anne Morris, Mrs Janet Harrison and Mrs Sheila Price, Mrs Linda Thornhill and Mrs Shirley Horner, the Department's Computer Officer for her help and support in computing and technical matters.

My thanks are extended to all Muslims in Loughborough who provided me and my family with an enjoyable social life. Without this Muslim brotherhood, our experience in Loughborough would have been more difficult, especially for my family. I am grateful to Khlifa al-Kubaisi, M Al-Kaabi, their families and all people from Qatar for their support.

Thanks are also due to my fellow Saudi Ph.D. students in Loughborough University, Dr Nasser Al-boqmi from Nottingham University, brother Ali Alkuraides and his wife.

A special thank you goes out to my friend and colleague brother, Ahmad Khudair, who generously supported me morally and helped me a lot especially during the writing- up stage. His comments and friendly treatment are highly appreciated.

I would also like to register my thanks to all those who participated in my survey in Saudi Universities, in particular the medical and computer staff without whose help this work would not have been completed.

My thanks are due to some individuals who provided me with personal support. Particularly, Eng. Lugman, Eng. Maid, G. Al-zahran, Saeed S. Al-Kahtani and Abduallah Al-Karni from SCT, Dr. A. AlShamekh and Dr. Abdallah Al-Salamah from Sultan Humanitarian City., Dr. Alnaim and Mr. Enam Ulhque from King Faisal specialist hospital, Mr. Alexander and Mr. H.Al rubaiaan from Kingdom Hospital., Dr. Nasser S. Al-Kahtani from King Faisal University, brother Jaman M. Al-Zahrani from King Fahad University, Eng. Abduallah and Majed Al-Enzi from King Saud University. Dr. Musaid Al-tyyar from Umam University Saud Al-Kahtani from Saudi Armco, Abduallah S. Mushayt, Saud G. Al-Zahrani and his family and Gharmallah Awdah and his wife, Eng. Rashed Al-Zahrani and Lieutenant Majed, and Mazen, Ayedh S. Al-Zahrani, Jamaan M. Al-Zahrani, Zaeed H. and captain Salman Alroybah and Hammed Alaysa and his family.

I am grateful to the Saudi government for their financial support for my Ph.D. study; in particular I am indebted to KAMA for giving me the opportunity to pursue my higher education. Also, I am grateful to all my colleagues and faculty members at KAMA.

My sincere thanks and gratitude go out to all my people in Riyadh, my relatives every where, with a very special thank you to my brother, Hizam, and his family. I owe a great deal to them for their hospitality, encouragement and moral support. Also, thanks go to my brothers, Mohammed, Saeed, Jamaan, Salam and Abduallah. Also, thanks are due to Khaled M., Abdulrahaman M., Saleh M. and Khaled Hizam. Finally, my deepest thanks go to all my sisters for their love, consideration, and constant care.

I wish to acknowledge and express my sincere thanks to many people for their outstanding contribution toward my Ph.D. Truthfully, many people have helped me throughout the duration of this research I wish to thank all of them but unfortunately all the names cannot be listed here.

List of Abbreviations

ATM	Asynchronous Transfer Mode
B-ISDN	Broadband Integrated Services Digital Network
BT	British Telecom
EDI	Electronic Data Interchange
EHR	Electronic Health Record
EM	Electronic Mail
EPR	Electronic Patient Record
HIS	Hospital Information System
HL7	Health level 7
ICT	Information and Communication Technology
IfH	Information for Health
IS	Information System
ISD	Information System Development
ISDN	Integrated Services Digital Network
ISP	Internet Services Providers
IT	Information Technology
JANET	Joint Academic Network
KACST	King Abdulaziz City for Science and Technology
KAU	King Abdulaziz University
KAUH	King Abdulaziz University Hospital
KFSHRC	King Fiasal Specialist Hospital and Research Centre
KFU	King Fiasal University
KFUH	King Faisal University Hospital
KSU	King Saud University
KSUH	King Saud University Hospital
LAN	Local Area Network
MAN	Metropolitan Area Network
MD	Medical Doctor
MIS	Management Information System

NCP	Network Control Program
NOC	Network Operation Centres
NREN	National Research and Education Network
NSA	Networks System Architecture
OS	Open System
PAD	Packet Assembler/Disassembler
PC	Personal Computer
PDNS	Public Data Networks
PSDN	Packet Switched Data Networks
PSE	Packet Switching Exchange
PSTN	Public Switched Telephone Networks
SAA	System Applications Architecture
SNHNS	Saudi National Healthcare Network System
SSM	Soft System Methodology
STC	Saud Telecom Company
SUHNS	Saudi University Hospital Network System
TCP/IP	Transmission Control Protocol/Internet Protocol
UK	United Kingdom
USA	United State of America
WAN	Wide Area Network
WWW	Word Wide Web

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Chapter 1
Introduction

1.1 Background

Information Technology (IT) has evolved rapidly during the latter half of the 20th century, and particularly since the 1980s following the widespread adoption of the personal computer. This has allowed IT to become progressively more prevalent in all areas of society in the developed world and increasingly in the developing world. Future improvements in computer processing power and communication networks should ensure that this trend will continue. As the 21st Century is entered, the accent has moved towards the communication aspects of information technology. Thus, the emphasis has changed slightly from 'pure' IT to Information and Communication Technologies (ICTs).

The use of ICT is gradually becoming more familiar in healthcare applications. This is due to the decreasing cost of ICT and the required telecommunication network infrastructure, and their increasing power in terms of processing capability and bandwidth. These resources are also becoming easier to use, thus reducing the opportunity cost of participation. Nowadays, strategies for incorporating ICT and its infrastructure are required to integrate the healthcare aspect of computing with network performance for the benefit of the clinical end-user and patient alike. Many medical applications have benefited from the introduction of ICT in which medical data can be stored in databases and retrieved by authorised medical personnel using remote access techniques. This has allowed innovative use of clinical data; for example, medical cases can be discussed live among groups of physicians from distant geographical locations. It is not unusual for clinicians in Saudi Arabia, for example, to seek the on-line help of their counterparts in the Johns Hopkins Hospital in Baltimore, USA.

During the 1970s, the use of medical computing was confined to the use of centralised computing architectures and their applications were limited to simple functions such as statistical manipulation of physiological data. The 1980s witnessed the development of a variety of computing and communication technologies. For example, local area networks (LANs) that allowed several microcomputers to share information resources were among those technologies that evolved rapidly during this time. In the 1990s, both computing and communication technologies became more advanced, in terms of faster processors, smaller physical size, and the exponential rise in memory capacity. The adoption of wide area networks (WANs), geographically more distributed than LANs, also became possible.

A growing trend towards the integration of voice, images and data over WANs made possible by increasing bandwidth available could be discerned. The existence of the Integrated Service Digital Network (ISDN) and its technological development in digital switches, such as Switched Multimedia Data Service (SMDS) and digital transmission mode, such as Asynchronous Transfer Mode (ATM) brought about further possibilities for international collaboration between users at distant geographical locations. Degoulet and Fleschi (1997) consider that the availability of ISDN technologies and high-speed networks enables the transmission and reception of digitised medical images. Image compression techniques and the development of high-speed networks make possible the transmission of video sequences, and videoconferences may be used for group discussions for clinical cases.

In terms of healthcare, data, information and medical knowledge are becoming increasingly digital. To deal with this technological change, the required infrastructure in terms of communication networks and medical workstations needs to be updated regularly in a planned sequence. These changes have allowed the traditional one-to-one relationship that existed previously between patient and physician to move towards a one-to-many relationship.

World-wide, many hospitals have implemented a LAN with computer terminals in all patients' rooms, allowing the nurses to communicate with doctors, specialists, medical records, laboratories and so on. Special diets, orders for tests and medication, can all be entered from the patient's room. Moreover, patient information, such as a nearest relative, can be found easily. This kind of system is anticipated both to reduce hospital operational costs and increase the quality of healthcare. Thus, computerising medical records can significantly improve healthcare. A patient's record stored on a computer is both more readable and more precise than a manual record. Data coming from different hospitals or from external consultations may be linked, ensuring improved continuity in healthcare. Turban *et al.* (1999) suggested that the information infrastructure that supports these medical communications would allow a doctor to check a patient's record from any location.

In the developed countries, especially in the USA and the UK, it has been proposed that the national information infrastructure be used to convey medical information. Examples of good practice can be found in studies in Wisconsin, USA (Pemble, 1997), and Essex, UK (Health Report, 1999). The Wisconsin Health Information Network (WHIN) is an example of a successful model of a community health information network. WHIN began as a joint venture of Aurora Health Care and Ameritech in 1992. This project focused on providing clinician access to clinical information management. Initially, the WHIN pilot study involved two hospitals and six physicians to bring a wide range of various medical information providers to the network. In 1997, the participants were 16 hospitals, 1300 physicians, eight clinics, and seven insurance companies. WHIN is currently owned by the original investors and other equity ownership is available to health organisations within the Wisconsin region.

In the UK, British Telecom started rolling out its largest NHS community project in 1999. This five-year project will link 300 sites and 10,000 users within ten NHS organisations across Essex (Heath Report, 1999). The network will comprise three major acute sites to create the North Essex Community Network. Eventually, all general practices in North Essex will have access to the network

Many hospitals are planning to link physicians and other healthcare providers by using ICT. For instance, the Dental School at the University of Bristol has completed a two-year trial using video conferencing. The findings from this project have been implemented and are responsible for a reduction in waiting time for patients needing specialist dental advice. This kind of scheme could be used in the future across other specialists in the dentistry field (Stephens, 1999).

In the developing countries, particularly in Saudi Arabia, IT is needed for rapid economic development. Saudi Arabia's commitment to IT can be traced back to the late 1960s when a team of IBM specialists arrived to install the first information handling service for the Arabian American Oil Company (Luqmani *et al.,* 1992). Saudi Arabian universities already make extensive use of ICT. King Saud University, for example, is moving towards an integrated computer communication network service. Its School of Medicine and the University Hospital have video terminal capabilities for teaching purposes. However, these terminals are not yet connected to a national network so, as yet, other universities do not benefit from them.

Other universities are using or planning to establish computer networks to facilitate their services. King Abdulaziz University, for example, has work in progress to implement computer networks for all university colleges. However, Bukhari (1994) studied the impact of ICT on the Saudi academic environment and indicated that a number of complex issues arise on Saudi university campuses due to the implementation of campus-wide network systems. These issues include training, lack of ICT staff and lack of funding. Bukhari's findings suggest that a new ICT strategy is essential to support and develop effective networked campuses in Saudi Arabia universities. It is the ICT healthcare issues in Saudi University Hospitals that are investigated in this thesis.

1.2 Statement of the Problem

Due to the growing use of computers and continuing improvements in ICT, there has been accelerated growth in the use of LANs in the developed world. In the developing countries, such as Saudi Arabia, there is an interest in ICT development planning for the entire country. In the last two decades, the introduction and application of advanced technology in various sectors of the economy have added greatly to the development process in Saudi Arabia (Ministry of Planning, 2000). The Saudi government has promoted efforts to apply ICT for the removal of inherited resource constraints and the maximum exploitation of national capabilities (KACST 1998, 2001). In response to the increasing demands for a rapid development in high technology performance, a telecommunications network has been installed for the transmission of data, telex, etc. throughout Saudi Arabia. Recently, the Saudi Telephone Company (STC) added ISDN (Integrated Services Digital Network) services to provide a digital, long distance transmission network and a videoconferencing service between major cities within Saudi Arabia, as well as external links to other countries. These technological developments have not been without problems. For example, most of these ICT network developments were either within industry or within the healthcare sector with no inter-domain channels between them. As such, there was little or no crossover of ideas and developments.

Some Saudi University Hospitals are developing their own low speed computer networks with limited inter-university connections. However, most people who work in the healthcare sector have indicated that the time has now come to establish a national computer network for Saudi University Hospitals to share their valuable resources for the benefit of healthcare and the higher education system.

1.3 Research Aim and Objectives

The principal aim of this study is to investigate the needs for provision of the infrastructure required for computer network systems to enable Saudi University Hospitals to exchange medical data, information and knowledge. This aim can be achieved by fulfilling three interconnected objectives, as follows:

Objective 1: to explore ICT needs for the provision of a health care service.

This incorporates:

- analysing the literature of ICT healthcare in the developed world;
- investigating health service practitioner expectations, needs, and attitudes towards ICT; and,
- relating the development in ICT healthcare to the needs and expectations of Saudi citizens.

Objective 2: to investigate the current use of ICT in Saudi University Hospitals.

This incorporates:

- analysing the present use of ICT, taking into account the current use of computers and computing networks, among staff;
- investigating the potential benefits of ICT;
- investigating where, or from whom, staff seek advice if they face computer problems;
- identifying issues that may be encountered when introducing ICT; and,
- investigating the needs, expectations and attitudes of health service end-users towards ICT and the underpinning computing networks.

Objective 3: to investigate the technological change, organisational change and management of change necessary to implement a computer network infrastructure for Saudi University Hospitals.

This incorporates:

- investigating the current management organisational structure in Saudi University Hospitals;
- investigating any mismatch between the opinions and attitudes of Saudi University decision makers and those of the clinical end-users towards the introduction of ICT and its infrastructure in Saudi University Hospitals;

- identifying the competencies required for introducing ICT and its infrastructure; and,
- Identifying the co-operation and co-ordination needed by Saudi University Hospitals for sharing information resources in an effective and efficient way.
- Developing a conceptual model based on SSM for the establishment of a nation-wide computer network system to provide easy access to medical information resources and an easy way of sharing computer resources (hardware and software) among Saudi University Hospitals.

The government of Saudi Arabia is preparing a comprehensive long-term national plan for science and technology for the period 2000 – 2020. One of the objectives of this national plan is to create a sustainable science and technology information resource. The research performed to fulfil the above aim and objectives will provide guidelines and recommendations of use to the Saudi government in their authoring of the national plan by introducing ICT and its infrastructure into the healthcare domain.

1.4. The Motives for this Study

There are several motives behind the decision to conduct a research project of this kind. These include the following:

- the author's interest in the area of computer applications in health care;
- the expanding interest and dependency on ICT and applications in all aspects of life in Saudi Arabia;
- the lack of an empirical study in health care computing in developing countries, and in Saudi Arabia in particular;
- although it is acknowledged that some Saudi University Hospitals have achieved considerable use of computers, there is lack of knowledge to investigate and evaluate what has actually been done so far;
- there is a lack of empirical research regarding the problems encountered by Saudi University hospitals in their attempts to establish and manage a computer network system;

- there is a scarcity of such studies in the developing countries; and,
- to the best of the author's knowledge, issues relating to computer network problems (e.g. hardware, software, and network management) in Saudi University Hospitals have never been studied.

1.5 Plan of Thesis

This thesis comprises ten chapters. Chapter One gives an overview of the thesis and then covers the identification of the research problem, research goal, and objectives and reasons for undertaking this research. Chapter Two discusses the research methodology. It presents a review of the major research strategies used in the field of information systems research. The review highlights the strength and weaknesses of each strategy in general and is followed by discussion on the rationale for the particular strategy chosen for this study. As Checkland's Soft System Methodology is used to identify change required, the literature reviews form part of the analysis of the 'problem situation unstructured'. For this reason, they are presented after this methodological chapter. Chapter Three contains a historical review of computer networks, components and topology. In addition, it identifies network applications and explores the advent of the Internet in Saudi Arabia. This makes the reader aware of the great progress made in computer networks. Chapter Four gives an overview of ICT in health care in developed and developing nations. Their benefits and problems are discussed in conjunction with major problems and issues such as security, and confidentiality in the electronic health record. ICT in health care in Saudi Arabia is thus put into the context of developed and developing nations. Chapter Five presents responses to the questionnaire, data findings are analysed to reveal an understanding of current issues that surround the introduction of ICT in the University Hospitals in Saudi Arabia. Chapter Six analyses data obtained via interviews with key people in Saudi Arabia. Chapter Seven involves the application of SSM to analyse the data collected from clinicians and computing staff in Saudi Arabia and highlights the SSM stages regarding the current situation of Saudi University Hospitals. Chapter Eight discusses in more details the basic concept of the proposed computer network system, some ideas about possible change that are agreed by key people to be systematically desirable, technically possible and culturally feasible. Chapter Nine brings together in an integrated way the issues raised from the primary and secondary data analyses. Finally, Chapter Ten offers the main findings of the study with recommendations for future study. The overall plan and how the chapters are linked, can be seen in Figure 1.1 below.

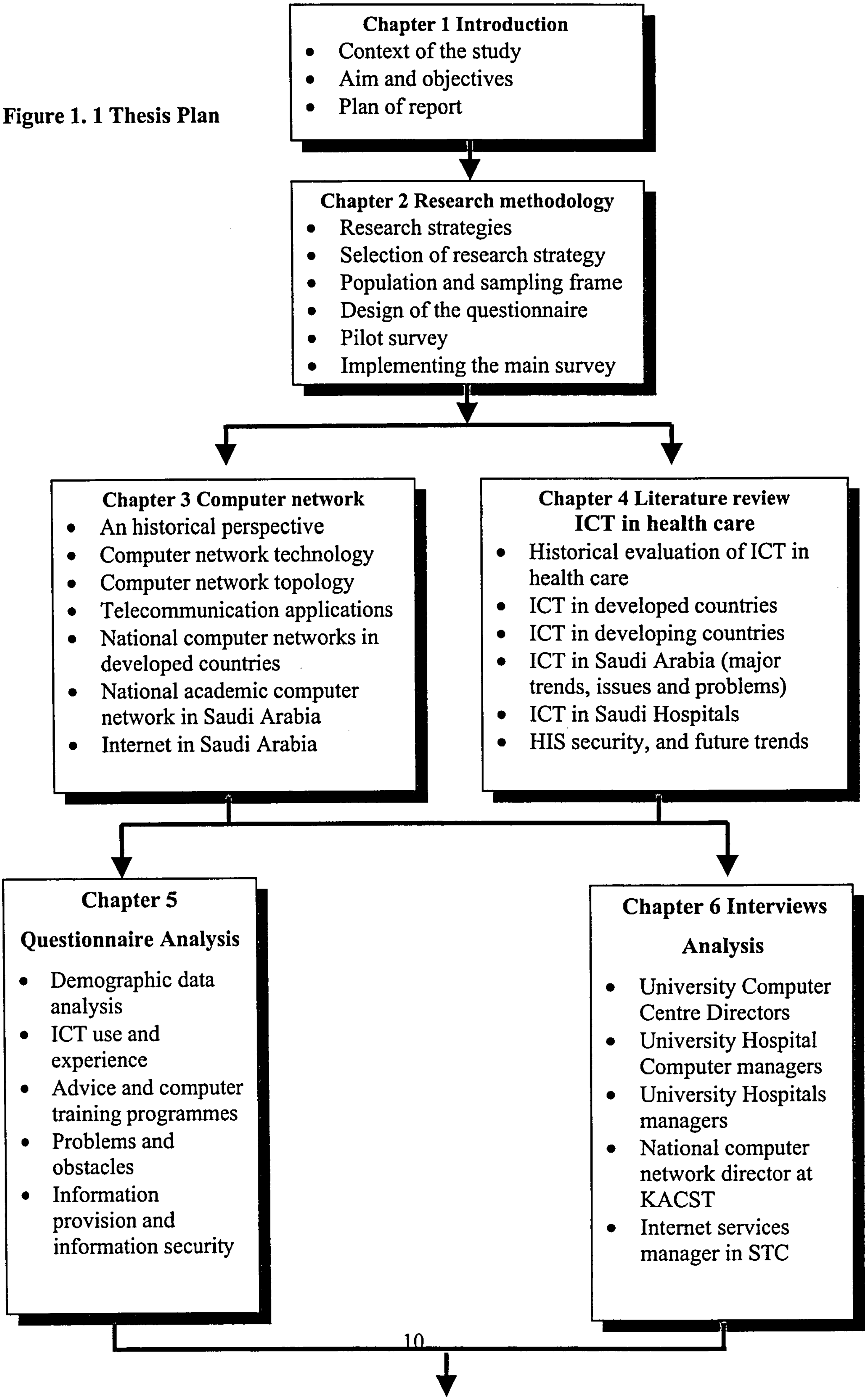


Figure 1. 1 Thesis Plan

Figure 1.1 continued

Chapter 7 Application of the SSM to IST in Saudi University hospitals

- System of interest
- The problem situation unstructured (stage 1)

A. Wide aspect of Saudi Arabia
B. Ministry of Higher Education
C. Universities and University Hospital
D. Healthcare services in Saudi Arabia

- Rich picture diagram (stage 2)
- Root Definition (stage 3)
- Building a conceptual model (Stage 4)
- Comparison (stage 5)

Chapter 8 Change and implementation for national computer network system

- Feasible and desirable change for this work (stage 6)
- Strategic management relevant system
- Funding relevant system
- Communication relevant system
- Technology relevant system
- Maintenance and monitoring relevant system
- End-user training relevant system
- Taking action(stage 7)
- Integration of conceptual model for the complete system
- Discussion with change agents
- Implementation plan for this project

Chapter 9 Discussion

- University Hospitals' perspective
- Universities' perspective
- External bodies' perspective
- SUHNS- Like in advanced countries
- Expected problems of a general nature

Chapter 10 Conclusion and recommendations

- Summary of the study
- Summary of the major findings
- Recommendations
- Future studies

Chapter 2

Research Methodology

2.1 Introduction

This chapter presents a review of the research methods used in the field of information systems research. The review highlights the strengths and weaknesses of each method in general and follows with a discussion on the rationale for the particular set of methods chosen for this study. The most appropriate research methods for this study were chosen and comprise: a questionnaire survey supplemented with interviews, document analysis, direct observation and the use of Soft Systems Methodology to investigate the human activity systems involved in the study. These methods will be described in more detail.

2.2 Research methods

Several research methods used within Information Systems (IS) research have been reviewed in the literature. This study is influenced by the framework developed by Galliers (1992) in which he identifies eight major research methods that are currently being applied in the information systems domain. These are: 1) Laboratory Experiments; 2) Field Experiments; 3) Case Studies; 4) Action Research; 5) Simulation; 6) Phenomenological Studies; 7) Forecasting; and, 8) Surveys. Each research method is discussed briefly below.

2.2.1 Laboratory experiments

The most significant characteristic of laboratory experiments is the identification of the precise relationship between variables in a designed and controlled environment using quantitative analytical techniques. The major strength of this method rests in the ability of the researcher to isolate and control a small number of variables, which may be studied intensively. The major weakness of this method is the limited extent to which identified relationships that are exhibited in the laboratory actually exist in the real world where control parameters are relaxed.

2.2.2 Field experiments

Field experiments are an extension of laboratory experiments, attempting to construct an experiment in a more realistic environment. The strengths and weaknesses are similar to those of the laboratory experiments. An additional weakness is the difficulty in finding organizations prepared to be experimented upon.

2.2.3 Case study

Case study research involves a small number of samples or 'cases'. It involves using in-depth analyses through interviews or group discussions of a number of cases from which conclusions can be drawn. Case study research is very relevant in studies that focus on the understanding of areas of organization functioning that are not well documented and which are amenable to investigation through contact with the organization (Bryman, 1989). It is best used in studies that require deeper understanding of how things happen rather than testing relationships between them (Gordon and Langmaid, 1988). The main drawback with the case study approach is that it is often criticized for its lack of applicability across domains.

2.2.4 Action research

Action research refers to the research enquiry process and aims to integrate action and reflection in a learning environment that comprises the collaboration and cooperation of the enquirer, practitioners and lay people. According to Antill (1985), the action research approach might be seen as a subset of the case study and field experiment categories. This relates to the fact that action researchers know that their very presence will affect the situation they are researching (that is, the well known Hawthorne Effect).

The strengths of this form of research include the very practical benefit of engaging the client organisation in the research method and the fact that the researcher's own biases are made overt in undertaking the research. Its weaknesses include the fact that its application is usually restricted to a single organisation or single type of organisation. Other limitations of the approach include the subjective nature of enquirer interpretations and the lack of control of individual variables. Hence there are sometimes difficulties in distinguishing between cause and effect.

2.2.5 Simulation

Simulation is a method 'used to solve problems which are difficult or impossible to solve analytically by copying the behavior of the system under study' (Chatfield, 1988). Its strengths are associated with its ability to model future scenarios (behaviours) based on changing control parameters. Its weaknesses relate, as in the case of laboratory and field experiments, to the difficulties associated with devising a simulation that accurately reflects the real world situation it is supposed to model.

2.2.6 Phenomenological studies

According to Vogel and Wetherbe (1984), phenomenological studies are based more on opinion and speculation than observation. According to Galliers (1992), this research method tends to be more of a free-flowing process and is more likely to be individual, rather than group, activity. This kind of creative process makes a valuable contribution to the building of theories, which can subsequently be tested by more formal means. Its strengths lie in the creation of new ideas and insights. Its weaknesses arise from the unstructured, subjective nature of the process.

2.2.7 Forecasting

Forecasting rests on statistical techniques such as regression analysis and time-series analysis where behavior over time in the future is predicted by behavior over time in the past (Chatfield, 1988). An alternative non-statistical approach to forecasting is the use of the Delphi technique, in which round-robin recordings of ideas are discussed among the panel of experts who generated them. Refinement of the ideas occurs as a consequence of this discussion and further round-robin iterations selectively focus in on credible options.

Its strength includes the ability to provide insights into likely future occurrences, but these insights are dependent on the precision of past data in the one case and the expertise of the scenario builders on the other.

2.2.8 Surveys

Survey research looks at a particular phenomenon or observation by means of a questionnaire or interview (Leedy, 1974). It involves obtaining information directly from participants by posing questions to them. The researcher's task is to collect data relating to the variables and, based on the data gathered, to examine the patterns of the relationship between the variables, based on the responses presented at the time the question is asked (Dane, 1988). Survey research normally deals with studies on how people feel, perceive and behave, and the object is to determine how these variables are related (Wiersma, 1991).

The advantage of survey research is that its results can be generalised to represent the views of the population because it involves a large number of respondents who are representative of the population. This tends to satisfy the objective of this research, which attempts to seek information from a large number of institutions in order to generalise findings across a wide spectrum of sectors.

There are problems in the survey method. Great care has to be taken to ensure that the sample is truly representative In surveys, all respondents will be asked the same questions and question wording is not as easy as its seems. Therefore careful piloting is necessary to make sure that all questions mean the same to all respondents. Surveys can provide answers to the questions What?, Where?, When? and How? However, it is not easy to find responses to why? from surveys. If a survey is well structured and piloted, it can be a relatively cheap and quick way of obtaining information (Bell, 1999).

A postal survey approach is considered more suitable for many purposes than engaging in face-to-face interviews. This is because: a large number of respondents can be reached in an economic manner; it helps to collect standardised and precise information; and, it saves a lot of time and contributes to simplicity in data analysis (Dillman, 1978; Bell, 1999; Wiersma, 1991, William, 1999).

2.3 Selection of Research Methods

Since this study aims to provide empirical data from the real world, research methods that deal with experiments were deemed inappropriate. Apart from surveys, the other methods are typically practical for only a small number of samples. The main advantage to be gained from these typically intensive approaches is that they can provide rich data about underlying processes. They are also good at identifying new variables and possible relationships between them. As a result, these methods have been found to be very useful for theory building. Their utility in theory testing is under question as their small sample sizes restrict opportunities for the generalisation of any findings. The choice of action research does not necessarily mean that other forms of research methods cannot be employed. However, after considering various other types of research methods, the most appropriate research methods for this study was a survey in form of a mail questionnaire and face-to-face interview supplemented by a document analysis of activities relating to Saudi University Hospitals. Direct observation was also used in a structured way to obtain a procedural perspective of actions in participant University Hospitals and Departments. SSM was chosen as the preferred action research method because it provided richness of analysis combined with being able to cope with vague, conflicting and complex problem situations. (see appendix j for further details).

The mail questionnaire was the most appropriate research instrument to begin the investigation because, not only is it able to reach a large number of geographically dispersed organisations, it is also the least time-consuming and the most effective data collection procedure (Dane, 1988). Undoubtedly, the mail questionnaire is the technique most used by researchers in the behavioural and social sciences (Bennett, 1988). For information of a somewhat broad and exploratory nature, involving large numbers of people, the questionnaire is a useful technique and is relatively easy and cheap. It is recognised that the major difficulties are associated with response rates and bias.

Interviews can be both structured and semi-structured in nature. Structured interviews are a purposeful discussion between two or more people. The use of interviews can help to gather valid and reliable data, which are relevant to the research question(s) and objectives. Interviews are a far more personal form of research than questionnaires. In the personal interview, the interviewer works directly with the respondent. Unlike with mail surveys, the interviewer has the opportunity to probe or ask follow-up questions. Also interviews are generally easier for the respondent, especially if what is sought are opinions or impressions about a particular problem situation (William, 1999).

Semi-structured interviews are a popular and effective method, which can be used to assess views when the target sample is small. It is non- standard set, you will have a list of theme and questions may be vary from interview to interview. This means you omit some questions from some interviews. The order of questions might vary depend on the interview. Also, additional questions might be required. In spite of these advantages, inaccurate and false data may be given to the interviewer. Semi-structured interview was felt to be the most appropriate because of its easiness to carry out and to analyses. The main aim of interview was to gather evidence about concerned organisations, opinion, feeling and exceptions relating to co-operation activities. Therefore, this study employed semi-structured interviews (see appendix D).

Document analysis provides an opportunity to examine documents that will be used extensively in the preliminary stages in the investigation but sparingly in the later stages of the research. The examination and evaluation of existing documents relate to ICT in Saudi University Hospitals and more generally in health service provision in Saudi

Arabia over the last five years. From these studies an outline of the current state of healthcare can be gleaned. Documents examined include policy documents, annual plans and, operational guidelines, plus the reports of various committees.

Direct observation is essentially a technique for gathering data about the subjects involved in a study. It is an effective way of gathering several kind of descriptive information. It is also effective in situations where the researcher wishes to study specific areas of human behaviour (Saunders *et al.,* 2000). For example, in this study the interaction between medical staff and computers was of interest.

It was expected that there would be some difficulties in obtaining the required information because some potential respondents are not yet accustomed to the idea of an externally conducted survey. Also, some people prefer to keep medical information confidential because of the Saudi tradition of not releasing information. However, permission from the Deans of the medical schools was obtained to conduct this study. This gave the required permissions to access the medical information. Computer department managers were asked to provide unlimited access to the information resources required. These included visits, meetings with staff and questionnaire distribution and collection. During the visits and meetings the objectives of the research and its benefits to Saudi University Hospitals were explained. Visits were made to the computer training room and discussions were held with the trainers. Direct observation during these visits enabled the collection of direct information about human behavior, physical lay out, workstation, offices, and locations. Finally, ideas and important comments were recorded in written form for further analysis.

Stage 1 and 2 of the SSM will enable an analysis to be carried out of the strengths and weaknesses of the existing ICT infrastructure in Saudi universities and the current status of the national Saudi network. It also assists in the examination and identification of possible human activity issues, which might be encountered, when ICT is implemented. This study will contribute to a greater understanding of the particular circumstances affecting the implementation of ICT in Saudi University Hospitals.

2.4 Population and sampling frame

The study population is derived from the three of the eight Saudi Universities that have hospital attachment (King Saud University, King Faisal University and King Abdulaziz University). The first task in the survey method was to identify the population, and second to decide on the sample (members of the population) to be surveyed. The characteristics of the three University Hospitals in Saudi Arabia demonstrate that they are very similar in terms of their administration, organisation and objectives. It was thus possible to draw the sample from all three Saudi University Hospitals as indicated below.

NO	Categories	K.K.U.H Riyadh (Center)	K.A.U.H. Jeddah (West)	K.F.U.H AlKobr (East)
1.	Physicians	469	93	329
2.	Nurses	960	325	480
3.	Pharmacists	29	31	15
4.	Paramedical	498	251	352
5.	Computer staff	16	6	11
6.	(Subtotal)	1972	706	1187

Figure 2.1. Sampling frame for this study.

2.4.1 Questionnaire

A pre-pilot questionnaire was trialled before the main pilot study. The purpose of this pre-pilot survey was to refine the questionnaire so those respondents will have no problems in recording their responses. In addition, it enabled the researcher to obtain some assessment of the questions' validity and reliability of the data collected (Saunders, 2000). The recommendations of Dillman (1978) were followed, who stated that the main purpose of the pilot study is to elicit feedback from the prospective respondents on the content of the questionnaire itself.

The pre-pilot questionnaire was tested at King Faisal University (KFU), King Saud University (KSU), and the Institute of Public Administration. A number of faculty members and staff in the above organisations indicated that they would be willing to comment on the questionnaires and as a consequence fifteen questionnaires were sent to them. To confirm the relevance of the items to their scales and sections, the questionnaires were reviewed and corrected by these independent respondents. Moreover, two members of staff in the Department of Information Science at Loughborough University were invited to criticise and to give their comments. Interviews were also conducted to review and correct the pilot questionnaire in the Loughborough area with the following people, i.e., Dr Alswadi (Physician), Dr Al-ghamdi (Physician), Dr Al-smail (Assistant Professor in De Montfort University's Computer Department), and Mr. Alsbag (former Hospital Manager in Saudi Arabia for 10 years).

The comments of the participants in the pre-pilot study together with the independent respondents led to a number of changes in terms of wording and layout. Two respondents recommended that one question be added. It was recommended that the questionnaire be distributed in English language for two reasons: healthcare personnel in Saudi Arabia would be willing to complete the form in English, and the vocabulary relating to ICT is less well developed and less widely accepted in Arabic than in the English language.

After appropriate changes were made for the questionnaire, a visit was made to King Abdulaziz University Hospital (KAUH) to apply the pilot study. 200 questionnaires were distributed in several departments. The response rate to this pilot study was 77%. Generally, there were no major criticisms or comments about the pilot questionnaire except for further minor recommendations concerning the layout. The pilot study gave added confidence that the questions and sampling frame were appropriate.

In order to compile comprehensive information about users of ICT in Saudi University Hospitals, a full questionnaire was distributed that examined demographics, the respondent's use of the computer network system, their training needs, expectations, feelings and attitudes. This questionnaire was sent to all Saudi University Hospitals and in order to obtain a representative sample, 25% of the total clinical and computer staff were invited to participate in this study. This allowed questionnaires to be sent to 900 respondents in seven different employment categories (see Figure 2.2) via their respective Heads of Department.

Department	KAU	KSU	KFU
Nursing	44	150	125
Laboratory	60	60	60
Medical Records	60	60	32
Computing	18	15	11
Pharmacy	14	51	27
Radiology	0	60	45
Other	4	4	0
Total	**200**	**400**	**300**

Figure 2.2 Questionnaire distribution by Institution and Department

The ratio of distribution of questionnaires followed the relative size of the participant hospitals. Distribution within hospitals varies according to population of the Departments chosen. The Departments were chosen as those that had prior ICT exposure, although the experience of the users within these Departments varied (see Chapter 5 for further details).

2.4.2 Design of the Questionnaire

The aim of this study is to investigate the use of computer system in Saudi University hospitals. The overall aim of the design exercise is to develop a questionnaire that fits the purpose of effectively addressing the research objectives, yet is as simple and user-friendly as possible. A number of questions used in this study were adopted from previous research because they have been shown to possess a high degree of reliability and validity (Furnell, 1995; Al-Shanbari, 1998; Bukhari, 1994; and Almilhim, 1994;).

Others, however, were developed specifically to meet the needs of this research. A copy of the questionnaire used during the main survey is reproduced in Appendix C.

The principle of parsimony applies in designing a research questionnaire in order to keep the questionnaire as simple as possible whilst still obtaining the necessary information (Weirsma, 1991). In designing the questionnaire, therefore, careful attention was given to constructing questions that were precise and concise. Furthermore, to enhance the response rate, this study followed Dillman's (1978) advice that questionnaire design should reward the respondents by:

- showing a positive regard for them and making them feel important to the study;
- using simple questions and avoiding complex questions to reduce the mental effort required completing the questionnaire, and;
- establishing trust by providing a token of appreciation.

A summary of the research findings was provided to interested partners. Studies have also shown that the number and quality of responses is positively correlated with the format and the layout of the questionnaire (Berdie *et al.*, 1986, Saunders, *et al.*, 2000). Other steps taken to encourage a satisfactory response rate include, for example, the front page must emphasise the assurance of confidentiality and the number of questions are limited to fit a four-page layout. Only the most important and relevant questions were asked, so as to avoid redundancy and to maintain reliability. This was considered to be particularly important in maximising the response rate from extremely busy senior IT executives and healthcare personnel.

2.4.3 Questionnaire Structure

In sequencing the order of questions, the four basic principles of ordering suggested by Dillman (1978) were followed. The four principles were applied on the basis that they would increase the respondents' motivation for, and confidence in, completing the questionnaire. The four principles are:

- sequence the questions in descending order of importance and usefulness;

- group the questions that are similar in content or question type together;
- take advantage of the cognitive ties that respondents are likely to make among the groups of questions in deciding the order of the questions involved; and,
- position the questions that are more likely to be difficult after questions that are likely to be easier to answer.

Conforming to Dillman's (1978) four principles, the questionnaire was structured with four main sections, each encompassing a different theme, as follows.

1. Section A: Background information. This section comprises seven questions, for example, on age, job description, organisation belong to, department etc.
2. Section B: ICT use and experience. This section consists of seven questions, for example, on Computer use and experience, type of computer used, network used, attitudes toward computer etc.
3. Section C: ICT issues. This section comprises four questions, for example, source of advice when confronted by a problem, satisfaction with training programmes.
4. Section D: ICT Information Provision. This section consists of four questions, for example, user expectations for network development, sharing of information, patient confidentiality and security issues. By analysing the responses, a picture can be drawn of the current situation. As will be seen, this picture contributes to the action research intervention to form Stage 1 of the SSM.

2.5 Semi-structured interviews

The main idea of the interviews was to supply relatively rich information about the current situation, which could not be gathered by questionnaire. In order to get the richest picture possible of the current situation of ICT use in Saudi University Hospitals, interviews were carried out with three main groups of people, University Computer Directors, University Hospital Managers, and Computer Department Managers of hospital computing facilities. Further, an external perspective was gained by inviting for interview such people as the Internet Services Manager at both STC, and KACST and

Directors of the National Computer Network Centre. By obtaining internal and external perspectives (information providers) the survey method was enriched in the following way.

1. University Computer Centre Directors

The role of the university computer centre is to organise and provide information technology and ensure that the university uses such technology to best accomplish its goals and objectives. The objectives of the university computer centre are as follows:

- to develop, operate, maintain and manage computer services; and,
- to acquire technology and encourage the effective utilisation of computer services and ensure that end-users are educated to use this technology effectively.

University computer centres are managed by senior teaching members of Faculty who are appointed as Director by the University Chancellor (President) on the basis, for example, of specialisation and length of service in the university. They hold this position for three years. Usually they have a good background in computing. However, they are not always computing professionals, but have acquired management experience, as at KFU. For the purpose of this study, the University Computer Manager from each site was chosen for interview

2. Deans of the Medical Schools

Deans of the Medical Schools (University Hospital Managers) are in charge of university hospitals as well as being the Dean of medical schools. Their major tasks are to manage the hospital, medical school and administrate daily routines. In Saudi Universities, the University President appoints the Deans for a fixed period of four years. Each Dean delegates to three or four Vice Presidents to assist in University Hospital management activities. For this study, each Dean was interviewed.

3. Hospital Computer Managers (HIS managers)

These individuals are responsible for the hospital's computing facilities. Their job demands someone who can assume a role in planning and monitoring ICT activities as applied to the hospital setting. They should have a computer background or experience in other related areas. Unfortunately, there are some who are non-professional, in terms of their background experience, as in the case in KAUH. For the purpose of this study, one Hospital Computer Manager from each site was chosen for interview

4. King Abdulaziz City for Science and Technology (KACST)

KACST, being the national technology centre, is responsible for the formulation of national science and technology policies and for the co-ordination and promotion of applied scientific research. It is also in charge of the national plan for computer use. KACST consists of four Directorate Generals for Information Systems. One of these directorates is the Directorate of National Networks. A senior staff member, who was in charge of the national computer network policy, was chosen for interview. A further senior staff member, in charge of the Internet Service Unit, was also selected for interview.

5. Internet Manager at the Saudi Telecom Company

The Saudi Telecom Company (STC) is developing a high-speed network connecting most parts of the Saudi Kingdom. Currently, STC has a national backbone that carries Internet traffic within the Saudi Kingdom and to the node for international links. The role of the STC is to build the infrastructure that support data transfer in all formats including Internet, Tele-medicine, e-commerce and other data transfer related networks. A senior staff member in charge of Internet service provision was chosen for interview.

2.5.1 Semi-structured interview content

The interviews were used as a follow up to the questionnaire in order to get the richest possible picture of the current situation of computer and computer network on campus. Altogether, twelve key players were chosen for interview derived from the University sector and the Industrial sector. Arrangements were made to interview the selected people by telephone call or by visiting the site where the interviews were to be conducted. Appointments for interviews were made directly with interviewees personally with a minority via their secretary. Some interviews were agreed to straightaway whilst others required a follow-up call. The interviews lasted from 45 to 90 minutes dependent upon the interviewees themselves. Further, a total of 23 semi-structured interviews were undertaken with a second tranche of managers who represent a more operational perspective throughout the country (see Appendix D&E). More specifically, those interviews are typified by the following group of respondents:

- University Computer Centres Directors
- University Hospital Managers (president of the schools of medicine)
- Head of Hospital Computer Department (HIS Managers).
- Director of National Networks and Internet services manager in (KACST).
- Internet Services manager at Saudi telecom (STC.).

The type of questions asked to each respondents group in indicated below

University Computer Centres Directors

University Computer Centres Directors were invited for interview as follow:

A. King Saud University Computer Centre Director (Central region - KSU);
B. King AbdulAziz University Computer Centre Director (Western region - KAU);
C. King Faisal University Computer Centre Director (Eastern region - KFU).

This interview focuses on six elements in order to satisfy the aims and objectives of this study, as follows:

- **A.** Current status of ICT services and resources (hardware, software and people);
- **B.** University computer system policy, future plans and funding;
- **C.** Computer networks and networks services on the university campuses;
- **D.** Current situation of LAN/WAN connections on the campuses;
- **E.** Training and education issues; and,
- **F.** Future plans arrangements and expectations for using sophisticated technology.

University Hospital Managers

University Hospital managers were interviewed as follows:

- **A.** King Saud University Hospital Manager;
- **B.** King AbdulAziz University Hospital Manager;
- **C.** King Faisal University Hospital Manager.

The second set of interviews was carried out with University Hospital managers (Deans of Medical schools) to investigate how the computer department supports their work and how they use ICT. These interviews, therefore, focused on six elements in order to satisfy the aims and objectives of this study, as follows:

- **A.** Factors that militate against the implementation of ICT;
- **B.** Expectation for the university hospitals to use video conferencing or Tele-medicine;
- **C.** Arrangement, expectation, co-operation with other universities to exchange knowledge, experience, skills and clinical information;
- **D.** Problems and obstacles encountered from a clinical perspective of linking all Saudi University Hospitals electronically;
- **E.** ICT policy, future plans and funding; and
- F. Training and education issues.

Head of Hospital Computer Department (HIS Managers)

Hospital information system managers were invited to participate as follows:

A. Hospital Computer Department Manger in KSUH;

B. Hospital Computer Department Manger in KAUH;

C. Hospital Computer Department Manger in KFUH.

These interview questions concentrated on six elements in order to satisfy the aims and Objectives of this study, as follows:

A. Current status of computer system, the number of staff in the department and ICT services provided;

B. Computer networking, current and future status;

C. ICT policy, plan, and funding;

D. Future ICT expectations, for example, use of sophisticated ICT;

E. Training and education issues;

F. Problems and obstacles associated with use of HIS

Director of National Computer Networks and Internet services manager

The fourth set of interviews was conducted with the director of national networks at KACST. This interview covered four elements as follows:

A. National computer network policy and computer services in KACST;

B. ICT provision and expectations for using high technology in Saudi within five years;

C. Problems and obstacles associated with ICT in the universities, and adoption of ICT in the Saudi Kingdom generally; and,

D. Training and education provision by KACST.

Internet Services Manager at Saudi Telecom Company (STC)

The fifth set of interviews was conducted with the Internet Services Manager at STC. This interview covered seven elements as follows:

A. The role of STC and ISPs in Saudi Arabia;
B. Internet connectivity within the Kingdom;
C. Problems and obstacles associated with the adoption of the internet ;
D. Future plans to improve the services and expand internet dial-up services;
E. Technical specification of the elements that make up the infrastructure;
F. Time plan for national infrastructure; and,
G. Cost implications for the use of STC's information infrastructure.

2.6 The steps taken toward implementing the survey

The first step was to print out 700 questionnaires and associated covering letters. The covering letter provided the context of the overall research plan and how each individual response was important. It assured confidentiality and thanked the respondents in advance for their co-operation and participation (see appendix B). An official letter from the Saudi Cultural Bureau in London gave permission and sanctioned the research survey's implementation in Saudi Arabia (see appendix I)

Contact was made with key people in Saudi University Hospitals to arrange for interviews and to deliver the questionnaires. A visit was made to the Deans of the Medical Schools in order to get permission to distribute the questionnaires and perform the interviews. Discussions were held about the objectives of the research and how Saudi Universities in general, and University Hospitals in particular, could benefit from it. Each of the Deans of the Medical Schools was willing to support and give enough help to conduct this study. Moreover, Computer department manager's were visited and asked to help by giving the necessary information, co-ordinate with each department, and introduce researcher to the Head of each Department where main study were intended to be applied. The purpose of the visit to Saudi Arabia that took place between January 2000 and April 2000 was to collect data about University Hospitals in Saudi Arabia and to apply fieldwork in KSUH and KFUH as well as to carry out interviews in KAU.

2.7 Action Research

The action research methodology employed in this study was direct observation and SSM.

2.7.1 Direct observation

According to Saunders *et al.* (2000) there are two types of direct observation: participant observation and structure observation. Participant observation is qualitative by nature and is derived from the work of social anthropology. Its emphasis is on discovering the meanings that people attach to their actions. In contrast, structure observation is quantitative by nature and is more concerned with the frequency of those actions. The great advantage of direct observation is that it enables the researcher to collect direct information about human activities. This method allows the collection of data at the time they occur in their natural setting. However, direct observation also has some limitations, for example, observational research must be designed in such a way that observers do not have knowledge about the subjects that are likely to bias their perceptions. Also, research results are limited to overt action or surface indicators from which the observer must make inferences.

2.7.2 Soft Systems Methodology

SSM has been developed since the 1970s by Professor Peter Checkland at Lancaster University. SSM has stimulated much interest and also has a roused considerable academic debate regarding its use in wider management problems and information systems issues. It was developed through action research, where systems ideas are tested out in client organisations. This approach originated from the use of the Jenkins approach to problem solving (Jenkins, 1969). Checkland found that the Jenkins approach could not cope with 'messy' situations of, for instance, complex organisational issues. SSM is not a technique (a method that requires certain procedures to be followed in order in obtain a predictable outcome), but is a set of guidelines for applying system ideas. These guidelines help an analyst to approach investigations methodically, they still allow considerable scope for individual interpretation. The systems approach has split into hard and soft camps. The hard methods consider systems that have a clear purpose and well-defined goals, and are useful for designing solutions that achieve those gaols. The soft methods recognise that many human activity systems are so complex that they do not have a single goal and to impose a solution that embodies a single purpose can be extremely damaging to the system under investigation. SSM lies in this second camp to deal with human activity systems (Holland, 1995).

Since its inception, SSM has had a considerable success as a general purpose problem-solving methodology, tackling the messy or unstructured problems which managers of all kinds and at all levels have to cope within their work. The emphasis of SSM is not on finding a solution to a specified problem, it is on understanding the situation in which a perceived problem is thought to lie.

Advantages and disadvantages of SSM

In this study, SSM is used to take action to improve aspects of the problem situation. This approach is used because of the advantages it gives to the understanding of the problem situation. Checkland (1981, 1999), Checkland and Scholes (1990), Smallwood (1990), Al-Hasan (1992), Maciaschapula (1992, 1995), Holland (1995), and Dix *et al.* (1998) summarised these advantages as follows:

- SSM is a mixture of theory and practice. It has its own terminology and is structured in clear stages for tackling unstructured problems and improving them,
- SSM takes into account cultural factors, which are incorporated quite clearly for applying to the real world of human affairs,

- SSM is a learning tool, which is related to the nature of a human activity. That is, the root definition is only one way of describing the actual human activity system,
- SSM is a way of understanding the activities. It is a way of exploring the process of managing information,
- SSM is helpful in the context of developing quality assurance,
- SSM is a flexible and a customisable approach depending on the situation. It is adaptable and able to accommodate a wide range of study topics such as NHS, business and industry etc.

In spite of the advantages of the soft system approach, the authors also provided a set of disadvantages. These are summarised as follows.

- Although the SSM is very sophisticated and mature, it requires experienced analysts and is dependent on a high level of intellectual input,
- SSM is time-consuming. For example, apart from the skills needed to apply this methodology, it requires interviewing people in order to describe thoroughly the situation of the rich picture,
- Problem owners decide the outcome of the process, but it is possible that the problem owner will never agree with the proposals that are derived. In any case, it may require repeated iteration to develop the conceptual model further to provide for more detailed discussion. It is an open-ended methodology. Changes suggested could possibly lead to a new problem situation that would need to be tackled,
- The results of the methodology cannot readily be generalised. The degree of subjectivity of the research could be another question. As was stated by Checkland (1981), SSM is a subjective process because no two people will look at any particular aspect of the world in exactly the same way.

Soft system approach applications

SSM has attracted considerable attention and it has been used successfully in several fields. In the early years, it was natural to look for industrial applications of the idea, because, as was mentioned the original group of people developing the approach came from a Department of Systems Engineering. SSM has been applied to different kinds of studies, but Al-Hasan (1992) claimed that many of the case studies have not been published because they are consultancy projects for companies and organisations.

More recently, SSM has had a practical application in organisational analysis. For example, Checkland and Scholes (1990) used SSM in the industry sector. Al-Hasan (1992) used SSM to examine personnel management problems in Kuwait Libraries, Kurbanoglu (1992) used SSM to investigate co-operation network activities among Turkish information units. Suhaimi (2001) used SSM to investigate ill-structured problems in public sectors in Brunei. Bustard *et al.* (2000) used it for system modelling in business to examine the potential gain from using this technique and Chilvers (2000), used SSM to examine issues facing those information professionals attempting the long-term management of digital data objects in the UK.

In the medical field, Checkland and Scholes (1990) applied SSM at the community level within the NHS in the United Kingdom. Also, Brember (1985) chose SSM as a way of relating the evidence of a user survey to the practical problems of medical library management. Moreover, Smallwood (1990) used SSM to address problems concerning the transfer of patient information and communication patterns amongst nurses. Maciaschapula (1992) used SSM to investigate information problems at the structure level of healthcare in Mexico. Also, in 1995, he used SSM to identify the value, impact and barriers to information access, and used it in relation to the quality of healthcare. Additionally, Goossen (2000) applied SSM in nursing informatics and discussed and explored how to apply SSM in nursing information management. Connell (2001) used

SSM to help in the design of an information system for health service users providing care in the community in a part of the South and West Health Region in the UK. However, in terms of using SSM in University Hospitals, no studies were found regarding the use of SSM.

Reasons for adopting soft system methodology in this study

A number of research methodologies exist to investigate problems found in all kinds of scenarios in all sorts of organisations. Some of the methodologies and techniques that can be used can be classified as hard system approaches that use a means end analysis via appropriate quantitative scientific methods. For example, cost benefit analysis of alternate designs to procure the optimum choice. SSM deals with human activities system, it will make an important contribution to this research study. It permits a defensible sequence of actions, leading to an identification of what information is required for the computer system, which is proposed for Saudi University Hospitals.

The topic of this study is the establishment of an infrastructure for computer network systems for University Hospitals in Saudi Arabia. The problem is clear in certain ways, but it is a very difficult problem to tackle, as there are only vague ideas about the problem situation and how to tackle it. Also, there are many stakeholders with different views on what is the declared purpose of the system. For example, some people may possibly argue that the purpose of the system will improve health care services and will create new jobs for ICT and health care professionals. From another perspective, others may believe that it will make University Hospitals operate more efficiently and improve the higher education system. Moreover, ICT and its applications are expanding and changing very quickly in response to global change. This effect is felt in Saudi Arabia in particular. Furthermore, Saudi Arabia is a unique country in terms of culture, religion, and its political, and education system. SSM, as defined by Couprie *et al.* (2000), provides a way of dealing with problem situations in which there is a high social, political and human activity components.

Consequently, it is possible to summarise the main reasons of the choice of the Checkland's Soft System Methodology for this study.

- It is the most appropriate for studying and tackling complex problems, such as in this study, the provision of a computer network system and the co-operation among Saudi Universities involved in its use which reflect on the relationships between people, machines and information systems. These involve the efficient storage and retrieval of information and also the planning, management, monitoring, maintenance and control of this information system. SSM also allows the quality of information and co-operation to be examined.
- It is applicable to 'soft' systems, enabling the author to take a holistic view of a co-operation network for information provision, as, in this case, Saudi Arabia. This is helpful in exploring a wide range of problems such as technology, funding, people, environments etc.).
- It is useful in building conceptual and theoretical frameworks in empirical research involving 'human activity' systems, which is one of the objectives of this on-going research and part of the characteristics of system approach.
- It is 'open-ended', leading to the investigation and examination of issues that had perhaps not been originally thought of since SSM avoids, at the outset, the firm definition of the problem.
- It can be employed by an individual on multi owner /client problem situation. Its design to incorporate different perceptions deal with many problem-owners. Also, Its attempt to identify the political climate explicitly.
- It is clear from the literature that this approach has been found useful in the past in the study and examination of complex problems in large organisations. Moreover, It is flexible and a customisable approach depending on the situation.

2.8 Summary

This chapter describes the major research methods used in information systems research. Advantages and disadvantages of each method were discussed. It was found that the combination of two methods was the most appropriate way to fulfil the stated research objectives. These methods were surveys (in the form of questionnaires and interviews) and action research (in the form of direct observation and use of SSM to investigate the human activity systems involved in the study). The advantages and limitations of the selected research methods were discussed and steps to overcome the limitations were considered.

This chapter also described the development process of questionnaires (e.g. design) and interviews (e.g. sampling methods). It also highlighted the preliminary results of a pilot study exercise. In the pilot study 215 questionnaires were distributed to medical and computer staff in the UK and Saudi Arabia. From the results obtained it was clear that questionnaire design was consistent with the aims and objectives of the study. The next chapter will discuss computer networks.

Chapter 3

Computer Networks – A Historical Perspective

3.1 Introduction

The use of ICT has transformed how organisations do business, allowing for global alliances that seek out market opportunities. This activity has parallels in healthcare as will be seen in Chapter 4, whereas this chapter will cover the required computing infrastructure necessary for the adoption of ICT in terms of growth of computer networks, components and topology. This chapter will also identify network applications and will explore the advent of the Internet in Saudi Arabia.

3.2 Growth of computer networks

A network can be defined as a group of components, individuals, or organisations that are interconnected to form a system, which is intended to achieve some specified goal. Such a network must have a communication mechanism. It follows that a computer network is a system of physically separate computers with telecommunication links, allowing the resources of each participating computer to be shared by each of the others. Bocij *et al.* (1999, p 151) defined a computer network as

> "a communications system that links two or more computers and peripheral devices and enables transfer of data between the components".

Similarly, Gupta (2000) considered a computer network as a system of interconnected computers, terminals, and communications channels. He also claims that IT personnel often use the word 'network' interchangeable the with the word 'telecommunication'.

Computer networks have proliferated since the 1980s as they provide the technological solutions for fast and efficient communication. Continued growth of the Internet is one of the more interesting and exciting phenomena in computer networking. However, it may introduce new social, ethical and political problems. Any adoption of the benefits that computer networks bring in the developing world, for instance in Saudi Arabia, will need to take these factors into consideration. However, perhaps the driving force behind the widespread use of computer networks in the developing world will be the dramatic and continuing decrease in cost of computer hardware and software, accompanied by an increase in computer capability and usability.

3.3 The telecommunication system

A telecommunication system consists of hardware and software components that transmit information from one location to another. These systems can transmit text, data, graphics, voice, documents, and full-motion video information. Turban *et al.* (2001) summarised the major components of telecommunication systems as follows.

- Hardware: all types of computers (e.g., desktop, server, mainframe) and communication devices (such as a modems or small computers dedicated solely to communications).
- Communication media: the physical media through which electronic signals are transmitted, including wireless media (used with satellites and cell phones).
- Communication networks: the links between computers and communication devices.
- Communications software: software that controls the telecommunication system and the entire message transmission process.
- Communication protocols: the rules for transmitting information across the system.
- Data communications companies: regulated utilities or private firms that provide data communications services;
- Communication applications: (for example) electronic data interchange, teleconferencing, videoconferencing, electronic mail, facsimile, and electronic

funds transfer.

When these components interact in designated ways, the telecommunication system components are able to send messages across the world in an instant of a second. We all experience this phenomenon, for example, when making credit card transactions in foreign countries – the teller (automated or human) seeks verification and confirmation of the transaction at a geographically remote site from the host computer on which the credit details of the authorised signee are kept.

3.4 Computer network architecture and protocols

There are a number of ways of classifying communication networks. Traditionally, networks have been classified as either Local Area Networks (LANs) or as Wide Area Networks (WANs). A category that has recently begun to receive much attention is Metropolitan Area Networks (MANs) (Stallings, 1997). The interconnected computers may be of the same type, or of different types, including microcomputers, workstations and mainframes in the same system. Computer networks also differ in the type of protocols used, and in their topologies. In order to allow computers to communicate successfully with each other, a standard framework of routine and rules (i.e., a set of protocols) is required. A protocol determines the sequence of codes required for data exchange and the bit or characters sequences required controlling the exchange. According to Gupta (2000), protocols have three major components:

* A set of characters that mean the same thing to the sender and the receiver;
* A set of rules for timing and sequencing message; and,
* A set of methods for detecting and correcting errors.

The main goals of the protocols are to accurately identify each device to ensure that each message is transmitted accurately to its correct destination, and detect and correct errors as they occur. Gupta argued that the most popular protocols are TCP/IP (Transmission

Control Protocol/Internet Protocol), Integrated Service Digital Network (ISDN), System Network Architecture (SNA), System Applications Architecture (SAA), XMODEM, YMODEM, and Kermit.

3.4.1 Local Area Networks

LANs connect two or more communicating devices, usually at the level of a single building or campus of up to a few kilometres in size. For example, they are used to connect personal computers to share resources (such as storage devices, printers, programs and data files) and integrate a wide range of functions into a single system. Therefore, every user device on the network has the potential to communicate with any other device. LANs allow organisations to share expensive hardware and software. For instance, several PCs can share a single printer by being connected together in a LAN. Moreover, in office, a LAN can give users fast and efficient access to a common bank of information while also allowing the office to pool resources such printers and facsimile machines (Turban, *at el.* 2001)

Wischhusen (1996) believes that the advantage of LANs, compared to having several stand-alone PCs, include that they can:

- share the resource of disk drives, printers and powerful computers;
- share software;
- access files stored on the network from any PC; and,
- communicate with other PCs on the network, which is especially useful if they are not in the same room.

Sometimes LANs include a mini or mainframe computer with a number of 'dumb' terminals connected to it, but commonly the PCs are connected to one powerful computer known as a file server. In connecting devices together to form a network, the cable layout (topology) is important. Its logic is a key element in supporting the different LAN approaches, such as the Ethernet and the token ring. Ethernet is popular LAN technology that uses a shared bus topology and CSMA/CD access. Basic Ethernet operates at 10 MB/sec,. Fast Ethernet operates at 100 MB/sec, and Gigabit Ethernet operates at 1000 MB/sec. Whereas the 'token ring' is a ring topology network that uses token passing for access control, it is also a phrase that applies to a specific token passing ring topology defined by the IBM Corporation. (Comer, 1999)

There are three normal types of LAN topology: bus network topology, ring network topology and star network topology (see Figure 3.1).

Bus topology

Bus topology is the most heavily used network topology. A bus is a single linear communications medium that can begin at any location and end at a node connected by cable taps or any similar device. The ease of installing and adding nodes to, or removing nodes from a bus, are important points when a topology is chosen. Much of the popularity of the bus topology is due to the existence of the Ethernet, which can be used with a range of links such as telephone line, coaxial cable and optical fibre. All workstations are attached through appropriate hardware, interfacing directly to a linear transmission medium (the 'bus'). All signals are broadcast in both directions to the entire network, with special software to identify which components receive each message. If one computer in the network fails, none of other components in the network are affected.

Ring topology

Ring topology is one in which all computers are linked by a closed loop in a manner that passes data in one direction from one computer to another. Each computer can communicate directly with any other computer and each processes its own applications independently. If one of the component computers fails, other networks will not be affected. In fact, the ring topology can be considered as the bus topology that has the last node connecting back to the first node, so completing the ring configuration.

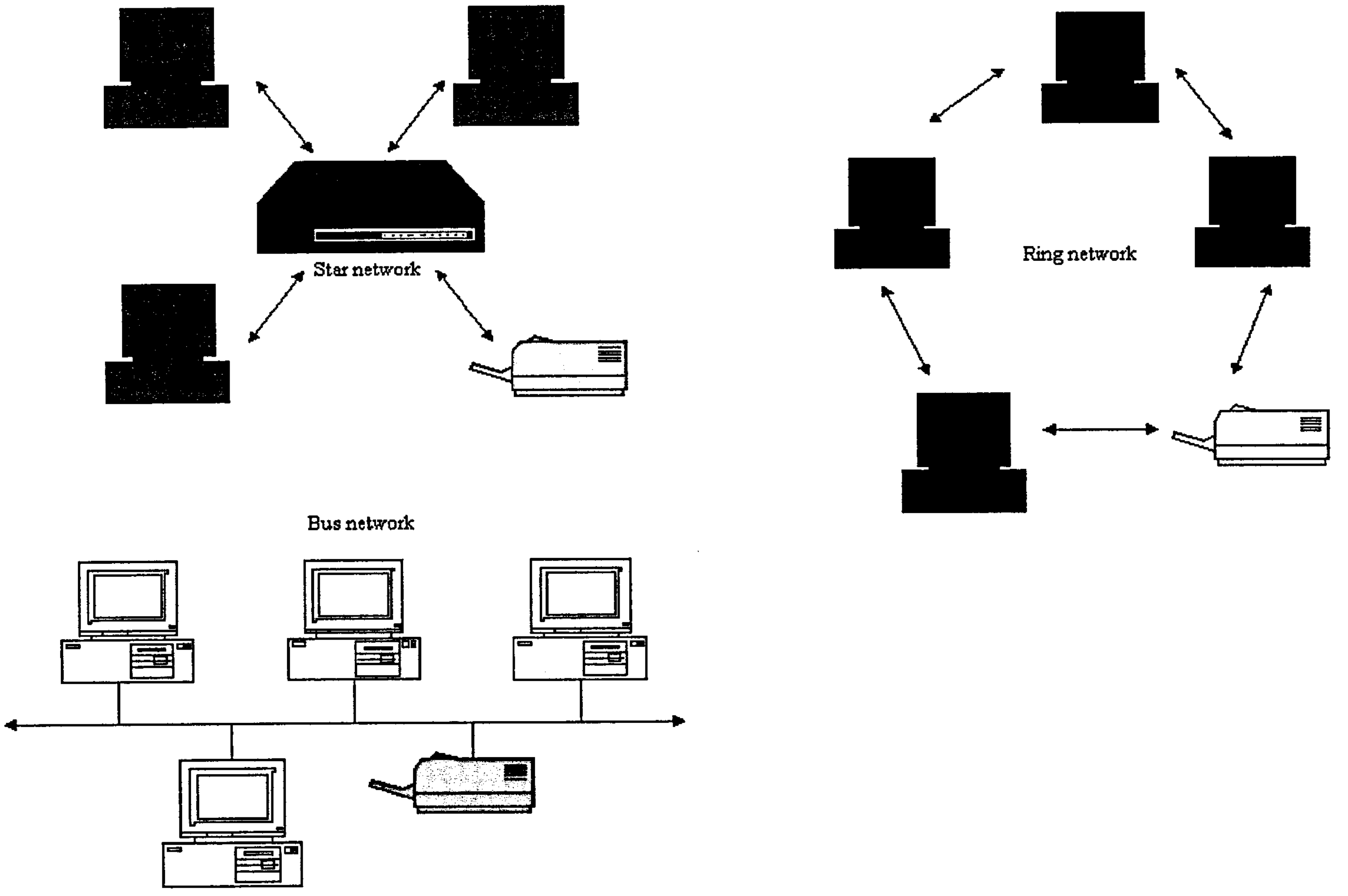


Figure 3.1 Network topology

However, there are other distinctions; the nodes in the ring are linked in a point-to-point fashion through which all transmissions on the network must pass until they reach their destination. The time required for the data to travel around the ring between the interconnected device is called the 'walk time'. Each workstation in the ring has a unique address to identify it for e-mail applications etc.

Star topology

Star topology (sometimes call a hub topology) consists of a central host computer connected to a number of smaller computers or terminals. This topology is useful for applications in which some processing must be centralised and some can be performed locally. The problem with this configuration is that all communication between points in the network must pass through the central computer, because the central computer is the traffic controller for other computers and terminal in the network (Laudon and Laudon, 2000). Thus, a weakness with this topology is that if the central host computer is 'down', the whole network system is affected.

3.4.2 Metropolitan Area Networks (MANs)

MANs were established in the early 1980s as a means of interconnecting islands of computers across entire towns or cities, typically spanning distances of up to 50 Km. A MAN is basically a bigger version of a LAN and normally uses similar technology. This class of network is used for the fibre optic cabling of towns or cities for the transmission of facilities such as video, voice and other data. MANs were created to form the basis for dedicated packet switched networking; however, this is now suffering from bandwidth exhaustion, high cost and lack of flexibility. So, although MANs are popular, they suffer from problems that limit their functionality.

3.4.3 Wide Area Network

A WAN is spread over a very large geographical area that could even be world-wide. Communication is facilitated not only by a physical cable between computers or by telephone lines, but via microwave or satellite links for global transmission. Fitzgerald (1999) claims that WANs are nothing more than the traditional long distance networks developed by business organisations and government agencies. The current performance of WANs does not fully meet the requirements of distributed systems, therefore, its performance will be dramatically changed by the projected introduction of Broadband ISDN (B-ISDN) networks to provide an integrated communication infrastructure for voice, video and data transmission.

Wischhusen (1996) defines two types of WANs – public Wide Area Networks and private Wide Area Networks. Public WANs are usually available through telephone and cable TV networks, whereas private WANS use privately owned or rented lines. Many large organisations use a private WAN established specifically for their own benefit.

Efficient and effective telecommunication networks are crucial for the normal operation of WANs. Each type of telecommunication network represents a phase of the development effort to improve services using quite different technology and approaches. These are the public switched telephone networks (PSTN); packet switched data networks (PSDN) and the integrated services digital network (ISDN, B-ISDN).

Public Switched Telephone Networks (PSTN)

Public Switched Telephone Networks (PSTNs) form an extensive, existing network of cabling reaching into almost all inhabited areas of developed countries, and providing international connections worldwide. This made it attractive as an immediately available option for computer networking in the early stages of the development of WANs. PSTNs are designed for voice communications, and therefore requires the use of an interfacing device, usually a modem, for data transmissions. The network makes use of circuit switching technology and is a rather noisy and unreliable channel, prone to errors and miss-connections. Since a switched phone line is normally charged on a time and distance basis, it is not ideal for inter-computer communication over long distances.

Public Data Networks (PDN)

Public Data Networks (PDNs) have been established specifically for the transmission of information in a digitised form, but cannot be used for voice communications. They provide fast and reliable data transfer with more flexibility. International communications can be achieved at a reasonable cost, since they are charged for by the amount of data transferred. The X.25 protocol is the communication standard for this network. PDN is essentially a store and forward network, which operates at speeds fast enough to give the impression of a direct connection to the end user. The end systems can be connected as follows:

- directly to the network through an X.25 interface;
- to a local PSE (packet switching exchange) via a device called a packet assembler/disassembler (PAD), which divides the data into X.25 packets for transmission; a PAD device can be installed in the end-system premises; and,
- through a local telephone network link to the nearest PAD device provided by the network operator.

PDNs were a popular medium in which to exchange text messages, however they are now largely superseded by Integrated Services Digital Networks.

Integrated Services Digital Networks (ISDN)

The development of ISDNs has been governed by a set of recommendations, which were first issued in 1984 with more complete versions issued in later years. ISDN came to full fruition and widespread deployment in the early to mid 1990s. ISDN is a public network providing end-to-end digital connectivity, which is capable of supporting a range of digital devices and services, both voice and non-voice. This allows users to send and receive data, text and images from computer systems as well as offering an enhanced telephone service. This is achieved over a single ISDN connection, so that one network may be used for all applications, at the same time as providing higher transmission speeds.

Integrated Broadband Networks (B-ISDN)

Narrow-band ISDN circuits do not have a high degree of flexibility in adjusting to varying demands. For example, a voice call does not use the full capacity of a 64 KB/sec channel, but others cannot make the spare capacity available for use during a session. So Broadband ISDN (B-ISDN) has been introduced to overcome such problems by using a universal fast packet switching technique for all information streams, and allocating 'bandwidth on demand' rather than relying on fixed bandwidth channels. Two rates have been proposed for B-ISDN: a basic service with a digital access rate of 155 MB/sec, and a primary rate service at 622 MB/sec.

Microwave and satellite networks

Telecommunications that do not involve physical wires are becoming more widely used. This category includes microwave transmissions, cellular radio, and wireless local area network based on radio waves. Nowadays, the two types of channels in use are local microwave, which covers distances up to a few hundred kilometres and satellite channels that span the globe. Microwave transmission offers an alternative to physical point-to-point communication. It provides high-volume, long distance, point-to-point transmission in which high frequency radio signals are transmitted through the atmosphere from one terrestrial transmission station to another. Microwave transmission can be aimed in a single direction, preventing others from intercepting the signal. It works best when a clear path exists between the transmitter and receiver. As a result, most microwave installations comprise two towers that are taller than the surrounding buildings, where the microwave transmitter on one tower is aimed directly at a microwave receiver on the other (Comer, 1999).

Satellite networks are commonly used for relays across long distances, such as establishing connections between Saudi Arabia and the USA. The satellite contains a radio receiver and transmitter to relay the message transmitted in one place to the receiver in a geographically distant location. As placing a communication satellite in orbit is expensive, each one comprises many receiver-transmitter pairs, each operating independently.

In the past 20 years, wireless communication has become increasingly important as cellular systems have been developed. Digital wireless communication is of course, not a new idea because as early as 1901, Marconi demonstrated a ship-to-shore wireless telegraph using Morse code. Modern digital wireless systems have better performance but the idea is the same (Tanenbaum, 1996).

Universities and educational facilities in the developed and developing world are discovering the flexibility and cost effectiveness of implementing wireless LANs. Some universities have installed antennae to allow students to consult (for example) library catalogues from any site on campus. Carnegie Mellon University (USA) is in the forefront of developing and using this kind of technology. It provides mobile Internet access that covers all academic and administrative buildings in the university for students and faculty members (Carnegie Mellon University, 2001). Although wireless LANs are easy to install, they also have some disadvantages; they have a typical capacity of 1 to 2 MB/sec, which is much slower than wired LANs. The error rates are much higher and transmissions from different computers can interfere with one another. Currently, users of the wireless LANs receive both sound and pictures on their mobile computer without significant delays. It is believed that the use of wireless networks will increase and efforts will continue to make wireless computer networks far easier to use. This kind of technology has also been developed for healthcare solutions – allowing doctors to access patient laboratory results from anywhere within the confines of the Hospital. One hospital, the John Radcliffe Hospital in Oxford, UK, used the ventilation shafts as ducts for the antennae.

3.5 Telecommunication network applications

There are many examples of telecommunication network applications. Such applications have brought new efficiencies to the workplace and they have the potential to help an organisation to achieve their business objectives. Some of the applications that are pertinent to this study are discussed briefly below.

3.5.1 Electronic mail (e-m)

Computer-based messages can be electronically manipulated, stored, combined with other information, and transmitted through telephone wires or wireless networks. The sender inputs the message at a terminal and includes address and routing instructions to get the message to the intended recipient(s). Text, graphics, sound, animation, or application files may be attached to the message. The system then automatically routes the message to the recipient(s). At the receiving end, a recipient can read the message on a computer terminal, print it, file it, edit it, and/or forward it to other recipients (Turban *et al.,* 1996; Turban *et al.,* 2000). Electronic mail eliminates telephone charge costs and time delays and other problems associated with physically delivered mail.

3.5.2 Electronic Data Interchange

Electronic data interchange (EDI) is the electronic transmission of routine, repetitive business documents directly between the computer systems of separate companies doing business with each other. Several authors, for example, Alter (1997), Beheler (1999), Bocij *et al.* (1999), and Laudon and Laudon (2000) discuss the direct and indirect benefits and cost of EDI. The benefits include eliminating manual paper processing and performance improvements that result in direct savings and faster, more complete information transmission that result in indirect savings. Takaoka (2000) suggested that EDI can be used as a strategic weapon – the improved buyer-supplier relationship through EDI is presumed to reduce the time of the design cycles and supports a rapid response to challenges. There are several disadvantages in the use of EDI, such as the lack of common understanding in the management domain, the need for a high level of management commitment, the fact that EDI standards are still in state of change, and perceived lack of security.

3.5.3 Distance Learning

Telecommunications technology is enabling many people to learn outside the classroom and from a different geographical location, a process called distance learning. The 'e-learners' have content transmitted to them in real-time (different place, same time) or packaged in some way for asynchronous delivery (different place, different time). Some universities are offering a list of courses and programmes, such as Ziff-Davis University, where there are five degree programmes available through an online interaction (Ziff-Davis University, 2001). Carnegie Mellon University in the USA also offers distance learning programmess in its School of Computer Sciences, School of Public Policy and Graduate School of Industrial Administration (Carnegie Mellon University 2001).

3.5.4 Facsimile machines

Facsimile (fax) machines can transmit documents containing both text and graphics over ordinary telephone lines, transmitted via either analogue or digital encoding. Analogue encoding converts the white and black areas of a page into encoded sine waves. These modulated signals are then converted back into white and black areas for printing by the receiving facsimile machine. Digital encoding converts a page's white and black area into binary 1s and 0s before transmission, to be re-encoded in the receiving facsimile machine.

3.5.5 Teleconferencing, video conferencing, and data conferencing

Technology makes it possible today for people to meet 'electronically', even though they may be tens of thousands of miles apart, by using teleconferencing, video conferencing and/or data conferencing. Teleconferencing allows a group of people to confer simultaneously via telephone or electronic mail. Data conferencing includes the ability for two or more people to work at distance on the same document simultaneously. Video conferencing is teleconferencing in which participants see each other on a video screen. Video conferencing has many advantages such as saving travel time and associated costs. Some business organisation use video conferencing to promote remote collaboration form different locations or fill in a personnel expertise gap (Laudon and Laudon, 2000). Video conferencing is much more expensive than the other applications due to its need for greater bandwidth.

3.6 National Computer Networks

For the purpose of the present study, a brief discussion of the development of the national academic networks in the UK and USA will be included to act as a baseline for comparison with the situation in Saudi Arabia.

3.6.1 National Academic Network in the UK

The development of a national network plan in the UK goes back to the 1980s. The Joint Academic Network (JANET) in the UK was officially installed in April 1984. At that time a variety of networks served the scientific community. In 1985, JANET was established with the support of a number of funding agencies such as the Science and Engineering Research Council (SERC) and the Natural Environmental Research Council (NERC). Nowadays, JANET is a wide area network serving the UK academic community (Bull, 1994).

Structure of JANET

JANET serves to interconnect the LANs at each connected educational establishment. Its main objective is to provide users in academic institutions and research councils with computer connections to the national UK computer backbone. Initially, JANET was a PSN, largely running over 2 MB/sec lines, using eight separate switching centres located throughout the UK as the principal nodes, each one connected to several other centres.

The Network Operation Centres (NOCs) of JANET are located at: Bath University Computing Centre, the Queen's University Belfast, University of Cambridge Computer Laboratory, Daresbury Laboratory, Edinburgh University Computing Service, University of London Computer Centre, Manchester University Computer Centre and Rutherford Appleton Laboratory.

JANET topology

JANET is a distributed centre network. It acts as a 'bearer' network between LANs, in this type of network members of JANET are divided into groups, each one connected to another by 'trunk' connections.

JANET used the X.25 protocol to interconnect the campus networks at linked sites. This protocol was the dominant protocol in Europe before the Internet Protocol (IP) set the standard in the early 1990s. The JANETIP service (JIPS) was introduced to univeritieis in 1991 due to the benefit from the world-wide Internet. Many universities provide a full TCP/IP services with JIPS traffic (Coulouris, 2000). Additionally, JANET provides users with many information services such as processing remote database enquiries, file transfers and electronic mail. It also gives access to many information services such as electronic bulletin boards and electronic journals.

Management of JANET

The Joint Network Team (JNT), based at the Rutherford Appleton Laboratory near Oxford was the main management body for JANET. The JNT was in charge of campus network facilities in the universities and facilities on sites funded by the Computer Board. The development of policy and the general management of networking programmes is now the responsibility of the Joint Information System Committee (JISC) of the UK's Higher Education Funding Councils and managed by the UK Education and Research Networking Association (UKERNA).

SuperJANET

SuperJANET was planned as the academic network for the 1990s. As the USA is upgrading its networks for high performance computing, so the UK is preparing SuperJANET, but there are no plans to make SuperJANET a commercial venture like its counterpart in the USA. SuperJANET uses optical fibre technology to provide a bandwidth up to 622 MB/sec using Asynchronous Transfer Mode (ATM) packet switching techniques, working at a speed some thousand times faster than the original JANET. The British academic community can receive video services and use pictures, graphs and voices in their research and teaching activities.

3.6.2 The National Network in the USA

The development of a national computer network plan in the USA goes back to the 1970s and has its roots in the US Department of Defense when it developed plans for a PSN in the late 1960s. This computer network was called ARPANET.

During the 1980s, the Federal Government initiated a number of very important programmes to build and improve national computer networking. However, US Congress proposed the development of a national high speed and capacity telecommunication network called the National Research and Education Network (NREN). Its aim was to improve the US nation's electronic communication infrastructure.

Background to the Internet

The Internet is a world-wide network of computer networks. It serves millions of users in over 150 countries. Currently, the Internet is the world's largest international computer network that consists of a global set of interconnected Transmission Control Protocol/Internet Protocol (TCP/IP) networking sharing a common address. Table 3.1 illustrates the development of the Internet from a USA perspective.

Due to the lack of security of the early computer networks, sharing of data and information across the networks was very infrequent in the 1970s. With the introduction of ARPANET which had military-backed, high-grade security, this problem was addressed. For example, the TCP/IP network protocols replaced the earlier, more insecure, Network Control Program (NCP) protocol. The US government set up the NREN (National Research and Education Network) in 1991, as an electronic superhighway system that would allow researchers, business people, educators and students around the country to communicate with each other effectively. President Bush signed the High Performance Computer Act in 1991. The development plan of NREN had three stages. Firstly, upgrading and interconnecting existing agency networks into a 1.5 MB/sec national networking test-bed. Secondly, integrating the national network into a 45 MB/sec backbone by 1993. Finally, implementing a technological leap to a 2-3 GB/sec data rate from the mid-1990s. Currently, the NREN operates with a high-capacity (150 MB/sec) fibre optic network that links and gives access to supercomputer centres throughout the USA. Table 3.2 on the next page lists the network operation centres in the USA (Al-Shambari, 1998). As indicated above, the US Government sponsored the Internet during its early stages of development.

Years	Content changes
1969	ARPANET (Department of Defense (56 KB/sec)
1979	USENET established
1980/81	CSNET(Computer Science Network) and BITNET established
1983	Split of the original ARPANET into two parts: ARPANET (for R&D), and MILNET (for military operation)
1986	NSFNet established to link six NSF funded Supercomputer Centres (56 KB/sec). Start replacement of ARPANET
1989	NSFNet backbone upgraded to 1.5 MB/sec (Tl)
1990	ARPANET finally devoted to research & educational purposes
1991	NREN Bill: High Performance Computer Act enacted
1992	NSFNet (NREN) backbone upgraded to 45 MB/sec (T3). ANS, Advanced Network Services Inc. established
1994	Upgraded to 150 MB/sec
1995	NSFNet (NREN) backbone transformed to commercial services (ANSnet)
1996-7	NREN backbone upgraded to 650 MB/sec
Late 1990s	NREN aims to develop a national 2-3 GB/sec network

Table 3.1 The History of the Internet in the USA

BITNET (Because It's Time Network) is the other major academic network in the USA. It was established in 1981 under the auspices of EDUCOM, a higher education association concerned with the effective use of information technology. It provides interactive electronic mail and file transfer services, using a store-and-forward protocol. This is an academically-oriented, international, computer network, which uses a different set of computer instructions to move data. It became less important as more sites linked with the Internet (Arnold, 1994).

The main decision-making body for the Internet is the Internet Society, originally a voluntary organisation, which aims to promote Internet technology and developments. A sub-group of this, the Internet Architecture Board (IAB), is responsible for approving new and upgraded standards and for allocating resources such as IP addresses. The Internet Engineering Task Force (IETF) is another voluntary body, with open membership, which represents users in the Internet debates (Laudon and Laudon, 2000).

Alabama	Alabama University
Colorado	Colorado State University
Illinois	University of Illinois
Minnesota	Minnesota University
New York	Cornell University
New Jersey	John von Neumann Centre
Ohio	Ohio State University
Pennsylvania	Pittsburgh University
San Diego	University of California
Texas	Texas University
Illinois	Argonne Centre
New York	Ithaca Centre
California	Palo Alto Centre
Massachusetts	Cambridge, MIT

Table 3.2 NREN supercomputer network operation centres in the USA

3.7 National Computer Network in Saudi Arabia

Saudi Arabia started the plan for a national network infrastructure in the mid-1970s. During that time, the Saudi Arabian Government established a central computing site to support a research and development project called the Saudi Arabia National Centre for Science and Technology (SANCST) (Luqmani *et al.*, 1992).

In 1985, the Saudi Government extended SANCST's responsibility to become involved in developing a national network infrastructure to serve all Saudi Arabian sectors as well as other Arab countries. The name of the organisation also changed at that time to King Abdulaziz City for Science and Technology (KACST). KACST is an independent scientific organisation administratively attached to the Prime Minister. The main functions of KACST can be summarised as follows (KACST, 1998,2000):

- conduct applied scientific research programs in the fields that serve the economic and social development objectives of the Kingdom;
- advise on science & technology policy for the country and drawing up a planned strategy for its implementation;
- foster and support the development and use of computers and other scientific methods and technologies (the areas of emphasis are IT and system integration);
- provide the nation with a technologically sophisticated workforce; and,
- initiate and support joint research programs between the Kingdom and international scientific institutions in an effort to keep pace with scientific developments in the world by awarding research grants and undertaking joint research projects.

The organisational structure of KACST had several General Directorates and Directorates including the Directorate General of Information Systems. This unit was responsible for the production of national Science and Technology databases, provision of on-line search services, and the operation and maintenance of two data communication networks. The Directorate General of Information Systems consists of four Directorates: databases, national networks, computer centre, and information services.

3.7.1. GULFNET

GULFNET was the first computer network in the Arab world. It provided communication among the academic communities in Saudi Arabia and other Gulf State countries. It was established by KACST with the assistance of IBM. It was a 'stored forward' network, similar to BITNET in conceptual design and other characteristics. The main goal of GULFNET was to provide an infrastructure to facilitate the exchange of data, information and messages between scientists, engineers and researchers in the Arabian Gulf countries, who had access to computers connected to the network.

In 1995, there were 13 universities and research institutions in Saudi Arabia and other Gulf countries connected to GULFNET. This allowed national databases to be searched on-line by researchers utilising GULFNET facilities. The GULFNET hub node is at KACST. This is connected to various other nodes through leased telephone lines. The GULFNET system was managed by the member institutions via a steering committee that comprised the Directors of Computer Centres of participating universities and research institutions who formulated the rules and regulations.

3.7.2 Internet in Saudi Arabia

Over the past 20 years, Saudi Arabia has witnessed tremendous growth in ICT due to the requirements of the various development plans initiated by the Government. Computers and communication systems have become the cornerstone of progress in different sectors. On the other hand, some years ago connection to the Internet by the Saudi public was very difficult and expensive. Anyone who wanted to subscribe to the Internet had to access it via the State of Bahrain, there being no Internet Service Providers in Saudi Arabia (Burkhart and Goldman, 1998).

The first connection in Saudi Arabia to the Internet was through a satellite earth station located at King Faisal Specialist Hospital and Research Center (KFSHRC) for telemedicine with Johns Hopkins Hospital in Baltimore, USA (Al-Hajery and Al-Musa, 1998). In 1994, KASCT assumed responsibility for the coordination of Internet activity within the Kingdom of Saudi Arabia. A pilot project was implemented in 1996 in which dial-up connections were made available to faculty staff in KACST and KSU (Al-Zoman and Mansuri, 1998).

Saudi society remains one of the most conservative in the world. Therefore, change to new technology has been slow due to religious and social concerns. Regardless of the importance of the Internet, it has some negative aspects that conflict with Islamic faith and Arabic culture and traditions (Jones, 1996). The Saudi Government halted the Internet project in June 1996 due to its social and cultural consequences. They appointed a national committee to consider the advantages and disadvantages of public access to the Internet. KACST conducted several studies (e.g., Al-Zoman and Al-Bader, 1998) on how the negative aspects of the introduction of the Internet into Saudi society could be avoided. This study drew upon the errors committed by some Arab countries due to implementation of the Internet without considering its negative impact (Siddiqui, 1997).

Approval was given in 1997 for KACST to introduce the Internet into the Kingdom of Saudi Arabia, and to make it available to research establishments, academic institutions and both the public and private sectors. The preparation of organisational procedures by KACST with co-operation and co-ordination from STC was attained, and the Internet was launched in January 1999. The project was expected to finish by the end of 2000, but it was a little bit over time. Now all regions in Saudi have embraced the Internet.

As has been mentioned the Internet service was launched in 1999 and by the beginning of 2000 it had achieved the following activities:

- provided a national ATM network;
- connected KACST to the Internet;
- provided a national backbone computer network;
- provided a dial-up access for up to 5,000 subscribers,; and,
- connected the 7 universities.

Future plans incorporate the following objectives:

- increase capacity in existing 6 LCAs;
- expand Internet dial-up services area;
- total ports deployed Kingdom-wide in excess of 14,000; and,
- improved 'quality of service'.

The Internet project has just finished and is suffering from different problems (technical, financial, and organisational). It is expected that KACST and STC will continue to lead the development of the Internet in the Kingdom to eventually provide a service that becomes a benchmark in the developing world.

3.7.3. Internet services in Saudi Arabia

The current Internet service in the Kingdom is organised into three main levels as follows:

- First Level: Internet Services Providers (ISP). These are commercial companies that provide Internet access to the general public, government and private sector through dial-up and leased lines. ISPs are connected to the National Computer Backbone and to the International link at the Internet Service Unit (ISU). They provide their subscribers access to these networks

- Second Level: National Computer Backbone. STC is developing a high-speed network connecting most parts of the Kingdom together. Currently, the main regions of the Kingdom are covered by this backbone with expansion planned for the remaining regions. ISU and all ISPs are connected to the National Computer Backbone.

- Third Level: International Link. This is the link that connects the National Computer Backbone to International Internet connections. The International link is operated by ISU and all international traffic to the Kingdom will go through this link.

In order to obtain Internet services in Saudi Arabia, individuals, companies, organisations or Government agencies other than universities, have to subscribe through one of the licensed commercial ISPs. Although the ISU is responsible for providing Internet service in Saudi Arabia does not provide connectivity or support to end-users. The role of the ISU is to provide Internet connectivity to universities and licensed commercial ISPs, the latter in turn provide the service commercially to individuals, companies, organisations, and Government agencies.

3.8 Summary

Computer networks have become an essential part of our life. Networking is used in every aspect of business, schools, and military organisations to share expensive resources. This chapter covered the widespread introduction of networking and the new social, ethical and political problems that it brings. The driving force behind the widespread use of the computer network is the dramatic and continuing decrease in cost of computer hardware and software, accompanied by an increase in computer capability. This chapter summarises the major components of telecommunication such as hardware, communication media, communication networks software, communication protocols and communication applications.

This chapter also identified network applications that are pertinent to this study. Also, a brief discussion of the development of the national academic networks in the UK and USA were presented to act as a baseline for comparison with the situation in Saudi Arabia. Finally, this chapter closed by exploring the advent of the Internet in Saudi Arabia and its problems and impact on Saudi society. In order to improve the situation in Saudi University Hospitals advanced countries (e.g. the UK) and their latest plans will be compared with the computer network in the Saudi University Hospital. Obviously, the NHS in the UK is far ahead of Saudi Arabia, but the researcher believes it will be possible to extract and obtain benefit from their experiences in the field of health care and computer network (see chapter 9). The intention in carrying out this comparison is that developing countries, such as Saudi Arabia, is worth studying due to the insights gained from the introduction of computer networks. The next chapter will take these concepts further, covering ICT in health care.

Chapter 4
ICT in Healthcare

4.1 Introduction

The purpose of this chapter is to give an overview of ICT in health care in developed and developing nations. Firstly, the ICT developments in advanced nations will be reviewed. There then follows a discussion of the benefits and problems of using ICT. Following this, ICT in Saudi Arabia in the past and the future will be discussed with more attention being paid to ICT in a health care setting. Then attention will shift to information security as one of the major issues. This has attracted considerable attention especially in a health care environment. Finally, the future of ICT in health care will be discussed briefly.

4.2 Historical Evaluation of Information Technology in HealthCare

The historical development of computing in hospitals has gone hand-in-hand with the advanced use of information technology in healthcare. Generally speaking, health information systems were implemented through manual-based information processing before computer systems were available. However, as with all manual systems, there are drawbacks associated with conformity and standards. To improve the quality of healthcare information systems a computer-based solution is viewed as essential to minimise these types of errors. To illustrate some of the human factors involved in the processing of healthcare information, it is useful to investigate its historical context. The first health information system started in the early 1960s when a small number of hospitals began to automate selected administrative operations. Applications were limited to the processing of some patients' data, the processing of clinical laboratory data and the elementary use of statistical analysis.

Duncan *et al.* (1998) reported that a few systems were developed for electronic storage of in-patients data and medical record abstracts for use following discharge. These early hospital information systems were batch-processing systems with no on-line user access to data in the computer files.

The first HISs were developed in the mid-1960s in the USA and in a few European countries such as the Netherlands, Sweden and Switzerland.

Among the best-known early hospital computer systems were those developed by:

1. King's College Hospital System (London) – John Anderson.
2. Massachusetts General Hospital Computer System (Boston) – Octo Barnett.
3. The Kaiser Permanente Hospital Computer System (San Francisco) – Maurice Cohen and E. van Brunt.
4. Karolinska Hospital Computer System (Stockholm) – Paul Halle.
5. The London Hospital System – Bud Abbott and Barry Barber.
6. Stockholm Country Hospital Computer System (Stockholm) – Hans Peterson.
7. University of Hanover Hospital Computer System (Hanover) – Peter Reichertz.
8. Texas Institute for Research and Rehabilitation Hospital Computer System (Houston) – C. Vallbona and W. Spencer.
9. PROMIS System (Burlington, Vermont) – Larry Weed.

Some of these early systems have passed into oblivion and others have developed into modern systems. All were pioneers in their time and faced problems of creation, implementation and financing (Abbot *et al.*, 1990).

A revolution in computing occurred during the 1970s. The computing hardware configuration was centralised by using one big computer and connecting all terminals in a star network topology. However, computers became smaller and less expensive, with more processing power and some major vendors began to develop application software packages for hospitals that could be used by any hospital, clinic or other health organisation.

Most of the early software packages supported administrative operations with only a few supporting clinical operations such as clinical laboratories, radiology departments and pharmacies. Users obtained direct access to computer files through on-line terminals connected to the system. The early 1980s saw the wholesale manufacture of microprocessors, which brought the cost of buying a computer down dramatically (Summers, 1992). Microcomputers and LANs permitted individual users to integrate their local databases into a larger centrally shared database. Computer-based HIS have affected healthcare workers, patients and organisations.

In the mid-1980s the major advance was the development of electronic data networks that connected general practice (GP) and larger systems together to share information on a decentralised basis. Hospitals were beginning to recognise their HIS planning problem. However, this gave rise to the idea that HISs should be specified and planned and not merely purchased when they become necessary.

The 1990s have witnessed dramatic changes in the healthcare environment, especially the development of Integrated Delivery Systems (IDSs). IDSs is a network of hospitals, physicians and other healthcare organisations that come together to provide all the required services for a defined patient population. Degoulet and Fieschi (1997) argue that the traditional one-to-one relationship that existed previously between patient and physician has changed to a one-to-many relationship. This type of networked relationship is becoming the norm between healthcare professionals and the health organisations. Duncan *et al.* (1998) confirm that, in spite of more than 30 years of research and development in implementing computer applications in healthcare organisations, most patients' records today are paper records. Health information networks are becoming a popular tool to exchange information among hospitals (Pemble, 1997). Many countries, such as New Zealand and Australia, have established a national health information system for the benefit of their population.

In the USA, several States also have implemented community-wide health care systems. For example, residents of Maryville, Kansas, a community of 12,000 people, benefit from a town wide Intranet which ties in to the town's hospital, health clinics, schools, county health department, emergency service, and other services in a seamless data network. The system will provide access to medical records almost immediately, which will enable health care workers to handle emergencies quickly (Turban *et al.* 2001).

4.3 ICT in Health Care in Developed Countries.

The development of technology and the introduction of computer systems in the workplace have entered a new era in the medical field. Computers are able to process information faster and more accurately than people and clinical decision-making may be facilitated through the up-to-date and accurate data made available by computers.
As a result, computerised clinical information systems introduced in different clinical departments have been considered as a means of benefiting patient care through increased medical staff efficiency.

Allen and Davis (1992) show that computerised clinical information systems reduce the time spent filing medical records, generate more complete and accessible patient data, increase nursing productivity and reduce nursing overtime. Also, similar studies conducted by Clemmer and Gardner (1992) show that nurses were overwhelmed with paperwork and errors are caused by inaccurate hand-written data, whereas computers are considered the most timely and accurate method to assist physicians and nurses in their record keeping and decision-making. Baranera *et al.* (1999) state that, in the clinical environment today, potential users still show a higher degree of skepticism about the usefulness of new computer applications. Anderson (1999), Kaplan (2000) and Starren *et al.* (1997) found that physicians have expressed a real need for an efficient on-line medical consultation system because it is easy to use, reliable and helpful. The replacement of manual systems with computerised systems will influence physicians, and nurses' attitudes and behavior. However, there is limited information and few data studies on how the implementation of computerised information systems has affected staff.

Anderson (1999) concluded that clinical information systems provide major benefits in the direct support of patient care. Those benefits include increasing efficiency in managing clinical information systems, improved quality of care and, cost savings through decision-making and, the management of patient care.

Investment in ICT is a major way in which organisations respond to changes in the business environment. Information systems are often fundamental to the operation of an organisation and, depending on the type of business, can be regarded as a strategic resource. The computer network can be designed to meet the needs of a single site or a multi-site organisation and can be used to provide communication links between an organisation and its trading partners (Etheridge and Simon, 1992). However, ICT can transform the way we live because it enables us to communicate with people where they are faster and more conveniently with a wider group of people in remote places. Chen (1992, p13) claimed that:

> "Telecommunication, networking and interconnected computer systems are important to healthcare because they provide the promise of improved efficiency and productivity through the sharing of work and data. Thus technology provides the capability to use and share information in new ways both within the hospital and outside the hospital".

Furthermore, ICT enables hospitals to increase effectiveness and efficiency. For example, integration among three different information systems is needed: patients, clinical information and financial data. Al-Khatib (1998) reported that a Wisconsin hospital saved \$1.2 million and cut order-processing time from 20 minutes to 5 minutes by installing an administration/clinical information system. He also added that some healthcare services use ICT to improve customer relations and use an integrated system for automated delivery of healthcare supplies.

It can be argued that ICT can improve the efficiency and effectiveness of healthcare organisations and thus provide direct benefits to patients. Accordingly, many countries have set out programmes to rebuild the ICT infrastructure of their national health service. For example, the UK government has embarked on a ten year programmes to modernise healthcare. The Prime Minister made a commitment in October 1997 that 25% of government services should have electronic access by 2002 (Burns, 1998, 2001). referring to the Secretary of State for Health, Frank Dobson said:

> "Using rapidly developing information technology, clinicians will be able to dispatch in a fraction of the time it has taken up to now. Patient's details will be transmitted between primary care and hospitals rapidly and electronically".

The core objective of the new strategy in the UK is for ICT to be introduced universally in the NHS on a 24-hour basis using modern electronic communications. Gregory and Davis (1999) claim that UK primary care is the leading global example of the widespread use of electronic patient records with success built primarily on the partnership between suppliers and GPs. ICT allows a doctor to check patients from their homes (either doctor or patient) and it lets doctors in several remote locations co-operate in a patient's care by immediately sharing his/her medical records, including X-rays and videos from operation rooms using multimedia computer screens.

In the USA, many hospitals implement computer terminals in all patients' rooms, allowing the nurses to communicate with doctors, medical laboratories, medical records, pharmacists and other healthcare personnel. It also allows them to order tests, medication and special diets, which are all entered from the patient's room.

Fortunately, the technology now exists to link physicians and other healthcare providers, hospitals, health educators, nursing care facilities, pharmacies, and researchers to the public. For example, Tele-surveillance remotely collects surveillance parameters and can even remotely control objects. It can facilitate home surveillance for chronically ill patients offering alternatives to hospitalisation. Specialties, such as nephrology for home dialysis and pulmonary medicine for management of respiratory deficiencies, are suited to this technique.

The availability of high-speed networks and ISDN also make possible the transmission of videoconferences to be used for group discussion in clinical cases or for education programmes and training. Degoulet and Fieschi (1997) envisage that electronic records may be accessed immediately, or after 24 hours, and can be accessed simultaneously by different users. Computerised records facilitate data sharing and communication between the different partners in the healthcare system.

The efficacious use of the smart card is another advantage being brought to bear on ICT in healthcare, especially in France. The use of smart cards, based on the model of banking cards, has several possible applications in healthcare networks. It may serve as an instrument for identification and authentication. For patients, it may serve as a method of payment or as a medium for storing critical information such as blood type or allergies. Neame (1997a) claims that smart cards are set to play a pivotal part in the future development of computing in general and particularly in healthcare applications.

4.3.1 ICT in Health Care in Developed Countries – the Problem Issues

As mentioned above, ICT healthcare deployment in developed countries mainly started as an aid to increase the efficiency of the organisation, usually beginning (in the USA) with payroll and patient account functions. Initially, very little attention was given to the automation of clinical information. The 1990s saw the introduction of computers into more than 80% of GP practices in the UK. (Brown, 1998). Additionally, the computerisation of GP practices has many administrative and clinical advantages in areas such as the patient database and repeat prescribing. Thus, the tools of ICT were initially adopted with enthusiastic expectations. Some people thought that these tools would be the solution to all problems, rather than just an important instrument to facilitate various activities.

In spite of all the benefits that computers provide to hospitals, ICT has had some problems. Several authors have discussed many problems and issues in health care settings in developed countries. For instance, Bryant (1998) investigated the importance of human and organisational factors in the implementation of computerised information systems in a European heath care setting. He classified the most important reasons for failure in three broad categories: technical shortcomings, project management shortcomings and organisational shortcomings. Wyatt (1994) had stated five years earlier that clinical information systems had a chequered history. Commentators identified three major barriers to success: inappropriate system development and function; lack of involvement of system users; and poor management. He also mentioned mistrust between clinicians and computer professionals.

Despite the potential advantages of ICT in medicine, successful computerisation is rare. There are many examples of health information systems going over budget, and/or being months or even years behind schedule. For example, an information system installed at the University of Virginia Medical Centre was implemented three years behind schedule at a cost that was three times the original estimate (Anderson, 1999). Clegg *et al.* (1997) found that up to 90% of all IT projects fail to meet their goals, 80% are late and over budget and 40% are abandoned. Similarly, Hochstrasser and Griffiths (1991) suggest that up to 70% of general projects related to information systems fail.

Heeks *et al* (1999) discussed why health care information systems succeed or fail. They stated that, some HISs do succeed, but the majority are likely to fail in some way. They argued that the greater the change gaps between current realities and the design conceptions of a new health care information system, the greater the risk of failure. Some generic conclusions can be drawn about successful approaches to HIS development. Examples suggest the greater use of participative approaches to HIS. Finally, they have identified four main forms of HIS failure:

- the total failure of a system never implemented or in which a new system is implemented but immediately abandoned,
- the partial failure of an initiative in which major goals are unattained or in which there are significant undesirable outcomes,
- the sustainability failure of an initiative that succeeds initially but then fails after a year or so,
- the *replication failure* of an initiative that succeeds in its pilot location but cannot be repeated elsewhere.

This categorisation will be used in the context of this study in Chapter 9.

Young (1991) evaluated the clinical use of computers as poor, because the vast majority of clinicians do not use the computers directly for patient care. Additionally, he discussed several problems that surfaced as result of the study. He also dismissed the idea that doctors' self-esteem was reduced by using these machines, that their natural conservatism prevented changes in practice, that use of computers caused cold, impersonal medicine and that they are a threat to status and jobs.

Regardless of the past, since computers have been introduced to the health care environment, attitudes of physicians and health professionals remain an issue that attracts considerable attention, and they strongly influence whether medical technology is accepted or not. Kaplan (2000) revealed over 50% of the causes of information system failure were due to staff non-acceptance. How physicians or anyone else react to or use computers is influenced by many factors such as values, norms, practices and beliefs. Similarly Baranera *et al.* (1999) pointed out in an analysis of physician's attitudes that there is a general lack of confidence towards computer-based projects.

The impact of computers upon general practice in clinical terms remains limited. Allen and Davis (1992) think the reasons for this may lie in doctors' attitudes to computers. A practice may be computerised, but the doctor may not make use of the facilities. Wyatt (1994) noted that some clinicians do not want to use computer facilities because they fear that juniors will outshine them because of superior computer literacy. Fung (1993) indicated that doctors, like the rest of society, have contradictory attitudes to the introduction of computers in medical practice.

Resistance to change and negative attitudes toward computers were identified as major problems in the health care sector. However, Anderson (1999) suggested several factors that may increase the acceptance and use of computer by physicians. He claimed that physician's involvement in the selection and implementation of systems is essential. Systems with no real ownership by the medical staff are likely to fail. One successful strategy is to enlist the assistance of influential physicians to encourage other members of the medical staff to use the system in practice. High level sponsors are needed when introducing a new clinical information system into a practice setting.

Gillies and Rawlins (1998) conducted a study to show the computer's impact on the achievement of doctors. They found that many practices at that time were making very limited use of their installed computer systems. Significantly, many practices used the systems to administer only a limited number of clinical areas and functions. They suggested that the way forward was through education and training. This may demonstrate the benefits of greater usage of computers and provide the skills required for achieving this result. The internal and external environment may influence clinical effectiveness. Therefore, any attempt to introduce ICT may consider the effectiveness of computer systems and should recognise the influence of these other factors.

Several writers, such as Murphy (2000), Forrest and Robb (2000), Plaice (2000), Starren *et al.* (1997), Gillies (1998), Wyatt (1994) have pointed out the lack of skills, training and education as barriers to the use of computers in the healthcare environment. For example, Gillies (1998) highlighted the following as barriers to greater use in specific cases: poor documentation, and lack of time and support for ongoing development of skills. He noted two issues regarding training:

1) different staff have different needs and may not receive the best training when working together,

2) there is a need for further training as the user progresses from being a novice to an advanced user.

Training medical staff to use computer communication technology is very important for keeping them up to date. However, Farmer *et al.* (1999) noted a lack of awareness of information technology among nursing staff in Scotland. They suggested some areas, which should be included in training nursing staff such as skills in searching electronic databases and the Internet, information awareness, assessing the quality of information and research methods. In the UK, many nurse and nurse educators are only just struggling to come to grips with the idea that nurses need to have some basic computer literacy skills. Conversely, in America, nurse educators have gone much further and Internet literacy is becoming an essential skill for nurses (Murray, 1995).

Degoulet and Fieschi (1997) summarised several kinds of difficulties that complicate the process of putting medical records into computers. These problems are as follows:

- computerising records requires complex medical data and knowledge modelling. The initial models, based on the linear organisation of paper records, have rapidly proved to be insufficient;
- medical terminology must be organised in complex dictionaries to achieve semantic coherence within pieces of distributed records;
- human problems are often underestimated, especially user interface problems, security, confidentiality, and the possible effect on the patient/physician relationship caused by the direct entry of the medical record in the patient's presence;
- the high cost of hardware, software, and access to communication networks are factors that inhibit the generalisation of computer-based records, and
- the training provided to healthcare personnel in the use of computer systems is usually insufficient.

Comac (1997), and Bloomfield *et al.* (1997) drew attention to the lack of expertise in the implementation of ICT in the NHS, causing underestimation of the time taken to get a new installation off the ground. They confirmed that many districts do not have the skills to develop their own computer programme. Also, they believed that the lack of a structured training plan was the most significant barrier to improved system performance.

Sheaff and Peel (1995) pointed out certain problems such as insufficient knowledge and fear of technology. They argued that health service managers (including health professionals) find themselves having to operate or introduce an information system without knowing what sort of information system to order, or how to install and operate it. Indeed information systems could be at risk when those responsible for deployment and development are unaware or unfamiliar, suspicious or even frightened of the technology itself. Laudon and Laudon (2000) stated that if that project team is unfamiliar with hardware and software or data base system, it is likely that the project will experience technological problems or take more time.

The lack of information on computer applications in the NHS is coupled with the desire to develop more client-orientated training packages. In the real world, commercial packages are not without problems. Moreover, the various data formats, all incompatible for reasons of commercial exclusivity, make it difficult for doctors to extract data for audit and analysis purposes (Gillies, 1998). He also pointed out that there are some basic problems that arise from poor system thinking and design.

The high cost of ICT is an important problem facing healthcare organisations. The National Health Service in the UK in the last decade has spent a large amount of money implementing computerisation in hospitals with the aim of improving efficiency and saving money. Jeans (1998) argues that some of these attempts have been naive and disastrously expensive; a large amount of money possibly spent on introducing computerisation with little evidence of its cost effectiveness.

Many reports have criticised the use of computer systems in NHS hospitals and there is a debate regarding the value of information technology to hospitals. Assessing the value from investments in ICT in hospitals is not straightforward. The NHS traditionally viewed value from ICT as saving money. Lock (1995) argued that whilst this was the norm in the 1960s, this is not sufficient in the 1990s and beyond. Additionally, Lock (1996) claimed that published evidence on the value of information technology in hospitals is scarce and far from conclusive. He also found few evaluation studies of automated information in healthcare. Only 13 of the 108 studies that were identified used economic analysis and he reported that few studies attempted to show cost effectiveness.

The complexity of the technology required for external links does not depend greatly upon the information transmitted. It is the information management procedures that become much more complex if clinical data are to be shared. Therefore, Gillies (1998) advised that data collection and coding procedures need to be agreed and validated between collaborating partners. Historical evidence shows that their operations lie alone within the context of a wider group. Linking medical records in general practice with those in hospitals is one possibility that computers could help with in order to improve the services to patients, but the limiting factor in the NHS is the lack of a standardised identification number. Moreover, Jeans (1998) believes part of the problem is the British phobia about being easily identifiable and one way around this is to have a Smart card, which can be read by a computer and could carry all citizens' medical data such as medical history and blood group.

Shum (1992) found that the usage of installed systems was well below the maximum potential level. This was supported by interviews, which revealed, in a few specific cases, a lack of practitioners' knowledge about their systems, problems in coding diagnoses and major cultural problems. Besides, there is a cultural problem here because general practices were not used to working together, so this can provide another very serious barrier to the successful implementation of a computer system. He pointed out that a further consequence is the worrying situation where a system is in use and functioning correctly, but doctors and practice staff have insufficient knowledge to recognise potential significant lack of data integrity.

Finally, information security and patient confidentiality have attracted considerable attention in an academic and practical setting. Several authors such as Amatayakul (1999), Anderson (2000), Neame (1997b), Benson (1998), and Anderson and Brann (2000) have discussed and considered heath information security and confidentiality which they agree are one of the prime patient concerns, and one of the most important issues. All agreed that patient medical information should be kept secure and confidentiality and privacy must be respected.

Overall, the literature identifies a number of issues associated with information technology in healthcare in developed countries such as:

1. lack of knowledge in the operation and use of this technology;
2. poor training and education in this technology;
3. the need for well trained technology staff;
4. the challenges of integration and lack of standards;
5. lack of funding and high cost of ICT;
6. resistance to and fear of technology;
7. poor utilisation and organisational problems;
8. variety of technical problems (hardware and software),
9. political implications and many other obstacles, and,
10. information security and patient confidentiality.

Several authors have presented possible solutions and made a number of suggestions regarding how to overcome these difficulties. In spite of the difficulties that have been encountered in ICT in the healthcare environment, computers have made wide inroads into the practice of medicine and the pursuit of the use of computers in medicine has never stopped.

4.4. ICT in Developing Countries

Over the past two decades a voluminous amount of literature has been published regarding ICT adoption in developed countries. In contrast, few studies have focused on developing countries in general and Arab countries in particular. IT might be the key tool that will assist developing countries to pursue their development through the availability and use of the information necessary for national strategic planning. However, the practical utilisation of ICT for the benefit of the population at large is still very limited.

Several writers, such as Ahmad and Zink (1998), Al-Sudairi (1994), Al-Sudairi (2001),. Bukhari (1994), Luqmani *et al.* (1992), Sadowsky (1993), Al-Shanbari and Meadows (1995), Siddiqui (1997) and Jones (1996) have indicated that the deployment and use of ICT in developing countries is very expensive and risky and can result in management, economic, political and social problems, whether resulting from the external or internal environment.

It has now become a truism that IT is very important for any nation for many reasons (e.g., economic, social, strategic). Many developing countries, among them many Arab and Islamic countries, are encouraged by the advancement and success of Western development. However, these developing countries have discovered eventually that certain systems were a total failure because they were not tailored for their own particular culture. It seems that IT is vital to the development of developing countries, but it is critical that this technology is adapted to their own special needs. Unfortunately, as long as these technologies are imported and merely used according to Western norms, the problems will remain.

A considerable gap has developed between ICT adoption in developed and developing countries. The time lag between adoption in developing countries compared with developed countries cannot be solely attributed to economics. This is particularly so in the case of the Middle East (Ahmad and Zink, 1998). Behery (1998) outlined, for example, the main reasons why Saudi Arabia is behind in the area of ICT this can be attributed to several factors, including:

- computer illiteracy;
- lack of government incentives to attract businesses (free-trade zones/subsidies);
- the absence of an adequate infrastructure to support industry;
- poor enforcement of intellectual property and copyright laws;
- lack of resources.

Burkhart and Goldman (1998) believe that Saudi Arabia remains one of the world's most conservative countries, so the most important issues surrounding the use of the Internet are cultural and moral. Likewise, Al-Rawas and Millmore (2001) found a resistance to technology in Oman due to the attitudes of staff. This was for the following reasons:

- being uncomfortable with technology because of limited ICT literacy;
- fear of new technology reducing staff confidence;
- lack of belief in, or commitment to, technology;
- unwillingness to change traditional methodologies;
- time and pressures preventing the development of ICT skills.

Similarly, South Africa has the same experience Klimpacher (1998) identified the weaknesses in South Africa as follows:

- the computer literacy of South Africa's population is very low;
- the awareness of telecommunication technology opportunities is too low;
- software developers are too small in size to be internationally competitive; and,
- there is a lack of internationally relevant related or supporting industries, such as hardware manufacturers.

Oyinloy (1998) pointed out that Africa lags behind other regions of the world in terms of the dissemination, and use of computer networking and related technology, as relevant communication infrastructures are either non-existent or unreliable. According to Nawe (2000), Tanzania suffers from the following ICT problems:

- lack of management development programmers for analysts, programmers and data processing personnel;
- lack of funds for the purchase of rapidly changing hardware and software technology; and,
- lack of proper training facilities and non-standardised training relating to ICT.

Likewise, Khazai (1997) summarises ICT problems in Iran as follows:

- lack of production of manufactured goods for the internal market and for exports;
- poor selection process in the higher education system;
- lack of resources; and,
- instability of foreign exchange.

Developing countries encounter problems relating to their environment, resources, culture, education systems, and their financial resources. Computers in these countries require large initial capital outlay and have high running costs due to scarce expertise. It is well known that the information systems in developing countries tend to be more expensive than in the international marketplace. Generally, these countries typically lack skill and scientific education, especially related to ICT. In addition, Sadowsky (1993) has indicated that the use of ICT in some developing countries is limited and they have not developed policies to confront the challenge at the different levels required (e.g., skills training).

4.4.1 ICT in Healthcare in Developing Countries – the Problems

The amount of published work addressing the issue of ICT in healthcare in developing nations is relatively slight, although an increasing interest is being shown in the area. In spite of some of the fears, these countries, such as Saudi Arabia, implemented computer systems in the 1960s. Rohan (1992) asserts that developing countries introduced computers in the health care sector in the early 1970s.

The organisation of medical care systems varies from country to country; it is an evolving process impossible to describe synchronically. As is acknowledged, when a medical care system exists, it does not necessarily mean that it functions according to design or that the people whom it is intended to serve use it appropriately.

The adoption of a certain type of healthcare system normally depends on the political, cultural and socio-economic situation of a country (Khalili, 1992). The numerous benefits of computers to developing countries cannot be denied. Studies of the literature suggest that use of computers produce better health information that actually leads to better management and, in turn to better healthcare for the population. ICT deployment in developing countries' healthcare systems was mainly started as an aid to the care of the environment and the efficiency of organisation; it was used to enable health organisations to carry out financial functions (e.g., pay bills, payroll, financial reporting).

The development of ICT has affected health organisations in different ways. For example, at a clinical level the physician can use the medical information system to collect patient histories, nurses can call on protocols such as nursing care plans, and pharmacists can receive alerts on the drugs prescribed which are contra-indicated by a patient's current therapy (Al-Hashimi, 1997).

Without IS it is not possible to think seriously of having a good health information system, as health systems need good and fast information as a basic input for health policies, health programming and health control. Pakenham (1997) noted that providing access to reliable information for health in developing countries is potentially the single most effective and achievable strategy for sustainable improvement in health care. It is also cost effective because the amounts of money required are negligible compared with those invested in health care and also because ICT presents exciting new opportunities.

Likewise, Pakenham and Smith (2000) also emphasise that there is massive potential for the development of international co-operation in supporting national and local programmes to improve access to reliable information in developing nations. Although ICT is used in healthcare in some developing countries, it has faced similar obstacles in advanced countries. For example, Al-Nahdi (1998) found that the computer deployment and utilisation in Oman health care and UK still face problems. The main problems are human rather than technical. He found that most human issues are to do with the style of leadership, poor utilisation, lack of skills, and lack of training.

Nabali (1991) investigated the adoption and utilisation of the computer in public hospitals in five Arab countries. She found a lack of complete awareness by users and management at different levels as well as problems with resistance and training. She recommended that efforts are made to focus on learning from organisations that have already been through the adoption process, including hardware and software acquisition and to the organisational impact of the adoption process.

Rohan (1992) highlights that poor countries face a number of challenges, such as insufficient local expertise, training, and a lack of resources to maintain their systems. He also pointed out that developing countries have the opportunity of learning from the successes and mistakes made in developed countries. Walsham *et al.* (1988) suggested that the problems of information systems development and use, especially in healthcare, are often more severe in developing countries. This is because of several factors such as the current state of knowledge, the availability of suitable equipment and infrastructure, a lack of financial resources, a shortage of technical competence, and constraints imposed by the social and political context.

According to Darjenta and Spyrou (1993), the understanding of the system and its factors is a prime prerequisite to secure the deployment, utilisation and development of technology. The problems associated with the use of technology may be because of human, rather than technical factors. They also explain the view that a real understanding of what the new technology can do is a prerequisite to incorporating an information system into a healthcare centre's everyday operation. Chen (1992) claimed that progress in the development of computerised hospital information systems has been quite slow for most of the under-developing countries during the last decade. He emphasised that the lack of IT expertise and cost difficulties are the most important barriers.

On the other hand, some countries are not yet ready yet to implement medical information systems. For example, Al-Hashim (1997)[1] undertook extensive research to identify tools that could assess Bahrain's readiness for medical information systems. It was concluded that there are no such tools in existence.

There is incomplete awareness of the power and the limitations of health information systems on the part of physicians and healthcare personnel in developing countries. Manual record systems are still relied on and there is little acceptability of automated medical records, resulting in technology not being used to its full potential. From the author's experience in dealing with some hospitals in Saudi Arabia, many of these hospitals are using PCs just as typing machines, regardless of the fact that a few physicians have computer knowledge and can use PCs effectively. Information networks or data banks could facilitate the integration of healthcare at the local and national level, but unfortunately, this is very limited.

The literature indicates that political, cultural, and educational systems and the environment have a strong impact on ICT in developing nations. Many problems and obstacles have been identified such as high costs, social or political issues, the favouring of short-term planning over long-term, and a lack of training and manpower skill requirements.

Summarising this Section, the most important difference between the developed and the advanced countries regarding the deployment of computers in healthcare is the

[1] Al-Hashimi, M., 1997. Multi-dimensional Approach of MIS towards Healthcare. Unpublished paper: 3.

availability of resources and the lack of skills and experience, which are frequently absent in the former. Generally speaking, in developing countries, ICT issues in health organisations are multidimensional. They involve the lack of skills, training, education, awareness, funds, an absence of supporting management knowledge, a lack of ICT policies and poor utilisation of technology that has been already installed in different organisations. As result, ICT utilisation in health care is still very limited.

4.4.2 Examples of the Medical Application of Computer Technology in Developing Countries

Each developing nation has reached different points on the ICT evolutionary scale. For example, whereas Saudi Arabia started using computers as early as the 1960s, Iran started to use them in 1955, Morocco in 1957, Mexico in 1958 and Panama in 1970. The following two examples indicate the use of ICT in healthcare in developing countries.

Oman

Recent developments in healthcare have been accompanied by the availability of facilities to collect, analyse and present health data. The Royal Hospital and the Sultan Qaboos University Hospital were the first health organisations in Oman to implement and utilise computer health information systems. Al-Nahdi (1998) conducted a comparative study to investigate the importance of computer deployment and its use in developed and developing countries' healthcare systems. He came to the conclusion that computer deployment and utilisation still face problems. Secondly, the main problems of computer failure are related to human, rather than technical issues. Finally, the results of the survey suggested that, though the respondents were aware of potential computer technology, problems of computer fear, training and lack of skills were experienced and often, few individuals possessed computing knowledge.

He suggests several points to be considered:

- anything about computer utilisation should start with a strategic information system to serve a competitive objective;
- the decision on computer deployment, and use should be made by a special committee that has expertise in ICT; and,
- there is a need for good strategic planning for computer deployment, use and development; this should be connected to the organisation's overall strategy.

Bahrain

The Bahrain Defence Force Hospital was selected to implement a medical information system called AL-Care (Bahrain Defence Force Hospital Profile, 1997)[2]. AL-Care is an in-house, on-line, integrated medical information system, and has been operational since 1994. AL-Care has contributed to the hospital mission in providing high quality care, while containing healthcare costs by providing the users with data, information and knowledge that support the decision-making process, and cost monitoring at each level. A number of major systems have been implemented at BDF Hospital, with AL-Care being the largest project. The patient care applications currently operational are: comprehensive patient registration, patient clinical summaries, appointments and attendance, pre-admissions, admissions, patient bed transfers, patient meal orders, automated patient file acquisition and tracking, detailed patient order and summary, and physician drug ordering. A recent module is the outpatient encounter, where physicians enter the patient's clinical details for the visit directly into the system (on-line). This module leads to the elimination of the manual paper/file encounter, and a reduction in manpower.

In comparing the AL-Care experience with other experiences in the country, it is important to highlight some factors, which contribute to the success of AL-Care. Among these factors are the assessment study, leadership support, user involvement, training strategy, and having medical informatics as the core developer. Future work will continue

[2] Bahrain Defence Force Hospital Profile, 1997. Bahrain.

to concentrate on moving towards the concept of a paperless hospital through a comprehensive "Patient Care System" that includes all clinical, administrative and financial components.

4.5 ICT in Saudi Arabia

ICT in Saudi Arabia can be traced back to the 1960s when a team from IBM arrived in Saudi Arabia to install the first information handling service for the American/Arabian Oil Company. This initial drive towards computerization was therefore led by the private sector and based on hardware and software designed by the industrialized nations (Lugmani *et al.* 1992).

Over the past 20 years, Saudi Arabia has witnessed tremendous growth in IT due to the requirements of the various development plans initiated by the government. Therefore, computers and communications systems have become the cornerstone of progress in both public and private sectors. Moreover, Saudi Arabia is now among the most advanced users of IT in the world, especially in the oil and military sectors, yet it is still defined as a developing country. However, Siddiqui (1997) reported that although Saudi Arabia is still relatively young in terms of implementing ICT systems, it has become an active player in recent years.

ICT policy in Saudi is based upon the assumption that the application of ICT leads to higher productivity (KACST, 2001). The Saudi government has encouraged all organisations to implement ICT. Therefore, most organisations have introduced ICT in some form or another to support and improve the efficiency and effectiveness of their operations. Unfortunately, for different reasons, sometimes technical, but more often organisational, many organisations have found it difficult to achieve their objectives.

The Saudi workplace has been changed dramatically by the introduction of personal computers. Due to heavy demand and usage of ICT, all major international computer companies have branches in Saudi Arabia and the competition among them is harsh.

Sulimani and Biyari (1998) maintained that the Kingdom is by far the largest market for ICT equipment in the Arab world. They also pointed out three essential elements for successful implementation of ICT in the Saudi environment. These are as follows:

- adapting the deployment of ICT concepts to the local environment;
- developing skilled Saudi manpower; and,
- building a national telecommunications network that can satisfy the needs of a national information network.

Saudi Arabia, with its financial capabilities, has a very rapidly growing industrial and economic situation with great potential for scientific and technological development. Nevertheless, it is hoped that introducing information systems in the production sector will benefit the GNP and that its added value will improve the quality and reduce the cost of goods. It was expected that all organisations in Saudi Arabia would continue to experience increased usage of ICT applications. For example, the universities will increase ICT usage in student records, special academic applications, libraries, research, teaching computer-related subjects, distance learning and statistical analysis.

Banks and financial institutions are the most important sectors to utilize ICT. A national ATM network and world-wide electronic fund transfer service is already implemented by all banks. Some hospitals began to be oriented more toward medical and patient care requirements and specialised departmental systems in departments such as a pharmacy, admissions and intensive care. Therefore, larger purchases of computers and communication systems can be imagined. However, a great demand for electronic applications is expected. Al-Sudairi (1994) reported that the market for data communication and applications is just starting to expand in Saudi Arabia. As more organisations realise the value of information, enterprise-wide networks will appear.

With the development of ICT, computer networks have the capability for connections to be made automatically in seconds, no matter what the location. Since the 1990s, rapid changes in digital telecommunication have occurred. It is essential that networks are fully adaptable to any change to help organisations take advantage of new opportunities faster. In Saudi Arabia, it is expected that new technologies using fibre optics and microwave communications will make metropolitan area networks a reality. Moreover, a drive for global communication will be evident, especially with the new telecommunication systems incorporating the latest digital communication equipment and services now being installed by the STC.

4.5.1 Major Trends, Issues and ICT Problem Areas in Saudi Arabia

There is enormous interest in using ICT in Saudi organisations (e.g., banks, businesses, and hospitals). Both the private and public sectors have made large investments in computer equipment (Al-Khatib, 1998). The introduction of such sophisticated equipment has changed traditional Saudi society. Furthermore, educational institutions, research groups and experts are interested in looking at and examining the issues related to the introduction of ICT they are trying to find appropriate and practical solutions.

Most managers in Saudi Arabia support ICT, even though some do not fully understand the issues that are related to implementing and using ICT in their businesses. However, unfortunately, while some organisations have an ICT policy to use ICT effectively in their businesses, some organisations have no formal ICT planning at all. Luqmani *et al.* (1992) claim that the complex culture of Saudi Arabia appears to be another social barrier to the widespread adoption and use of computers at both the intra- and inter-organisational levels.

Many writers, such as Al-Sudairi(1994), Al-Sudairi (2001), Bukhari (1994), Bukhari and Meadows (1992), Siddiqui (1997), and Al-Shanbari (1998) have claimed Saudi Arabia does not have adequate skilled manpower to run computer systems with maximum efficiency. Many organisations are dependent on foreign experts to implement and use ICT. It is believed that this situation exists, not just in Saudi Arabia, but also in other developing countries due to the shortage of people with ICT qualifications. It may be that the problem will be more serious and the situation will be worse in the next few years due to the budget deficit, which has arisen as a consequence of the Iraqi embargo and the Gulf War in 1991.

Another issue that is associated with the problem, is one of training and the cost of training abroad. It is clear that there is not sufficient training available in Saudi Arabia because of bureaucracy and other reasons. Al-Sudairi (1994) reported three issues that underlie the topic of ICT training. These are:

- the establishment of a corporate policy for training;
- financial commitment to undertake ICT training; and,
- the type of ICT training available.

Another problem related to those discussed above is the lack of high quality local maintenance and support services, which is a common problem facing Saudi organisations. Furthermore, with regard to organisational structure, some organisations' managers do not understand what ICT can do for their businesses.

Some Saudi managers have a positive attitude towards technology, but some are resistant to technical change out of anxiety that new technology will cause them to lose control over their organisation. According to research observations and experiences of working within government organisations, most organisations have planned and developed their ICT on an individual basis, without co-ordination with similar organisations. This creates duplication, high costs, wastes resources and is time consuming.

In summary, many of the issues and problems associated with IT in Saudi Arabia reflect the problems elsewhere in the world. However, some of these problems are associated to the Saudi culture rather than to technical or financial issues. The literature identifies several problems such as:

- lack of knowledge and experts in ICT;

- resistance to and fear of ICT;
- poor utilisation of computer systems;
- lack of co-operation and co-ordination between similar organisations;
- cultural problems; and,
- poor training and education in this technology.

Generally, in spite of the difficulties, Saudi organisations depend heavily on ICT and Saudi has become an active player in implementing ICT in almost all aspects of life.

4.5.2 ICT in Saudi Hospitals (The present and future expectations)

Unfortunately, some public and private hospitals in Saudi Arabia lag behind many other organisations in the use of computer and on-line technology. Many of these hospitals depend on traditional paper-based, clinical records and will for some time to come. The majority still relies on pen, paper, post, and often several staff to book outpatient appointments. This leads to unnecessary delays, frustration for patients and staff alike, and the potential for errors. In truth, up to now, the use of ICT in Saudi hospitals has not been a success story. Many resources have been wasted, some important data has not been collected and used, and some data has been collected but unfortunately not used. Additionally, some clinicians working in hospitals have come to view computerised data not as help, but as a hindrance to their work. However, IT has a very important role to play. Therefore all hospitals, especially those far behind (public hospitals) should adopt ICT for medicine and treatment, and not just for administrative purposes.

Programmes are needed to provide the most modern tools to improve the treatment and care of patients. It is hoped that by using the most modern tools and rapidly developing ICT, clinicians will benefit from each other's expertise, sometimes over long distances. For example, it is anticipated that, patients' details and test results will be transmitted between hospitals rapidly and accurately. It is also hoped that it will be possible for patients to book their appointments electronically. The same technology will be used by medical staff to send results to hospital specialists, and in the same way, to receive results and advice more quickly.

People in Saudi Arabia expect the health and social care system to provide them with high standards of service because Saudi Arabia is one of the richest developing countries in the world. Therefore, citizens expect services and treatment for people who are ill or vulnerable and for them to be able to live their lives with a high standard of dignity and independence. In addition, they expect quick, effective and convenient treatment. Healthcare and support should be available to help people when they fall ill or are finding it difficult to cope.

The Saudi government has paid a good deal of attention to healthcare and therefore, some hospitals have implemented advanced technology to provide high standards of healthcare. More specifically, some Saudi hospitals, for example King Fiasal Specialist Hospital (KFSH), have implemented sophisticated technology such as telemedicine, teleconferencing and other services, which require high technology (King Faisal Hospital, 2001). An ongoing project is to link KFSH with five sites around the country to give an equal opportunities of treatment to all citizens (AL-Nuaim, 2000)[3].

Other Saudi organisations, which have just been established, such as Sultan Bin Abdulaziz Humanitarian City, provide healthcare using high technology. This Charity Foundation is a private, not-for-profit organisation funded by HRH Prince Sultan. The fundamental objectives of the Foundation are to provide humanitarian, social and cultural services and to empower Saudi Arabia to participate in the spread of knowledge through modern means of communication. Some of these objectives include the provision of health and social cares for the elderly and handicapped. The foundation has several programmes, one of which is Medunet (Sultan Foundation, 2001). This programme aims to provide advanced technological solutions such as telemedicine and distance learning throughout the Arab world by bringing the powers of modern technology, such as

[3] Interview with Al-Naim, Tele-medicine Program Director in KFSH. Riyadh, 25.2.2000.

videoconferencing and Internet access, to the region. In this way, medical and educational resources that were once under-utilised in some regions and scarce in others will be made available through the Internet and via video-conferencing to communities across the region.

In terms of private hospitals, some of these hospitals have the same problems as public hospitals, as was mentioned previously. However, they still lag behind in the use of computers and related technology for medical purposes. Furthermore, medical staff in those hospitals have insufficient ICT knowledge, experience and skills to manage and use computers efficiently to take full advantage of their computer information systems. In contrast, some private hospitals have made extensive use of computers and have already obtained reasonable knowledge and experience. For example, the Kingdom Hospital is one of the best examples of hospitals using state of the art technology. It has implemented a fully integrated computer-based Hospital Information Systems that is unique in the Middle East. The Kingdom Hospital is truly a 'state of the art' technology cradle. In addition, the Kingdom Hospital could be viewed as an ideal model for a fully integrated hospital information system, especially in information security.

4.5.3 The Attitudes of Healthcare Personnel towards Computers in Saudi Arabia

Several researchers have studied the attitudes of physicians and nurses towards computers in the hospital environment: e.g., Fung (1993), Anderson (1999), Kaplan (2000), Murphy (2000), Almilhim (1994), Gillies (1995), Lee and Pow (1996), Gillies (1998a), and, Baranera *et al.* (1999). Of all the studies reviewed, only two were conducted specifically to determine the attitudes of physicians, and nurses towards computers in Saudi Arabia.

Moidu and Wiegertz (1989) studied computers and physicians to assess the attitudes, awareness and acceptance of computer applications in a healthcare setting. The sample size consisted of 90 physicians in central areas of Saudi Arabia. Only 41 physicians completed the survey. The results show that physicians' prior experience with computers was low while the desire to purchase and use them was high. The majority (80 percent) of the physicians were interested in applying computers in their routine work, but less than half (35 percent) were aware of applications in their own area of interest. The respondents had low confidence (21 percent) in the role of computers as an aid in medical decision-making. Fear of redundancy was expressed by 22 percent of the physicians. The study concludes that to minimize the fear of computer use would require the full participation and involvement of all computer users in the healthcare environment.

Al-Hajjaj and Bamgboye (1992) studied the attitudes and opinions of medical staff toward computers with a sample size of 120 professional medical staff (doctors, and pharmacists) and 22 medical students at King Saudi University Hospital and Medical School. The study indicates that about 38 percent of the respondents had no plans now or in the future to purchase a computer. However, a high proportion of male and female physicians had almost equal attitudes toward purchasing a computer. Forty percent of the respondents saw the computer as important to medical practices and 20 percent thought it useful but not necessary; 62 percent of physicians had no prior experience in using computers. Nearly half of the students and interns had no desire to purchase computers, even in the future. The study concludes that computer applications in medicine were considered desirable by most respondents but not essential or necessary. From a large group of medical staff, which had access to computers at work. Only 12 percent said they were satisfied with computer usage. In addition, more than 50 percent of medical students and internists had poor attitudes towards computers in medicine.

The attitudes and satisfaction of physicians and nurses with information systems have been studied widely in different hospital settings (e.g., Almilhim, 1994). A review of the literature shows a lack of standardization of the measures of physicians' and nurses' attitudes toward their satisfaction with computers. Some of the studies results express different findings regarding the relation between the demographic characteristics of physicians and nurses in their computer experience and their attitudes. In some of these studies, the level of education, computer training and computer experiences were correlated with participants' attitudes towards computers. Additionally, in some studies, nurses tended to be more positive than physicians. The literature indicated that training, work experience, age, participants' involvement in the planning and implementation process are the most important factors affecting the attitudes and levels of satisfaction with computers of physicians, nurses and other healthcare personnel.

4.6. ICT Security in Health Care

It has become quite clear from studies undertaken, that the security of health information and medical patient records are near the top of the concerns of patient and health care professionals all over the world (Anderson, and Brann 2000). The advent of computer networks for community health has lead to concern about security. Doctors and other professionals are worried that making patient information more widely available may endanger patient confidentiality and privacy.

Amatayakul (1999, p63) defined security as: "The administrative, physical and technical services of mechanisms to protect the confidentiality of private information, to ensure the integrity of information so that it is accurate and complete, and make information easily available to those with legitimate right to access."

The goals of information security in healthcare were also summarised as follows by Brennan *et al.* (1997):

- to ensure the confidentiality of healthcare data and the privacy of the patient;
- to ensure the integrity of healthcare data; and,
- to ensure the availability of healthcare data for authorized persons.

There have been many debates in the developed nations on the issue of information security and particularly that of patient information. In fact, health information is far more sensitive than the information holdings of just about every other industry and has the potential to cause much greater individual harm if it falls in the wrong hands (Amatayakul, 1999). Neame (1997b) emphasized that the area of security is one where mistakes cannot be afforded for several reasons. There is the damage done by the mistake itself, the resultant fallout and the loss of trust in the system and its management.

Some writers, such as Yeoman (1998), Brennan and Spours (2000), Hojerbak (2000), and Furnell (1995), stressed that there is widespread agreement between clinicians and managers on the need to protect sensitive information. They also believe that information security involves three main issues:

- *confidentiality*: This refers to making sure that information is only available to those who have the need to know and are properly authorised to do so.
- *integrity*: This refers to the prevention of unauthorised change or modification of information. However, there is an implicit requirement for users to be able to trust the system and be confident that the same information can be retrieved as was originally entered.
- *availability*: This refers to the information that should be made available and accessible where and when it is needed and in a suitable format to a properly authorised user.

Computer networks alleviate communication among different parties or organisations in healthcare systems; it also increases the danger of malicious access to confidential data. Exchange of medical information is very important among healthcare organisations for the benefit of both patients and society. However, it is hard to balance between the need for data exchange and the need to protect the information from alteration or misuse. Unfortunately, medical information sometimes might be misused and/or used for malicious purposes. For example, Anderson and Brann (2000) presented some examples, such as one the case in which a physician in the USA sold patient records to a car dealer and state employees in Maryland who sold patient information from the state medical database. They also revealed that The Sunday Times reported that, in the UK, anyone's medical record could be obtained for £200. Therefore, it is believed that the success of current technologies to protect information depends heavily on explicit policies, personal ethics and self-regulation.

Medical information is very sensitive information and should be protected. Moreover, Buchan (2001) states that the trust that exists between patients and healthcare professionals must be protected as we introduce modern decision-making tools, which are accessible world-wide, into clinical practice. He added that abuses could occur if the systems used and the policies adopted are not secure or perceived to be so such by the public. The main problem with information security in healthcare is not technology, but a lack of cohesive policy (Brennan, *et al.*, 1997). Camp (2000) claims that many of the problems of network security in healthcare are based on the fact that networking has been integrated into healthcare but security has not. To address some of the identified information security risks there are a number of solutions and techniques that can be applied, such as the following:

1. firewalls: Firewall is a system, or a group of systems that enforces an access control policy between two networks. It is commonly used as a barrier between the secure corporate Internet, or other internal networks and the Internet, which is assumed to be unsecured (Turban *et al.*2001). However, there are three types of Firewall, such as packet filter gateways, circulate level gateways and application level gateways.
2. public key infrastructure (PKI): This method uses a pair of keys (public and private) to encrypt and decrypt messages. Messages and data sent using PKI are encrypted and therefore, the message can only be decrypted using the private key.
3. access control and authentication: There are different authentication methods used to increase security and access control to a network. An organisation can select one or more methods of authentication most suitable for their application. One of the most popular methods is security ID because it provides strong authentication and does not require special readers or hardware.

4.6.1 Security threats to Heath Information Systems

As is known, information systems are made up of many components that may be in several locations, each component being vulnerable to many potential hazards. Data, software, hardware and networks can be threatened by many internal and external hazards. Most computer security problems are insider. For example, Anderson and Brann (2000) state that by one estimate, 85 percent of all computer security problems involve employees in the organisation.

Theoretically, there are hundreds of point can be subject to some threat. Yet these threats can be categorised as follows:

1. **unintentional threats:** Unintentional threats can be divided into three major categories
   - human error: This can occur in the design of the hardware programming, testing, data collocation, data entry, authorisation and instructions;
   - environmental hazard: This include earthquakes, flood, fire, and power failure;
   - computer system failure: This can be the result of poor manufacturing or defective materials.
2. **intentional threats**: computer system may be damaged as result of intentional threats such as inappropriate use of data, theft of equipment or programmes, transfer of data, sabotage or malicious damage to computer resources. It can also, occur as result of destruction from viruses, miscellaneous computer abuse and hackers.

4.7. The Future of ICT in Health Care

It is really very hard to imagine what technology will bring in the future and no one could have guessed how science and technology would bring such dramatic changes to our lives. Computer technology has transformed healthcare, not only by improving the accuracy of information available to clinicians, but also by improving the flow of information among people who are in need. Anderson (2000) believes that in the future, healthcare providers will need to interact directly with clinical information systems in providing patient care in order to take full advantage of the ability of these systems to organise information and to support clinical practice. Therefore, physicians and others need to change; they have to utilise clinical data.

According to Jeans (1998), computers have made wide inroads into the practice of medicine – sometimes insidiously and sometimes obviously. He also forecasts the following:

- increasing computerisation of medical equipment and services;
- increased use of Internet facilities for continuing medical education; and,
- smart cards held by patients, containing all their medical records.

ICT offers us another advantage, which is the smart card. Smart cards are cards that carry personal and health information and acts as an access key to patients' data wherever they are held. In France, smart cards are already being issued to healthcare providers and in numerous other locations, including Germany and Britain; healthcare smart cards are in use in either pilot or operational settings (Neame, 1997). Allen (1999) emphasized that smart cards are already compulsory in Germany and in France where they will be issued nationally by 2001. Many writers, such as Williams and Brown (1994) believe that many of the barriers to quality, cost effective and satisfying patient care will fail through implementation of clinical information systems. They also added that in the next few years, a new reimbursement methodology will be developed that would place even greater emphasis on accessing nursing documentation more quickly.

Lorenzi and Riley (1995) used their knowledge of technical and social trends when they looked forward to the future and presented the following brief vision:

- all medical records will be in full electronic format and each person will have a universal medical number;

- the electronic medical record will store visual information as well as printed information;
- individuals will be regarded more as customers than patients and will participate more actively in the decision process;
- customers/patients will have access to computer databases via hand-held, voice-activated devices that will offer guidance for possible problems. They will also have access to healthcare education programs through narrow casting technologies;
- researchers will use more powerful computers to conduct their research and manage the huge amount of data their research will generate;
- knowledge systems will allow the healthcare workers to gain access to the vast array of information that exists regardless of its physical location;
- virtual reality will be a major contributor to education in the future;
- knowledge management will be more fully developed and there will be electronic as well as human mediators.

These predictions include the integration of ICT systems, more interdisciplinarity from healthcare professionals, and increased cooperation across disciplines. Results from human factors research will be developed for planning, designing, implementation and evaluation of new systems, where end-user satisfaction will be a key measure of success. Further, more sophisticated software and hardware technology will be available, computers will be used heavily in the treatment of the patient and will be wirelessly linked to host systems.

Wyatt (1994) expects that the dream of embedded, ubiquitous computing will be achieved in which computer technology is as widespread as paper and pencil today. From his study, it can be concluded that the healthcare organisations of the future will be linked electronically and medical information will be shared and exchanged between organisations through networks that are both secure and confidential. He expects all citizens to have access to their own medical records allowing them the capability to check their medical file or laboratory result from home. In summary, patients' medical records will be accessed and shared in a secure and confidential way among specialists who have a rightful need to see patient information. Hardware and software in healthcare will change rapidly and therefore, healthcare professionals must educate themselves about technology change.

4.8. Summary

This chapter focused on ICT in healthcare in developed and developing nations in the context of the existing literature. ICT developments in healthcare in developed nations were also discussed together with their advantages and weaknesses. Several authors were cited to highlight a number of issues associated with ICT in healthcare in developed countries. These issues include lack of knowledge and skills in operation and use of this technology, poor training and education, the challenges of integration, lack of standards, lack of funding, variety of technical problems (hardware and software) and information security and patient confidentiality.

In contrast, few studies have focused on ICT in healthcare in developing countries. Here, problems relate to the multidimensional nature of the healthcare environment, lack of resources, political issues, culture, education and training systems that do not cater for ICT, and lack of national ICT specialists have been identified. It can be concluded that ICT is used in healthcare in some developing countries – the Saudi Arabia healthcare system is the focus of this work. This case study is well chosen, as the maturity of the domain can be gauged from the emphasis already placed on patient confidentiality and security of the EPR.

Finally, the future of ICT in healthcare and its expectations of technological and organisational change were discussed. Many authors expect that the use of ICT will change healthcare provision for the better. The EPR will be accessed remotely by authorized people and medical information will be shared and exchanged between healthcare professionals. Medical records will be available for the individual patient to access as easily as they now have access to their personal bank account.

Healthcare in the USA and UK can be regarded as good examples of what can be achieved with a well-resourced system. These examples also provide a goal for which the healthcare system in Saudi Arabia should strive. Data from the empirical study (see the next Chapter) will indicate where the Saudi healthcare system is at present and provide evidence for the change required (as discussed in Chapters 7 and 8). Further aspects for discussion are collated in Chapter 9. Therefore, the findings from this Chapter will be used as a baseline for comparison with the situation in Saudi Arabia.

Chapter 5

Data Collection and Questionnaire Analysis

5.1 Introduction

This chapter presents responses to the questionnaire detailed in Chapter 2 and their analysis. The chapter has been divided into four sections. The first part provides an overall picture of response demographics. The second part explores the use of computers, computer networks, computer experience and subject group attitude towards computer use. The third part emphasises the need for education, computer training programs and staff satisfaction with these components. Finally, the issues surrounding information provision are explored.

5.2 Questionnaire distribution and data collection

After obtaining permission and requesting the support and co-operation from the Deans of each of the Medical School, an official letter was sent to computer department managers in each site where the questionnaires were distributed. Obtaining the hospital computer managers support would encourage other departments to co-operate in completing the questionnaire. This method was used to raise the response rate. In addition several steps were taken to encourage a satisfactory response rate such as:

- the front page emphasised the assurance of respondents confidentiality;
- the number of questions was limited to fit a four-page layout, and, colour of paper was unusual and attractive;
- only necessary and relevant questions were asked to avoid redundancy and to maintain reliability;
- the questionnaire was designed to be as respondent friendly as possible to avoid too much time placed on busy clinical personnel, especially physicians and nurses;

- questionnaires were distributed and collected via heads of the departments, this encouraged employees to complete them;
- computer department manager from each site had excellent access to all departments and introduction was made to the head of each department; and,
- the Deans of the Medical Schools and computer department managers were keen to implement the proposed system therefore an official letter was sent to every department manager asking them to encourage their staff to complete the questionnaires (see Appendix H).

The questionnaires were distributed on February 10, 2000, and collected on various dates in March 2000. Four hundred questionnaires were distributed in KSUH and a further three hundred were distributed in KFUH. Questionnaire distribution by department is shown in Table 5.1. This Table also includes the 200 pilot questionnaires distributed to KAUH in July 1999. After collecting all the completed questionnaires a thank you letter (see Appendix G) was sent to each respondent.

University	King AbdulAziz University Hospital			King Saud University Hospital			King Faisal University Hospital		
Department.	**NI**	**NR**	**%**	**NI**	**NR**	**%**	**NI**	**NR**	**%**
Nursing	44	32	72.7	145	75	51.7	125	103	82.4
Laboratory	60	47	78.3	60	36	60.0	60	46	76.6
Medical Records	60	44	73.3	60	30	50.0	32	25	78.1
Computer	6	6	100	16	16	100	11	10	90.9
Pharmacy	14	12	85.7	51	35	68.6	27	16	59.2
Radiology	0	0	0	60	32	53.3	45	35	77.7
Others	16	13	81.2	8	8	100	0	0	0
Total	**200**	**150**	**75**	**400**	**232**	**58**	**300**	**235**	**78**

Table 5.1 Questionnaire distribution by Institution and Department
Key: NI = Number issued; NR = Number returned; % = Return rate

5.3 Problems and difficulties encountered during the fieldwork

A number of problems and difficulties appeared during the data collection as follows:

- obtaining the official letter and permission from the Dean of each medical school to distribute the questionnaire was most difficult and time-consuming,
- it was very difficult to arrange a time for interviews with some of University hospital managers because they were busy in managing three tasks (clinical, teaching and administration),
- the Head of Medical Records Department in KSUH initially refused to distribute the questionnaire until he received an additional letter directed to him personally and a telephone call from the vice-president of the University Hospital manager,
- the number of ICT professionals and clinicians in Saudi Arabia (obtained from the Ministry of Finance) was not accurate;
- one of university computer centres managers was not willing to answer the interview questions immediately. He chose to answer them and send it via the internet,
- the interviews were recorded on a cassette. However a female manager refused permission for her interview to be recorded;
- some clinical staff in KSUH were unwilling to reply. Therefore, the computer department manager made several telephone calls to every department manager asking them to encourage their staff to complete and return the questionnaires,
- a reminder letter was sent to follow-up calls and visits made to each head of department at KSUH to encourage them to speed up the process and reply, but without success,
- it is clear that some clinicians in Saudi Arabia are still not accustomed to co-operating with external researchers and with the idea of conducted surveys,
- some departments were visited to see their computer systems at first hand. However, a visit to the medical record department in KSUH was not possible, because some religious females refused to allow the (male) researcher to enter,
- one of university computer centre managers agreed to be seen directly, but others preferred to schedule a time for next day to meet, and,

- the main study took approximately five weeks to complete in some departments instead of the three weeks allocated.

5.4 Data analysis

The data collected from the three Saudi University Hospitals were coded and processed into a statistical software package (SPSS). Altogether, 900 questionnaires were distributed in February 2000. Of these, 617 questionnaires were returned giving a response rate of 68.6%. Descriptive statistics were used to characterise the response to each question in the questionnaire, after which an analytical test (χ^2 test) was used as a test of significance.

5.4.1 Demographic data

Target audiences were asked to which University Hospital they belong. The intention was to group respondents according to location and to get a comprehensive picture of the number of medical and computer staff who participated in this study. The majority of respondents (235 = 38.1 %) came from KFUH (Eastern region), followed by 232 (37.6%) from KSUH (Central region), and 150 (24.3%) from KAUH (Western region) as shown in Table 5.2.

Institution	**Response rate from each university hospital**			
	Number issued	**Number returns**	**% of returns**	**Overall %**
KSUH	400	232	58.0 %	37. 6%
KAUH	200	150	75.0 %	24.3%
KFUH	300	235	78.3%	38.1%
Total	**900**	**617**	**68.6%**	

Table 5.2 Response rate by university

Within the University Hospitals, the questionnaires were distributed in six departments. The analysis of the responses indicate that the majority come from nursing departments (210 = 34.0%), followed by laboratory departments (129 = 20.9%) and medical record departments (99 = 16.0%) as shown in Table 5.3. It was also found that staff in nursing departments are more likely to use computers than staff in other department in KSUH and KFUH.

	University				
Department	**KSUH**	**KAUH**	**KFUH**	**Total**	**Percent %**
Laboratory	36	47	46	129	20.9
Pharmacy	35	12	16	63	10.2
Radiology	32	0	35	67	10.9
Nursing	75	32	103	210	34.0
Medical records	30	44	25	99	16.0
Computer	16	6	10	32	5.2
Other	8	9	0	17	2.8
Total	**232**	**150**	**235**	**617**	**100**

Table 5.3 Respondents by department and university

The χ^2 test was used to assess whether there is a difference between the use of computers within the specific departments. The statistical result reveals that there is a significant association between computer use and location of respondent's Department ($\chi^2 = 44.62$, df6, $P < 0.001$, $N = 537$).

The respondents were then asked to specify their job description. The results in Table 5.4 show that most of respondents were nurses (161 = 26.1 %) followed by medical technicians (97 = 15.7%). There were 94 (15.2%) physicians, 49 (7.9%) pharmacists and 32 (5.2%) computer staff. It is worth noting that 77 (12.5%) respondents had jobs in areas other than those specified in the question (e.g., medical clerks).

A χ^2 test was used to test the significance of association between computer use at work and job description. The result shows that there is significant relationship between use of computer at work and job description ($\chi^2 = 35.476$, df7, $P < 0.001$, $N = 537$).

Job description	Place of work				
	KSUH	KAUH	KFUH	Total	%
Physician	40	11	43	94	15.2
Nurse	69	29	63	161	26.1
Paramedical personal	17	40	20	77	12.5
Administrator	8	18	4	30	4.7
Pharmacist	29	3	17	49	7.9
Computer staff	16	6	10	32	5.1
Medical technician	39	3	55	97	15.7
Other	14	40	23	77	12.5
Total	**232**	**150**	**235**	**617**	**100 %**
Percent %	**37.6%**	**24.3%**	**38.1%**	**-**	**100 %**

Table 5.4 Respondents by job description and place of work

Respondents were asked about their highest academic qualification. The responses were grouped into five classes. Table 5.5 shows that slightly over half of respondents (314 = 55.3%) possess an undergraduate degree, followed by medical degree (88 = 14.3%) and 50 (8.1%) had obtained a master's degree. Only 34(5.5%) of respondents had a Ph.D. degree.

Job description	Highest qualification				
	Undergraduate	Medical Degree	Master degree	Ph.D.	Other
Physician	22	23	13	20	16
Nurse	116	16	6	3	20
Paramedical personal	41	8	3	1	24
Administrator	16	3	5	-	6
Pharmacist	30	8	1	6	4
Computer staff	21	-	10	-	1
Medical technician	51	21	9	2	14
Other	44	9	3	2	19
Total	**341**	**88**	**50**	**34**	**104**
Percent %	**55.3%**	**14.3%**	**8.1%**	**5.5%**	**16.9%**

Table 5.5 Respondents by job description and qualifications

Table 5.6 shows that KAUH has the fewest respondents who hold a Ph.D. (5 = 3.3%) while KSUH had 16 (6.9%) and KFUH had 13 (5.5%). Other responses indicate that 104 (17%) respondents hold other degrees such as Diploma in medical or hospital management.

Highest qualification	Institution				
	KSUH	KAUH	KFUH	Total	%
Undergraduate	118	75	148	341	55.3
Medical degree	37	19	32	88	14.3
Masters degree	17	18	15	50	8.1
Ph.D.	16	5	13	34	5.5
Other	44	33	27	104	16.9
Total	**232**	**150**	**235**	**617**	**100**

Table 5.6 Respondents by qualification and institution

For the purpose of this study the respondents were grouped according to their age into eight classes. Most respondents (132 = 21.4%) were aged between 35-39 years old, followed by 130 (21.1%) aged between 40-44. Table 5.7 shows these results. Respondents in age groups 35-39 and 40-44 used computers more than others.

Age	Gender			
	Male	Female	Total	Percent %
20-24	14	14	28	4.5
25-29	40	46	86	13.9
30-34	55	59	114	18.5
35-39	63	69	132	21.4
40-44	56	74	130	21.1
45-49	39	49	88	14.3
50 or over	29	10	39	6.3
Total	**296**	**321**	**617**	**100**

Table 5.7 Respondents by age and gender

Respondents were asked to specify their gender. Table 5.8 shows that 296 (48.0%) of respondents are male. It was expected that female respondents would outnumber their male counterparts as the healthcare sector is one of the most suitable places for female workers in Saudi Arabia due to religious and cultural regulations.

Job description	Gender	
	Male	Female
Physician	62	32
Nurse	36	125
Paramedical	42	53
Administrator	17	13
Pharmacist	25	24
Computer staff	22	10
Medical technician	50	47
Other	42	35
Total	**296**	**321**
Percent	**48.0%**	**52.0%**

Table 5.8 Respondents by job description and gender

A χ^2 test was used to assess whether there is significant difference between use of computer at work and age group. The χ^2 test result indicates that there is no significant relationship between use of computer at work and age group. Another χ^2 test was done to assess whether there is difference between computer use at work and gender. Statistical results show that there is no significant association between use of computer at work and gender.

5.4.2 ICT use and experience

Respondents were asked to indicate if they use a computer at work, and if so, what type of computer connection was used. In this way it is hoped to find the extent to which networked computers have penetrated the university healthcare sector. Table 5.8 shows that 537 (87.0%) respondents use a computer at work. Of these 60 (9.7%) use a stand-alone computer while 477 (77.3%) use computers as part of a network.

Place of work	Use of computer at work				
	Stand-alone	Networked	Total	%	Not qualified
KSUH	-	212	212	91.3	20
KAUH	56	56	112	74.6	38
KFUH	4	209	213	90.6	22
Total	**60**	**477**	**537**		**88**
Percent %	**9.7%**	**77.3%**	**87.0%**		**13%**

Table 5.9 Responses by place of work and use of computer at work

From the responses it appears that KSUH and KFUH are fully networked. There is evidence that KAUH staff are lagging behind in the use of computers as part of their everyday work, based on the number of computers available and number of people actually using the computing facilities. Table 5.10 shows a break down of respondents and type of computer use at work in more detail.

Job description	Type of computer at work		
	Stand-alone	Networked	No response
Physician	2	74	18
Nurse	12	127	22
Paramedical	11	48	18
Administrator	6	22	2
Pharmacist	4	44	1
Computer staff (IT)	5	27	0
Medical technician	3	89	5
Other	17	46	14
Total	**60**	**477**	**80**
Percent %	**9.7%**	**77.3%**	**13.0%**

Table 5.10. Responses by job description and type of computer used at work

A χ^2 test was used to assess whether there is a significant difference between use of computer at work and University Hospital from which the respondent came. The χ^2 result shows that there is significant relationship between use of computer at work and place of work ($\chi^2 = 26.91$, df 2, $P < 0.001$, $N = 537$).

Respondents were then asked to indicate whether they had access to computing facilities at home. The intention was to assess the ability of medical staff to access medical information in terms of equipment and network connections available. Assessment of the impact of Saudi culture on computer use can also be gauged by investigating the gender split: Table 5.11 shows that out of 325 medical staff who use a computer at home 178 (54.8%) were male. This finding perhaps demonstrates the family commitments of females in Saudi culture.

Job description	**Use of computer at home**			
	Yes		**No**	
	Male	**Female**	**Male**	**Female**
Physician	39	21	23	11
Nurse	13	39	23	86
Paramedical	22	17	20	18
Administrator	7	10	10	3
Pharmacist	18	15	7	9
Computer staff (IT)	19	8	3	2
Medical technician	33	21	17	26
Other	27	16	15	19
Total	**178**	**147**	**118**	**174**
Percent %	**54.8%**	**45.2%**	**36.3%**	**53.5%**

Table 5.11 Respondents by job description, and computer use at home and gender

Many respondents (325 = 52.7%) had access to PCs while at home. Of these, 266 (43.1%) used stand-alone computers while the remainder had access to a networked home computer. This breakthrough of computer networks into the Saudi home market was not anticipated. There was a higher percentage of medical and computing personnel in the Eastern and Central regions owning computers than those in the Western region.

Computer staff, physicians and pharmacists are the heaviest users of computers at home, as indicated in Table 5.11. Moreover, it was found that physicians used computers at home more than any other subject group, where physicians represent 60 (9.7%) of the entire respondents. 60 (63.8%) of physicians own a home computer. Perhaps this is because physicians have the ability to buy computers due to their relatively high salary. Moreover, the nature of their work encourages them to retrieve information quickly and to analyse any data. The ability to be 'connected' to physicians in geographically remote places is perceived as a direct benefit of introducing ICT into the University Hospitals. Physicians are more likely to rely on English language in their daily work than other medical staff, so they can communicate with computing and Internet facilities easier. However, Table 5.12 indicates that the majority of personnel do not have access to the Internet, as connection to a network at home was very rare.

	Use of computer at home			
Job description	**Stand-alone**	**Network**	**Total**	**No response**
Physician	45	15	60	34
Nurse	42	10	52	109
Paramedical	34	6	40	38
Administrator	13	3	16	13
Pharmacist	27	6	33	16
Computer staff (IT)	21	6	27	5
Medical technician	45	8	53	44
Other	38	5	43	34
Total	**266**	**59**	**325**	**292**
Percent %	**43.1%**	**9.6%**	**52.7%**	**47.3%**

Table 5.12 Respondents by job description and type of computer at home

Respondents were asked to specify their computer experience in terms of number of years since their first computer use. Responses indicate that 29.1% of the sample had less than two years of using a stand-alone computer; Table 5.13 shows the results from which this statistic was gained. The result indicates that employees of the Saudi University hospitals are likely to have the basic skills required for the advanced use of ICT.

A χ^2 test was used to determine the association between use of computer at home and job description. The result shows that there is no significant association between those two variables

Job description	Experience of use of stand–alone computers						
	Period (Years)						
	0-2	3-4	5-6	7-8	9-10	10+	No response
Physician	28	23	14	7	6	8	8
Nurse	54	41	24	10	4	6	22
Paramedical	22	26	11	4	1	4	9
Administrator	6	12	5	1	1	4	1
Pharmacist	8	13	8	9	11	-	-
Computer staff	1	7	5	-	7	12	-
Medical technician	24	49	10	9	4	1	-
Other	21	17	7	8	7	4	13
Total	**164**	**188**	**84**	**48**	**41**	**39**	**53**
Percent %	**29.1%**	**33.3%**	**14.9%**	**8.5%**	**7.3%**	**6.9%**	**8.6%**

Table 5.13 Respondents by job description and experience (stand-alone computers)

In term of using networked computers, Table 5.14 indicates the relative experience in terms of length the exposed to the technology of each clinical group. 10% of respondents have never used a networked computer at all, and a further 44% have less than 2 years experience of using them. This perhaps indicates a barrier to the use of sophisticated ICT (e.g., using on-line information resources) and that Saudi Arabia is a newcomer to the use of ICT. On the other hand, it means that medical staff in Saudi University Hospitals have had rapid growth in experience in use of ICT.

Job description	Experience of use of computer networks							
	Period (Yrs)							
	Never used	0-2	3-4	5-6	7-8	9-10	10+	No response
Physician	4	42	23	4	2	4	5	10
Nurse	11	82	25	10	9	4	3	17
Paramedical	17	32	10	5	3	1	-	9
Administrator	4	13	6	1	1	-	2	3
Pharmacist	4	9	16	6	8	2	4	-
Computer staff	3	3	7	7	3	4	5	-
Medical technician	3	44	29	4	7	7	3	-
Other	11	25	11	7	6	5	2	10
Total	**57**	**250**	**127**	**44**	**39**	**27**	**24**	**49**
Percent %	**10.0%**	**44.0%**	**22.4%**	**7.7%**	**6.9%**	**4.7%**	**4.2%**	**7.9%**

Table 5.14 Respondents by job description and experience (computer networks)

Investigating these data in another way, that is by location (Table 5.15) revealed that KAUH in the Western region of Saudi Arabia is lagging behind in the race to embrace ICT.

Institution	Experience of use of computer networks							
	Period (Years)							
	Never used	0-2	3-4	5-6	7-8	9-10	10+	No response
KSUH	3	63	71	32	23	15	12	13
KAUH	51	57	7	4	3	1	3	24
KFUH	3	130	49	8	13	11	9	12
Total	**57**	**250**	**127**	**44**	**39**	**27**	**24**	**49**
Percent %	**10.0%**	**44.0%**	**22.4%**	**7.7%**	**6.9%**	**4.7%**	**4.2%**	**7.9%**

Table 5.15 Respondents by place of work and experience (computer networks)

5.4 3 Use of computer applications

A variety of software applications were assessed in term of their frequency of use, measured by the following five indicators: daily, weekly, monthly, irregular, never. In terms of daily use, Table 5.16 shows that the majority of those who responded, 338 (62.9%) use patient records, followed by 218 (40.6%) who use software for clinical data transfer, followed by those who use word processing packages (164 = 30.5%). Use of the Internet and e-mail was lower (17.1%). These data indicate that medical personnel do not have ready Internet access or may be they have, but they don't make much use of it. It is worth noting that staff in two of the three sites used computer network facilities more often for such activities as e-mail, word processing, data transfer. As before, (see Table 5.9) this survey showed generally lower levels of networking activities in KAUH.

Institution	Tasks				
	Patient record	E-mail	Clinical Data	Word processing	Internet
KSUH	134	46	88	53	40
KAUH	50	19	33	47	17
KFUH	154	25	97	64	35
Total	**338**	**90**	**218**	**164**	**92**
Percent	**62.9%**	**17.8%**	**40.6%**	**30.5%**	**17.1%**

Table 5.16 Respondents by institution and daily use of computer for selected applications

To understand who was using which sort of computer applications the data in Table 5.16 was further investigated by cross-tabulating the use of applications with job description. The results of this cross-tabulation can be found below in Tables 5.17 to 5.21.

Job description	How often do you use the computer for word processing? Period					
	Daily	Weekly	Monthly	Irregular	Never	No response
Physician	18	26	6	9	27	8
Nurse	31	10	5	22	78	15
Paramedical	31	5	-	11	21	9
Administrator	14	4	2	2	7	1
Pharmacist	11	10	6	6	16	-
Computer staff (IT)	13	3	4	1	11	-
Medical technician	17	9	21	12	38	-
Other	29	8	2	12	16	10
Total	**164**	**75**	**46**	**75**	**214**	**43**
Percent %	**30.5%**	**14.1%**	**8.6%**	**14.0%**	**39.9%**	**7.0%**

Table 5.17 Respondents by job description and computer use (word–processing)

Job description	How often do you use the computer for sending email?					
	Period					
	Daily	Weekly	Monthly	Irregular	Never	No response
Physician	28	12	3	18	25	8
Nurse	4	7	3	74	58	15
Paramedical	9	7	2	24	26	9
Administrator	4	4	1	11	9	1
Pharmacist	11	12	3	12	11	-
Computer staff (IT)	19	4	-	3	6	-
Medical technician	8	10	11	31	37	-
Other	7	6	4	21	29	10
Total	**90**	**62**	**27**	**194**	**201**	**34**
Percent %	**16.8%**	**11.5%**	**5.0%**	**36.1%**	**37.4%**	**5.5%**

Table 5.18 Respondents by job description and computer use (e-mail)

Job description	How often do you use the computer for clinical data transfer?					
	Period					
	Daily	Weekly	Monthly	Irregular	Never	No response
Physician	33	12	4	15	22	8
Nurse	63	11	1	23	48	15
Paramedical	27	2	2	11	26	9
Administrator	10	2	2	6	9	1
Pharmacist	7	9	11	7	15	-
Computer staff	16	1	-	5	10	-
Medical technician	51	8	7	9	22	-
Other	11	3	2	18	33	10
Total	**218**	**48**	**29**	**94**	**183**	**43**
Percent %	**40.6%**	**8.9%**	**5.4%**	**17.5%**	**34.1%**	**7.0%**

Table 5.19 Respondents by job description and computer use for clinical data transfer

Job Description	How often do you use the computer for patient record?					
	Period					
	Daily	Weekly	Monthly	Irregular	Never	No response
Physician	45	2	7	12	20	8
Nurse	90	4	4	12	36	15
Paramedical	41	2	1	5	19	9
Administrator	16	1	1	4	7	1
Pharmacist	17	6	6	6	14	-
Computer staff (IT)	17	1	-	3	11	-
Medical technician	73	1	2	3	18	-
Other	39	1	-	4	23	10
Total	**338**	**18**	**21**	**49**	**148**	**43**
Percent %	**62.9%**	**3.4%**	**3.9%**	**9.1%**	**27.6%**	**8.0%**

Table 5.20 Respondents by job description and computer use (patient record)

Table 5.20 indicates that 338 (62.9%) of medical personnel and computer staff use computers daily for maintenance of the patient record. Not surprisingly, nurses and medical technicians were the main users. Out of 161 (90=55.9%) were nurses and 73 (75.2%) were medical technicians. A χ^2 test was used to examine if there is significant relation between job description and use of the computer for patient record. The χ^2 result signifies that there is no statistical difference between job description and use of computer for medical record.

Job Description	How often do you use the computer for internet access?					
	Period					
	Daily	Weekly	Monthly	Irregular	Never	No response
Physician	29	9	7	9	32	8
Nurse	7	5	1	73	60	15
Paramedical	6	2	1	27	32	9
Administrator	4	4	-	12	9	1
Pharmacist	9	7	4	16	13	-
Computer staff	19	3	-	4	6	-
Medical technician	10	7	4	34	42	-
Other	8	5	1	28	25	10
Total	**92**	**42**	**18**	**203**	**219**	**43**
Percent %	**17.1%**	**7.8%**	**3.4%**	**37.8%**	**40.8%**	**7.0%**

Table 5.21 Respondents by job description and their use of the Internet

Table 5.21 shows data relating to Internet access. A χ^2 test was used to see whether there is a difference between the use of computers for connection to the Internet among medical staff. The result revealed that there is no significant relationship between the use of computer for Internet and job description.

Respondents were asked about their perceptions of computer use. The intention was to assess the attitudes of the respondents with their satisfaction of ICT. Table 5.22 shows that a large proportion of respondents (341 = 55.3%) were 'very happy', followed by 179 (29.0%) of respondents who were 'moderately comfortable', while only 33 (5.3%) of respondents were 'moderately uncomfortable'.

It can be concluded that overall there is positive attitude towards computer use in staff from the Saudi healthcare sector, in contrast to the relatively negative attitude among health care professionals towards computer use throughout the rest of the world, as mentioned in Section 4.6.3. This result was not expected prior to this questionnaire survey. To put this result into context, Saudi Arabia is very active in implementing ICT in almost all aspects of life.

This work is the first survey to be conducted in the Western and Eastern regions of Saudi Arabia to gauge medical staff attitudes towards use of ICT. Indeed, there have only been two previous studies conducted in Saudi Arabia as a whole (see chapter four for more details). The majority of surveys investigating end-user attitudes have been carried out in the Western world, typified by studies in the USA and the UK. Therefore, this study extends the general findings to the developing countries, typified by Saudi Arabia.

Job description	Attitude toward a computer				
	Very comfortable	Moderately Comfortable	Moderately Uncomfortable	Very uncomfortable	Total
Physician	38	35	16	5	94
Nurse	83	50	21	7	161
Paramedical	43	21	5	8	77
Administrator	18	7	3	2	30
Pharmacist	21	25	3	-	49
Computer staff	26	6	-	-	32
Medical technician	69	19	9	-	97
Other	43	16	7	11	77
Total	**341**	**179**	**64**	**33**	**617**
Percent	**55.3%**	**29.0%**	**10.4%**	**5.3%**	

Table 5.22 Respondents by job description and their computer attitudes

Table 5.22 show medical staff attitudes toward computers, out of 94 physician (38=40.4%) were very comfortable. Similarly, out of 161 nurses 83 (51.5%) were very comfortable with the corresponding figure for medical technician being 69 (71.1%). For a comparison to be made within regions in Saudi Arabia, Table 5.23 shows the same results as those shown in Table 5.22 but cross-tabulated by region (KSUH is in the Central region, KAUH is in the Western region, and KFUH is found in the Eastern region). As before, findings indicate that staffs in KSUH and KFUH have a more positive attitude towards ICT than those in KAUH.

Name of University	Attitude towards computer use			
	Very Comfortable	Moderately Comfortable	Moderately Uncomfortable	Very uncomfortable
KSUH	138	61	28	5
KAUH	67	50	15	18
KFUH	136	68	21	10
Total	**341**	**179**	**64**	**33**
Percent	**55.3%**	**29.0%**	**10.4%**	**5.3%**

Table 5.23 Respondents by (region) university and their computer attitudes

A χ^2 test was run to determine the association between attitude toward computer usage and place of work. The χ^2 result showed that there is significant association between staff attitudes towards computer use and place of work ($\chi^2 = 24.12$, df6, $P < 0.001$, $N = 617$).

Respondents were asked to specify if they use fax or telephone to communicate with national and international colleagues to obtain information relevant for their work. A large proportion of respondents 378 (61.3%) do not use a fax to communicate. Of the 239 respondents who do use the fax to communicate, 149 (62.3%) use it within the national boundaries of Saudi Arabia. With regard to the use of the telephone for communicating with colleagues, 511 (82.8%) indicated that they use the telephone. These results indicate that they may not need fax and phone facilities or there is an institutional restriction on using fax, especially for international transmission. The survey shows that physicians were more likely to use both fax and telephones nationally and internationally, as indicated in Table 5.24.

Job description	Using fax or phone for obtaining information for work				
	Using fax			Using phone	
	Nationally	Internationally	No	Yes	No
Physician	28	27	38	80	14
Nurse	24	16	121	142	19
Paramedical	18	9	50	60	17
Administrator	11	5	14	21	9
Pharmacist	20	5	24	47	2
Computer staff (IT)	9	10	13	25	7
Medical technician	21	7	69	77	20
Other	18	11	48	59	18
Total	**149**	**90**	**378**	**511**	**106**
Percent %	**24.1%**	**14.6%**	**61.3%**	**82.8 %**	**17.1%**

Table 5.24 Respondents by job description and their use of fax and telephone

5.4.4 Source of advice

Respondents were asked to identify the most important source of advice if they faced a computer problem. The objective was to identify the most important sources of advice preferred by the different types of respondent. Table 5.25 shows the results. Generally, hospital computer staff (286 = 46.4%) appeared to be the most popular source of advice for hospital staff. The second most popular source was department colleagues (156 = 25.3%), followed by use of an appropriate computer manual (82 = 13.3%). Interestingly, the University computer centre was little used (72 = 11.7%). It is clear that the most end-users try to get their advice from the nearest place available. Computer staffs themselves rely heavily (75%) on use of the relevant computer manuals.

Job description	Source of advice				
	University computer centre	Computer manual	Department colleagues	Hospital computer staff	Did not need advice
Physician	8	10	32	39	5
Nurse	21	11	26	92	11
Paramedical	13	10	19	35	-
Administrator	6	2	12	10	-
Pharmacist	7	7	12	23	-
Computer staff	1	24	5	2	-
Medical technician	11	4	28	54	-
Other	5	14	22	31	5
Total	**72**	**82**	**156**	**286**	**21**
Percent %	**11.7%**	**13.3%**	**25.3%**	**46.4%**	**3.4%**

Table 5.25 Respondents by job description and source of advice

This means that medical personnel seek help for computing problems from a professional source, and prefer human interaction. A breakdown of responses by job description and Institution (Table 5.26) indicates that the profile of responses is similar in KSUH and KFUH but markedly different in KAUH. This result is indicative of the different organisational priorities in KAUH.

Institution	Source of advice				
	University computer centre	Computer manual	Department colleagues	Hospital computer staff	Not Qualified
KSUH	13	23	46	139	11
KAUH	32	38	63	17	-
KFUH	27	21	47	130	10
Total	**72**	**82**	**156**	**286**	**21**
Percent %	**11.7%**	**13.3%**	**25.3%**	**46.6%**	**3.4%**

Table 5.26 Respondents by Institution and source of advice

5.4.4 Computer training

For the purpose of this study, respondents were asked to point out if they received computer training. The purpose of this question was to assess the efficiency of training programs and level of user satisfaction with computer training. Table 5.27 shows that a large proportion of respondents (442 = 71.6%) had received some computer training, although of course this also means that 28.4% have received no formal ICT training. 455 (73.7%) respondents were dissatisfied with the ICT training offered. In addition, upon breakdown of the responses into individual Institutions, it was found that respondents from KFUH were more likely to be satisfied. It is clear that more effective management of the computer training programme is needed. The type of computer training programmes and topics offered by university computer centres and Hospital computer departments is discussed in Chapter 6.

Job description	Amount of computer training received					Satisfaction	
	Days	Weeks	Months	Years	No training	Yes	No
Physician	25	10	8	3	48	17	77
Nurse	90	24	9	5	33	35	126
Paramedical	23	14	12	7	21	32	45
Personnel	5	10	7	3	5	13	17
Administrator	5	5	19	3	17	11	38
Pharmacist	7	2	6	13	4	15	17
Computer staff (IT)	36	22	13	-	26	18	79
Medical technician	19	14	18	5	21	21	56
Other	-	-	-	-	-	-	-
Total	**210**	**101**	**92**	**39**	**175**	**162**	**455**
Percent %	**34.0%**	**16.4%**	**14.9%**	**6.3%**	**28.4%**	**26.3%**	**73.7%**

Table 5.27 Respondents by job description, amount of computer training and their satisfaction

5.4.5 Problems and obstacles

Respondents were asked to rank up to three out of a list of problems that may be encountered in introducing ICT into Saudi University Hospitals. The purpose of this question was to give an indication of these issues that need to be resolved before further implementation of computer network systems. Most respondents (459 = 74.3%) rated lack of training as the major obstacle in using computers, followed by lack of a managed co-ordination of effort (343 = 55.6%). Table 5.28 shows the highest rated issues. Funding is usually a critical issue but was raised by only (240=38.9%) of respondents. It can be concluded that more attention should be paid to computer training programmes, as well as to co-ordination and co-operation among Saudi universities.

Problems and obstacles that may be encountered in Saudi University Hospitals	**Frequency**	**%**
Lack of computer programs training and education	459	74.3
Lack of co-ordination between institutions	343	55.6
Poor management	282	45.7
Lack of ICT staff	282	45.7
Lack of funding	240	38.9
Lack of information technology policy	211	34.1

Table 5.28 Problems and obstacles that may be encountered

It is clear that staff in KFU and KSU have achieved an acceptable level of competency in using computers, and these Institutions are more technologically advanced than KUA. Respondents were asked to add any issues or problems that they felt should be considered. Respondents raised several issues, including:

- lack of English language ability,
- shortage of staff who have strong ICT skills,
- employee attitudes and resistance to change,
- organisational structure,
- lack of network facilities and low network speed,
- insufficient software and difficulty in customisation, and,
- inadequate numbers of staff in network maintenance, operation, and management.

5.4.6 Information provision

Types of information that should be shared among University Hospitals

Respondents were asked to identify the types of information that should be shared among Saudi University Hospitals. A large proportion of respondents suggested information about new drug therapies (403 = 65.3%), new trends in treating specific diseases (393 =

63.7%), announcements for seminars (358 = 58.0%), hospital laboratory results (343 = 55.6%), and hospital news (343 = 55.6%). Table 5.29 shows these results in more detail.

Type of information	Yes		No	
	Frequency	%	Frequency	%
New drug information	403	65.3	214	34.7
New trends in treating specific disease	393	63.7	224	36.3
Announcements for seminars	358	58.0	259	42.0
Hospital news	343	55.6	124	20.1
Hospital Lab result	343	55.6	274	44.4
Patient record	342	55.4	275	44.6
Research information	321	52.0	146	23.7
Drug formulary	318	52.5	299	48.5
Diagnosis	314	50.9	303	49.1
Patient education	304	49.3	313	50.7
Physician directories	262	42.5	355	57.8
Epidemiology	259	42.0	358	58.8
Hospital statistics	254	41.1	213	34.5
Document information retrieval/viewing	248	40.2	369	59.8
Therapy	246	39.9	371	60.1
List of physician on a case basis	233	37.8	384	62.2
Medical Society announcements	230	37.3	387	62.7
Prognosis	210	34.0	407	66.0
Toxicology	161	26.1	306	50.1

Table 5.29 Opinions on the distribution of information

Confidentiality and security

Respondents were asked about security and confidentiality when sending medical information. The intention was to assess the knowledge in the sample about the importance of these issues. Table 5.30 indicates that a very large proportion of respondents 567 (91.8%) is aware of confidentiality and security measures when sending medical information. Physicians were very aware of this matter, with 89 (94.7%) responding to the need for confidentiality and security, as were the computer staff (31 = 96.9%). This result is not surprising, as it is these two groups who are the most sensitised to the awareness of these issues.

Job description	Confidentiality and security awareness	
	Yes	No
Physician	89	5
Nurse	151	10
Paramedical personnel	67	10
Administrator	28	2
Pharmacist	43	6
Computer staff (IT)	31	1
Medical technician	90	7
Other	68	9
Total	**567**	**50**
Percent %	**91.8%**	**8.1%**

Table 5.30 Respondents by job description and awareness of confidentiality and security issues

Expectation for video conferencing, and telemedicine

For the purpose of this study, respondents were asked to point out their expectation within five years for video conferencing and telemedicine in Saudi University Hospitals. It was intended to seek and assess user expectations of the technology and the preparedness of the healthcare community within a five-year timeframe. A further aim was to present on overall picture of ICT policy regarding improvements in healthcare services in Saudi Arabia. Table 5.31 shows that 515 (83.5%) of medical and computer staff expect Saudi University Hospitals to use this sophisticated technology nationally (171 = 27.7%) and (344 = 55.8%) internationally. System users in KSUH (210 = 90.5%) expect more use of these technologies than users in KFUH (206 = 87.6%) and KAUH (66 = 66%).

Place of work	Expectation for video conferencing and telemedicine				
	Yes Nationally	Yes Internationally	Total	%	No
KSUH	77	133	210	90.5	22
KAUH	48	51	99	66	51
KFUH	46	160	206	87.6	29
Total	**171**	**344**	**515**		**102**
Percent %	**27.7%**	**55.8%**	**83.4%**		**16.5%**

Table 5.31 Breakdown by place of work and expectation for high technology

Table 5.32 shows that 103 (64.0%) nurses expect that Saudi University Hospitals will use sophisticated technologies internationally within five years, while 43 (26.7%) of them think that the technologies will be used at the national level only. The corresponding figures for physicians are 52 (55.3%) internationally and 20 (21%) nationally. Indeed, only 102 (16.5%) of respondents do not expect Saudi University Hospitals to use sophisticated technologies within the next five years. This opinion may be due to problems that are mentioned above (Section 5.4.6), but also because some hospitals lag behind many other organisations in the use of ICT in Saudi Arabia.

Job description	Expectation for video conferencing and telemedicine		
	Yes Nationally	Yes Internationally	No
Physician	20	52	22
Nurse	43	103	15
Paramedical personnel	24	39	14
Administrator	11	13	6
Pharmacist	16	30	3
Computer staff (IT)	3	23	6
Medical technician	27	55	15
Other	27	29	21
Total	**171**	**344**	**102**
Percent %	27.7%	55.8%	16.5%

Table 5.32 Respondents by job description and expectations to use ICT

A χ^2 test was used to test the significance of association between place of work and expectations of use sophisticated technologies at work within 5 years. The result shows that there is significant relationship between those two variables ($\chi^2 = 65.52$, df4, $P < 0.001$, $N = 617$). Another χ^2 test was used to assess whether there is a difference between job description and expectations of using high technologies at work within 5 years. The result shows that there is significant relationship between them ($\chi^2 = 34.76$, df 14, $P < 0.001$, $N = 617$). These findings indicate that although Saudi healthcare personnel working in the higher education system are relatively new to the use of ICT, and their expectations of its use in the future is very high.

5.5 Summary

This Chapter has analysed the results of data collected from the questionnaire survey conducted from all three Saudi University Hospitals. The Chapter has been divided into four sections that represent the different parts of the questionnaire. The first part provides an overall picture of response demographics. The results show that the majority of respondents were nurses (26%), physicians (15%), and computer staff (5%). Approximately 55% of respondents possess an undergraduate degree, but only 6% have a Ph.D. degree. 48% of respondents were male. This finding was a surprise, as it was expected that female respondents would outnumber their male counterparts, as the healthcare sector is one of the most suitable places for females to work in Saudi Arabia due to religious and cultural regulations.

The second part explores the use of computers, computer experience and subject group attitude towards computer use. Study results show that 537 respondents (87%) use a computer at work. It appears that KSUH and KFUH are fully networked. It is observable that staff from KSUH and KFUH have more experience in use of computers than staff from KAUH. Indeed, the lack of computer availability at KAUH is having an effect on the overall development of staff in this area. It follows that the number of people actually using the computing facilities and the number of computing staff at KAUH are both lower than KSUH and KFUH. This can be attributed to issues such as: insufficient management experience and lack of funding. Another factor is that KAUH has recently moved to a new building and has just started developing their computer network - their computer network embraced only four departments when the data were collected in 2001.

Computer staff, physicians and pharmacists are the heavy users of computers at home. 64% of physicians own a computer. Perhaps this is because physicians have the ability to buy computers and the nature of their work encourages them to use this technology. The result can be used as an indicator to show that medical staff are likely to have the basic skills to use computers. Also, the result shows that 55% of respondents use a computer to access patient records, 35% use them for clinical data transfer, and 27% use them for producing word-processed documents. These data indicate that 83% of medical personnel do not have ready Internet access. In terms of user attitudes, it can be concluded that overall there is a positive attitude towards computer use from all staff in Saudi University Hospitals. This work is the first survey to be conducted in the Western and Eastern regions of Saudi Arabia to measure medical staff attitudes towards the use of ICT.

The third part emphasises the need for education, computer training programmes and staff satisfaction. Hospital computer staff appeared to be the most popular source of advice for medical personnel. This study shows that 72% of respondents had received computer training, but 74% of those who had received training were dissatisfied with it in some way. Staff in KFUH were more likely to be satisfied than those in the other universities. The most important issues that need to be resolved before further implementation are the development of high quality training programmes, co-operation and co-ordination of efforts of the three Saudi University Hospitals, and executive management training for those making resource decisions.

The last section of this Chapter deals with information provision. Medical and computer staff expect Saudi University Hospitals to use this sophisticated technology nationally as well as internationally within five years. Data findings are analysed to reveal an understanding of current issues that surround the introduction of ICT in Saudi University Hospitals. This finding will be used in Chapters 7 and 8. The next chapter will analyse the interviews undertaken to provide a fuller picture of issues associated with the introduction of ICT in the higher education system in Saudi Arabia.

Chapter 6

Interview Analysis

6.1 Introduction

The purpose of this chapter is to analyse documents and the results of data collected via interviews conducted in Saudi Arabian universities. The findings are grouped into three sections. The first section deals with data collected from university computer centres and hospital computer departments and investigates the current use of computer systems and the management of the provision of computer network services. The second section relates to University Hospital Managers, the emphasis of ICT on user satisfaction with computers and the network systems that allow them to communicate. The nature of computing resources in the organisation and its policy regarding future plans for ICT are also considered. The third section deals with external bodies. Focusing on their future plans, training support and assistance for universities in the use of their services. It also investigates their current ICT services and future plans to improve them. Recommendations for actions from the findings will be discussed as part of the SSM intervention found in Chapters 8 and 9.

6.2. University Computer Centre Directors

As discussed in Chapter 2, University Computer Centre Directors were invited for interview to find out what computer services support they provide to their end-users. Each University computer centre has different computer configurations, but all include mainframes, PCs, networking and application software. Usually, University Computer Centres are involved in a variety of activities such as computer operation, maintenance, monitoring, and end-user support and training.

Current ICT services and computer support

Respondents were asked whether they consider ICT resources in general hardware and software matches all end-user needs and it was also asked what kinds of computer services are offered to all end-users. In fact, every university has its own experience but the general response was that, their current ICT resources are insufficient. They still need certain hardware and software applications to operate their networks and to meet the needs of their university's users.

Moreover, ICT resources frequently change and are being upgraded very rapidly so it is hard to satisfy both their needs and those of their end-user since University Computer Centres on each site provide several services. However, interviewees reported that there are two kinds of main ICT services for the university's staff and students:

(a) Internet related services
(b) University's Student Record System (SRS) & Employees' Payroll System.

They provide an Internet email service to all university staff and students, they also provide Web access to approved academic and administrative staff on an email user ID base. It was found that Web access is open for all the university's students in the computer lab in KSU and KFU, whilst the case is different in KAH where Web access is limited to certain people. Students get authenticated for web access on their student ID base but they are subject to certain restrictions, rules and regulations. In general all universities concerned were only offering less than 50% of what they could offer at full capacity. They try to organise of their services which the realms of the user's level of understanding and ICT knowledge. KSU and KFU have a plan to increase their university network capacity whereas KAU is making progress in implementing their network plan.

ICT policy, planning and funding

University computer directors were asked how their ICT policies were decided, monitored and funded. Furthermore, they were asked if they had an IT committee to purchase ICT equipment. Their answers showed that purchases were made through an IT committee which does not have a link with the national policy. Usually, the ICT plan is funded through a project in the budget of the university. The ICT policy is to purchase new ICT equipment based on a request initiated by the department concerned and forwarded to the IT committee which transfers the request to the equipment sub-committee for review and recommendation. The IT committee's decision will be based upon their recommendation.

Interviewees pointed out that all the universities' policies on Internet related services are fully in accordance with those of King AbdulAziz City for Science and Technology (KACST). They follow the International protocols for Internet Services. On the other hand, each university has its own policies, according to their local requirements.

The interviews revealed that all universities purchase all types of ICT equipment on demand, keeping in mind future expansion. However, the purchase policy is to go for the tested and most reliable hardware with well-known companies such as IBM. Maintenance and support services after sale were very important factors. Each university preferred well-known vendors with whom it had good experiences in the past. Furthermore, in terms of implementation, all the universities had hardware and software tools to implement and monitor their policies and check that all the users act fully in accordance with ICT computer centre policies.

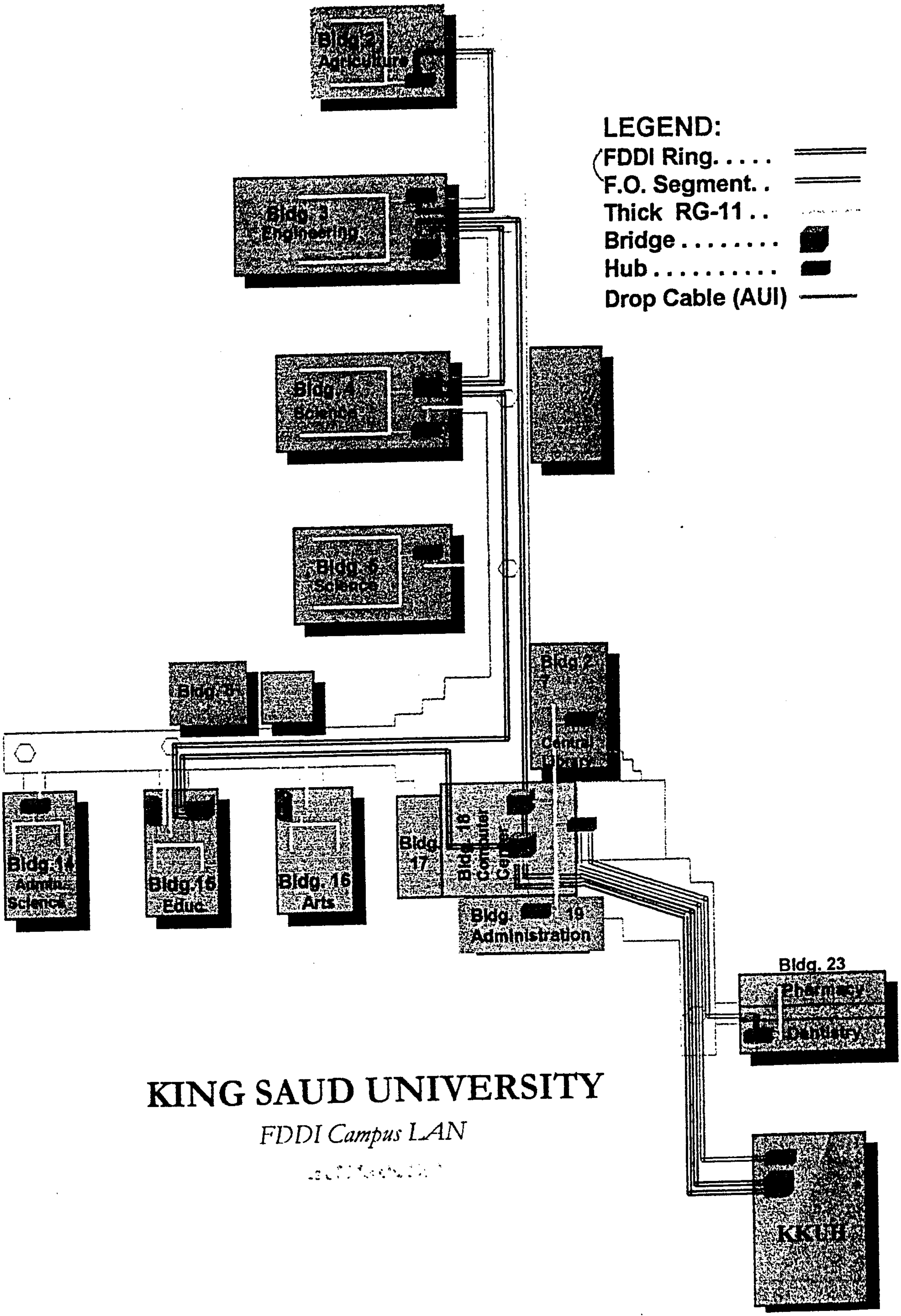
Network and network services

Respondents were asked about linking, and the scope of the network operating in their universities. It was found that in KFSU and KSU, all the faculties and departments are locally networked and then connected to the computer centre with a very high-speed link. KSU was more advanced than other universities. The University Computer Centre Director in KSU pointed out that its campus network consists of four LANs. The first two cover the Colleges of Pharmacy and Dentistry, College of Medicine and the University Hospital, the administration building and the main library. The other two cover the College of Science, College of Computer, the College of Art, the College of Education, the College of Administrative Science and the Audio-visual centre. In addition, its outpost in Al-Gaseem has remote access to the computer centre via satellite. All those LANs are linked together via two-communication network system. The configuration of KSU campus is shown in Figure 6.1

The case is almost the same with KFU. All the faculties and departments are locally networked, and then connected to the computer centre with a very high-speed link. Furthermore, their remote campuses (including University Hospital in Khobar and Dammam campus) are connected to the computer centre with high-speed 128 Kb leased lines. All these connections come to the main backbone switch in the computer centre in Al-Hasa and connect to its LAN and WAN. The Computer Centre is connected to the Internet through KACST with a high-speed 512 KB digital line. All the Internet services to the remote campuses are provided through the main campus computer centre. The configuration of KFU campus is shown in Figure 6.2.

The KAU campus network was less advanced than the networks of the previously mentioned universities. KAU had a five-year plan to implement a campus-wide network but this was still in its second stage. According to the University Computer Director, 50% of its buildings are already connected and operating a token ring fibre optic network backbone at speeds of up to 16 MB/s. PC labs are connected to certain buildings to provide faculty members and students where services for educational purposes. KAU had a partial campus network, with three Ethernet LANs in the computer centre building. Further steps and more effort are required for future network development. Network extension will bring about a campus network comparable to those that have been carried out and implemented at other universities. The configuration of KAU campus showed in Figure 6.3.

Figure 6.1. KSU Network configuration



KING SAUD UNIVERSITY

FDDI Campus LAN

Figure 6.2. KFU Network configuration

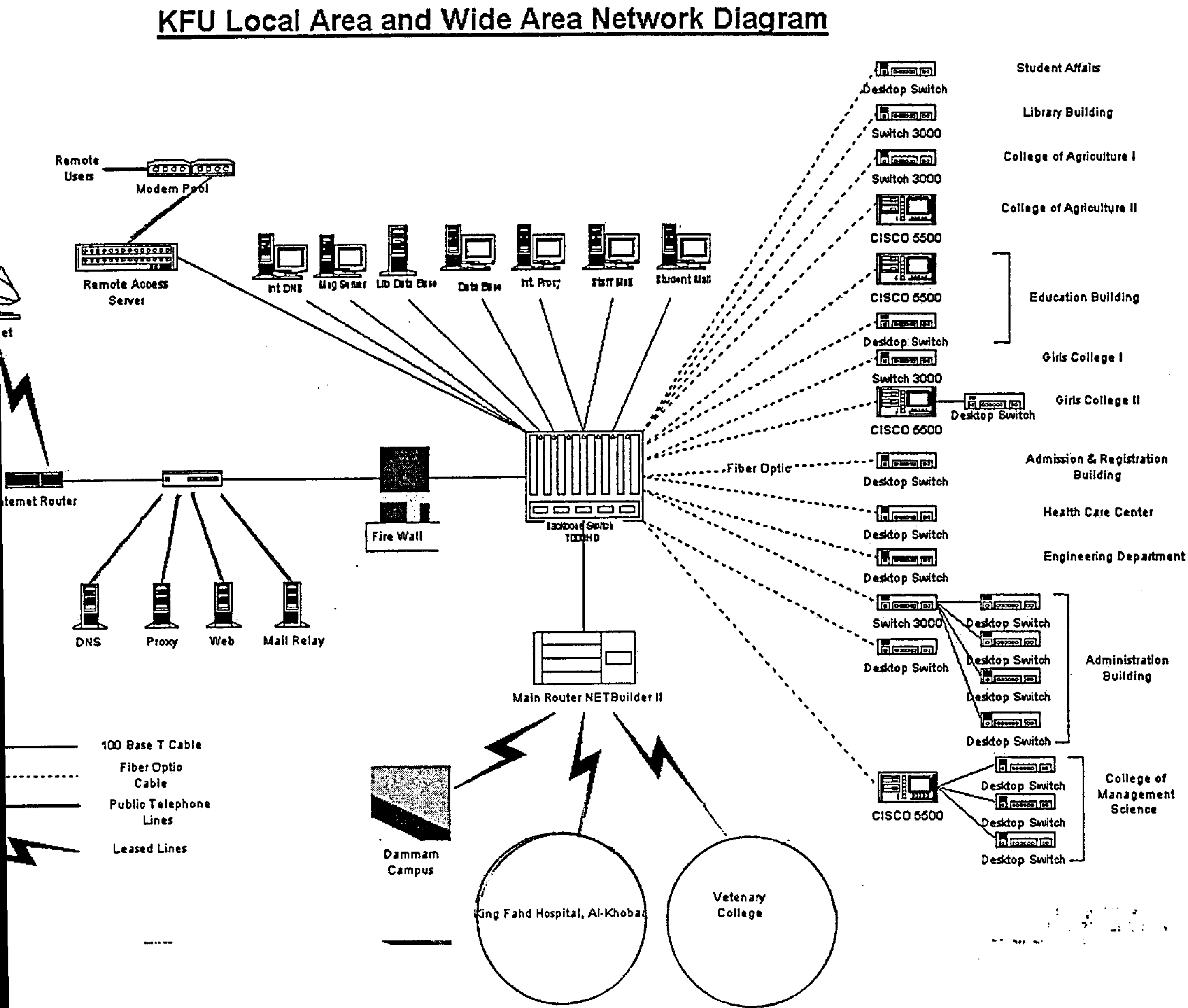
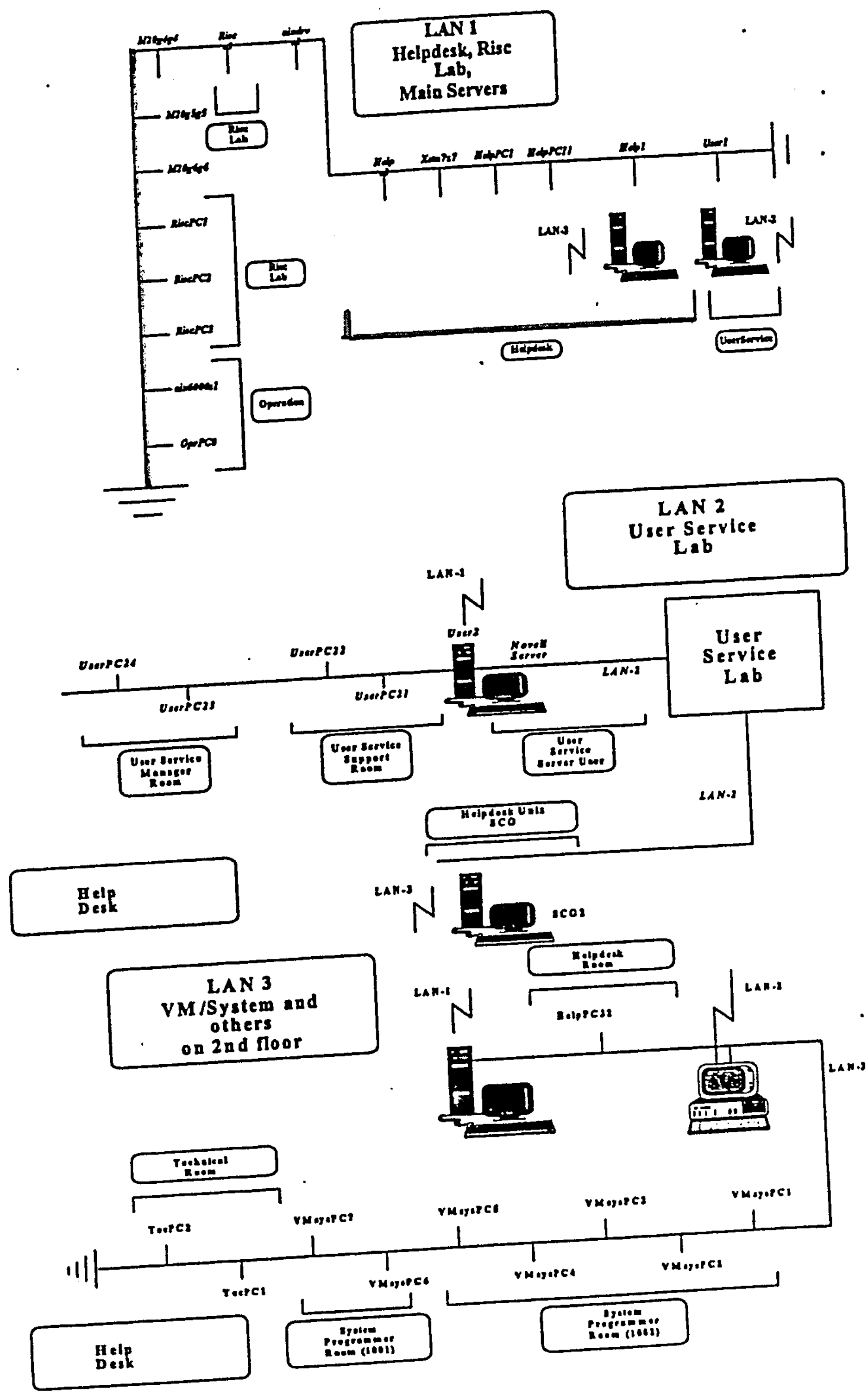


Figure 6.3 KAU Network configuration



Computer training and education for a new ICT skills

Interviewees were asked what their plans were to train their staff and encourage them to use ICT effectively and efficiently. They were also asked to point out problems associated with computer programs training. Interviewees highlighted the fact that all universities run basic training courses and offer a general guide to the computer facilities for end-users on Microsoft operating systems to help them to use their desktop computers effectively and to carry out their daily tasks. All universities have plans to continue with this in future and they hope that more and more users will benefit from these courses. In all the universities, end-user courses cover the following topics, as shown in Table 6.1.

No	Type and topics of end-users training in the computer centres
1	General guide lines to computer facilities
2	Basic computer skills
3	Programming language
4	Training to use KACST data base
5	Training to use the Internet
6	Graphic and statistic packages (e.g. SPSS,)

Table 6.1 Types of training offered by university computer centres

With regard to the methods of training the interviews indicated that the following methods are usually used. These are as follows: leaflets, formal group tutorials, individual tours for special needs' demonstrations and seminars. Interviews highlighted that KSU and KFU had more computer facilities and end-users had more of an opportunity to attend seminars than end-users in KAU. It also appeared that KSU and KFU have reached a reasonable level of knowledge in computers and computer networks. However, all universities depend on foreign suppliers such as IBM, and from time to time send their technical staff to the USA and the UK for training on different systems and applications, which they use or intend to use. On the other hand, all universities also run in-house computer training courses. The University Computer

Centre Director at KFU stated that "we run training sessions from Microsoft and Unix vendors from time to time".

In the respect of problems associated with training programmes, the interviews revealed a number of interrelated problems such as funding and shortage of technical staff, and maintenance of hardware and software. Rapid change in technology was mentioned as an important issue, encountered in all universities. It was clear that well-qualified and skilled staff were needed to operate their systems and train university staff to exploit computers effectively and efficiently.

Respondents were asked how they update and increase their knowledge of networking and computing. University computer directors subscribe to most of the popular IT magazines, attend national and international conferences and seminars, and visit computer and network exhibitions both at home and abroad.. Also, interviewees emphasised that the Internet is the most important source of knowledge for ICT issues.

Future plans, arrangements, expectations and information provision

Interviewees were asked whether there is any co-operation between University Computer Centres. They remarked that formal meetings began by the middle of 1999, but even before this, some of them visited other university computer centres. One university receives visitors from other university computer centres than it made visits itself. There are eight university computer centre directors in all the Saudi universities so in order to cope with technology and improve the university environment, those directors could and should meet regularly. The University Computer Director at KAU stated that "We must act jointly rather than independently in the interest of our own universities and nation as well". The interviews also indicated issues of mutual interest were discussed and directors plan to work jointly.

In terms of technical personnel required on each site in order to connect all Saudi universities electronically, interviewees pointed out that the number of ICT staff is not easy to define precisely because this depends on the network capacity and university size. Based on the perspectives gathered from the interview and documents analysis, the researcher recommends that at least six personnel are needed at each site. These are:

- Project manager,
- System administrator,
- Network technician,
- Network administrator,
- Systems analysis and system design, and,
- Training manager.

In addition, the interviewees were asked about potential problems associated with the establishment and use of a computer network system. They noted several interrelated problems during the interviews. Technical problems were mentioned. Most of these revolved around hardware and software compatibility issues. Moreover, KFU's director remarked on the shortage of consultants who deal with such problems. Reliability and system security were also repeatedly mentioned. University computer directors concluded that technology nowadays enables links to be made among all Saudi universities to exchange information whatever its form (e.g., text, image, etc.).

All the University Computer Centre Directors' talked about the arrival of the Internet in Saudi Arabia. Almost all the universities who were connected to Gulf Net have migrated to TCP/IP locally and most of them are already connected to the Internet. As a result, they believe that in one way they have already been connected together now.

6.3 University Hospital Computer Department Managers

In order to investigate the current situation of ICT and to understand HIS managers' experience and the problems that may be encountered into introducing ICT in the Saudi University Hospitals, a number of interviews with hospital computer department managers were carried out. Computer department managers were all male except in KSUH. In addition, all had specialised in computing degrees except for the manager at

KAUH. Their work experience varied with the Computer department manager in KSUH working for the longest period, 10 years.

Each hospital computer department had different computer configurations, but all included mainframes, PCs, networking and application software. Numbers of ICT staff were 15 in KSUH, and 20 in KFUH whilst there were only three staff in KAUH. The hospital computer departments are involved in a variety of activities such as:

- the operation, monitoring and maintenance of computer hardware and software,
- providing computer services to the departments in the hospitals, and,
- providing technical support and training for end-users.

The University Hospital in KFU had used computers for 18 years, and KSUH had used computers for 12. Both University Hospitals have fully-integrated hospital information systems and are aiming to make the hospitals paperless eventually. On the other hand, KAUH had a contract with IBM to implement a fully integrated hospital information within 18 months when data collected in July 1999. Unfortunately, up to now this project has not finished yet but it is expected to finish by the end of 2001. In addition their remit is to:

- implement a full hospital system, provide hardware and software for KAUH to improve and facilitate internal processes and contact external hospitals online,
- make policies and plan for future extension, and,
- offer training programmes for hospital employees.

Understanding of the current situation of ICT services

Computer department managers were asked what computers and terminals were available for medical staff within the hospitals. The responses were diverse from one hospital to another. In KAUH, there were 300 PCs (Pentium, 133, 16 MB RAM, 1.2 GM hard disk) but only 200 were actually being used as this satisfied the needs of all the end-users. There were 12 PCs provided by IBM for training purposes, and the rest were distributed between departments. In KFUH, there were 300 PCs (Pentium III) and these were all operating at high capacity. There were also 120 printers. In KSUH there were 550 PCs, 214 terminals and 226 printers. The PCs ranged from 486 to Pentium III. The figures above do not include 650 stand-alone PCs for office use. The HIS networks in KSUH include a spanning tree star topology fast switch Ethernet, an ATM network for Internet support, as well as two Unix servers and 6 Windows NT servers.

Hospital Computer Department Managers were dissatisfied because the computer systems did not match all their needs and they also complained about poor networking. Most Hospital Computer Department Managers wished to have advanced computer systems and networking which could help their staff to communicate and exchange information easily. The Hospital Computer Department Manager at KSUH said, "each staff member should have e-mail access to communicate with his or her equals within and outside the hospital". She also added that ICT services were at reasonable level, but did not match her ambitions and expectation in the information age.

With regard to computer services offered, medical and computer staff respondents mentioned the following services:

- electronic mail,
- electronic data exchange inside the hospitals,
- electronic bulletin boards,
- database searching,
- electronic journals, and,
- accessing other medical libraries.

Interviewees highlighted the fact that their hospital computer departments were linked to the university computer centre in KSUH and KFUH. However, the Computer Department Manager at KAUH claimed that, unfortunately his department was not yet linked to the university computer centre. There was only one terminal connected to the

Financial and the Personnel Departments from the university administration. He added that the medical library has only just been linked to the computer centre.

Current and future network systems

Interviewees were asked what arrangements there are for the use of LAN/WANS. They clarified that the University Hospital is part of the university. Typically, each university has its own IT committee and the Hospital Computer Manager is a member of that committee. In KSUH the Vice-Dean usually represents the hospital on the IT committee whereas in KFUH and KAUH, the Hospital Computer Manager represents the University Hospital. In spite of this, the Hospital Computer Manager in KSU also stated that she is required to submit a quarterly report to the Vice-Dean. She also added that KSU has an ATM backbone network, which is connected to all its buildings as a start connection and each building has its own LAN network. This ATM network includes the University Hospital, which has about 1400 nodes.

ICT policy, planning and funding

ICT policy in the universities concerned is decided through an IT committee, which has a link with university computer centre policy. The ICT plan is funded through a budget of the university. Usually, the ICT policy is to purchase new equipment based on a request initiated by the hospital computer department and forwarded to the IT committee. This then transfers the request to the equipment subcommittee for review and recommendation. The IT committee's decision will be based upon the sub-committee's recommendation.

Arrangements, expectations and ICT provision

Interviewees believed that it would be possible through ICT to connect all University Hospitals electronically to exchange medical information, basing this response on the ability of high technology to achieve such tasks. In contrast, they expressed concern that top management was not adequately informed regarding the difficulties encountered in linking all University Hospitals electronically. A number of problems involved in connecting all Saudi University Hospitals were mentioned during the interviews. These problems can be summarised as follows:

- shortage of ICT personnel (e.g., programmers, software specialists, engineers),
- lack of funding and difficulties in obtaining financial support from the Ministry of Finance for the project,
- medical staff attitudes and resistance to change,
- lack of co-operation between departments in hospitals and also between University Hospitals in general,
- difficulties regarding training due to the high cost of training and a lack of ICT specialists,
- difficulties in the organisational structure, and,
- the large amount of work that is not handled by the current system's capability.

However, Hospital Computer Managers believe the proposed computer network system will bring a lot of advantages. More precisely, the proposed system will help medical and administration personnel to achieve the following:

- better co-operation between University Hospitals in exchanging information,
- eliminating time, cost, distance and volume barriers, by providing remote access on-line for specialists, patients, the public to gain necessary information,
- conducting telecommunications and electronic conferences among special interest discussion groups(e.g. videoconferencing, teleconferencing, tel-medicine),
- providing health care professionals with 24 hour on-line access to relevant information from patient records,
- giving medical and nursing staff instant access at their desks or at bedsides to the most recent medical research and treatment practice, and,
- providing convenient, accurate, and up-to-date general information (e.g., on fitness, lifestyle and diseases) for the public through an on-line information.

The interviews indicated that University Hospitals should make organisational changes to fit in with the new system. It was found that the Hospital Computer Managers in KSUH and KFUH report to the Vice-Dean. In KAUH the manager expressed his unhappiness at having to report to the Maintenance Department or the Head of Administrative Affairs as he wished to report to the Dean of the Medical School or to the Hospital Board. Also, he pointed out that there were just three ICT personnel and a small department for data processing. He believed at least one of the following personnel are needed: computer programmer, engineers, system designers and computer operators.

In terms of information should be shared among the universities, Hospital Computer Managers indicated that all medical information in all its forms should be shared for the benefit of patients. This information should be available instantly, and then, as a consequence, performance will improve and satisfaction will increase.

Computer training and education for new ICT skills

Respondents were asked whether a computer training programme was available for medical staff and if so, what topics were covered. In each site there was a program of training for medical personnel. It was mentioned that each hospital had dedicated space for training. In KAUH, 12 PCs had been provided for this purpose by IBM, who also trained staff to enter and retrieve medical information. By comparison, KSUH had 10 PCs for training.

It was found that the most important tasks of hospital computer staff are to train medical staff working in the hospital. However, they use different ways of training are used, such as leaflets or individual tutorials for specific needs, the most common way was by formal group. Generally, hospital computer departments provide training courses to encourage hospital staff to use the available technology. These include:

- in-house training by computer staff,
- in-house training by outside computer companies,
- external training courses both national and international, and,
- publishing regular leaflets, manuals, and handout.

With regard to keeping staff up-to-date, all interviewees pointed out that the Internet is the best resource to improve their knowledge and refresh their minds. The University Hospital Computer Managers, like their University counterparts in the Computer Departments, subscribed to most of the popular IT magazines and visit national computer exhibitions.

Key issues

The most important problems associated with the use of ICT in Saudi Arabia were mentioned repeatedly. The Hospital Computer Department in KSUH summarised the key issues as:

- funding limitations,
- end-users training,
- shortage of computer staff, and,
- system problems (hardware and software).

Equally, each university has its own particular issues, but in general, the problems can be summarised as follows:

- insufficient finance and difficulty in getting financial support via Ministry of Finance to manage and purchase new computers equipment (hardware and software),
- technical problems which hardware and software (e.g., maintenance, security)
- lack of skilled people who have a background in computers or related areas,
- insufficient experience and knowledge in the operation and use of computers,
- difficulty in training due to different staff having their own needs,

- resistance to change and negative attitudes towards computers among staff,
- lack of co-ordination between departments and increased numbers of patients,
- lack of policy, top management support and understanding of IT benefits, and,
- variety of organisational structure and behavioural issues.

In addition, the interviews show that Hospital Computer Managers feel that the existing clinical/healthcare terminology creates difficulties, especially for new staff.

6.4 University Hospital Managers (Deans of Medical Schools)

Computers have had a great impact on medicine. Most hospitals use computers for routine tasks such as making appointments or other similar tasks. In Saudi Arabia a few hospitals have x-ray departments where images can be called up electronically and reviewed when required. Introducing a computer system in University Hospitals has varied from university to university. For example, KFUH first introduced computers in 1982, and KSU has used computers and their applications for more than 12 years. KAUF is only just making progress in this area.

When interviewees were asked what factors were holding back computerisation, they pointed out that there were several problems, which varied from respondent to respondent. These issues can be summarised to include the following points. There is a lack of personnel who have a background in computers and who are willing to improve themselves and participate effectively to improve their organisations. In addition, there is overall lack of experience and knowledge in the operation and use of computers in general compounded by negative attitudes towards computers among medical staff, as well as a general lack of motivation. Furthermore, there are difficulties in training due to different staff having their own needs and the need for specialised training for special applications such as Telemedicine. There is also a variety of organisational structure and technical issues, and widespread limitations and a lack of funding. Finally, there are difficulties regarding computerisation and management of large amount of work.

All interviewees emphasised the lack of professional staff who have experience and/or a reasonable knowledge in operating and using technology. Therefore, they believe that IT equipment is not fully exploited. For example, the KSUH manager stated, "we probably run at less that 50% of our fully-integrated system capacity".

In terms of using high technology such as telemedicine and teleconferencing in the near future, interviewees indicated that this may be possible. Telemedicine is in use in KFHC and they have connections with two American hospitals (Johns Hopkins Hospital and the George Washington Hospital), but it is very expensive. Telemedicine is available in KSUH for anyone who is willing to pay from their own budgets but this is not practicable for the general public due to high cost. Some University Hospitals, such as KSUH, have video terminal capabilities for teaching but are not connected nationally to allow other universities to take advantage of this. Moreover, KSU implemented computer systems for teleconferences but they are not used due to a lack of funding. KFUH has two video terminals for teaching, while KAUH is lagging behind in the use of ICT for treatment or teaching purposes.

Regarding the exchange of medical information, some University Hospitals do so but this is limited to knowledge and experience rather than patient information. It is believed that it is difficult to obtain patient consent and convince them to fill in the consent form. Generally, interviewees expected Saudi universities to use such high technology in the near future. The KFUH manager stated that, "we have a strong desire and ambition to implement patient records and other sophisticated technology such as smart cards".

Interviewees also highlighted that there is committee called “University Hospitals Committee” which holds meetings every six months and is chaired by the Ministry of Higher Education. Its main role is to provide suggestions and recommendations for the interest of all University Hospitals. The main points investigated by this committee were summarised as follows:

- budget issues and how to maximise spending,
- regulations, rules and procedures,
- co-operation and co-ordination to exchange knowledge and experience,
- increasing number of patients and their problems,

- utilisation of ICT and how to maximise its use for the benefit of the patient,
- discussion of common problems and exchange experiences, and,
- unification of efforts and brining all University Hospitals to the same level.

A number of problems associated with establishing a computer network system to link all University Hospitals electronically were identified. These problems can be classified as follows: 1) funding limitations 2) utilisation of ICT 3) gaps between universities in terms of capability, funding, experience, and the system being used 4) patient security, confidence and privacy 5) cultural and social pressure 6) geographical limitations.

The hospital managers interviewed indicated that to connect the hospital electronically is possible from a technical point of view, due to the capability of high technology. Saudi people are becoming familiar with computers and willing to use high technology. They believe that the project should have a clear and defined objectives and patient privacy should be protected. Therefore, a policy for patient security and privacy should be clearly defined and well planed. ICT policy was run through an IT committee and funded through the budget of the university.

Hospital managers were asked if they have training programmes for the medical staff and if so, what topics are covered. They pointed out that all University Hospitals run training programs for medical personnel training them to enter and retrieve medical information. Various methods of training were used, such as leaflets, individual tutorials for specific needs, but the most common way was by formal group tutorials. It was found that all University Hospitals have numbers of computers just for training sessions located in defined places for this purpose. It was also notable that computer departments in KSUH and KFUH in co-ordination with university computer centres, provided training courses. KAUH had fewer training programmes due to a lack of computer staff. All the University Hospitals used in-house as well as external training, regardless of the number, or the knowledge and experience of their ICT staff.

Regarding exploitation and utilisation of ICT resources (hardware and software), interviewees remarked that each university has its own experience but the general response was that their current ICT resources were insufficient. They still need some hardware and software applications in order to operate their network and to meet their end-users' needs. It is worth noting that a lack of funding and ICT specialists were the most important reasons for not utilising and exploiting their ICT efficiently.

6.5 National Computer Network Director and Internet Services Director in KACST

In order to obtain a full picture of the pertinent issues, interviews were conducted with outside bodies. Their opinions were captured. In KACST two senior managers (National Computer Network Director and Internet Services Director) were interviewed at the same time, as the tasks they provide are complementary.

National ICT Policy and Services

Throughout the world, science and technology is fundamentally important to the material advance and socio-economic development of nations. There is constant competition between nations to develop national networks. Developing countries are also making progress on the building of own national networks, and this highlights the fact that Saudi Arabia has set long-term objectives to guide the development of science and technology in the Kingdom according to the overall objectives and strategic principles of the seventh Plan. The set of policies that will be adopted during the seventh plan will be completed by the end of 2005. However Saudi Arabia has as a programme aim to prepare a national master plan for science and technology, as well as establishing an adequate mechanism for the proper co-ordination of scientific and technological activities among different agencies.

In terms of services, interviewees stated that there are various information services and facilities that are available to universities and to the public as well. For example:

- basic services: remote access, email and file transfer,
- on-line database services, nationally and internationally,

- databases that can be searched by academics and which are divided into four separate databases.

When the interviewees were asked to what extent these services were being exploited, they indicated that there was more resource available than was being used. However, they are planning to improve and market their services more actively in the near future. The interviews additionally revealed that only some universities use their services and databases. Some universities do not take advantage of KACST services due to their poor network infrastructure. In order to bring all Saudi universities to the same level and in order to take full advantage of the high technology, KACST provides a number of services. It provides adequate training programmes for university staff via seminars and/or visiting and instructing on site. KACST also offers technical support to all Saudi universities upon their request.

Moreover, interviews revealed that computer services in KACST are not fully exploited and utilised by Saudi universities. There are number of limitations on the use of computers and networks services in higher education in Saudi Arabia universities such as the fact that some end-users are not qualified to use computers and telecommunications. In actual fact, some of those end-users are not aware of the services while others do not have enough skills to use computers wisely. There are also certain difficulties in downloading applications and transmitting works that contain images graphics and/or scanned pages. Further problems including difficulty with public telephone company network and a lack of training programmes for end-users to encourage them to get the most out of KACST services so that they are able to make greater use of the network resources. Finally, there is a lack of suitable networks in some universities.

ICT provision and expectations

Regarding ICT provision and expectations concerning the connection of all Saudi universities electronically, interviewees stated that computer and related sciences have changed the world in many ways. More than that, due to the revolution in technology and mature growth in computer networks, it is possible to connect all Saudi Universities electronically and some universities in Saudi Arabia are already connected to the Internet. Saudi Universities have qualified and professional staffs in computers, who pursue their higher studies in advanced countries and these, are the people who will facilitate and guide the universities to adopt and implement sophisticated technology and exploit ICT efficiently and effectively. Therefore Saudi Universities expect to use sophisticated technology such as teleconferencing and telemedicine in the near future. Interviewees however, express their concern regarding certain obstacles such as the high cost of technical problems with establishing and running a national computer network and the fact that the success in establishing a national computer network system is not guaranteed. Furthermore, the level of co-operation in establishing and managing networks is difficult to forecast and there are concerns regarding security, computer crime, and the ability of the Saudi Telecom (STC) in providing dedicated lines with high speed for universities.

Key issues

The interviewees also revealed certain potential problems and obstacles associated with the networking of universities with KACST. Those problems such as the fear that KACST has insufficient information technology manpower (e.g. programmers, system analysts and network experts) that can support network together with the concern that KACST is suffering from several organisational problems, as are other public organisations in Saudi Arabia. Further difficulties include insufficient funds to support the plan for a national computer network system, a lack of co-operation and co-ordination among Saudi universities in general and the fact that university management bodies and their views regarding ICT in education vary from one university to another. Furthermore, the interviews show that there is concern regarding the technical problems that revolve around hardware and software compatibility, and the lack of end-users' computing and networking knowledge and experience. In fact, these problems (technical, organisational, behavioural, etc.) can be seen as interrelated and multidimensional.

To encourage university users to use ICT effectively, interviewees pointed out that KACST plans to upgrade its network and expand its services. The on going plan is to provide on-line education and training for all university staff as well as the public. Also, it plans to deliver accurate, convenient and up -to- date information about the services it offers, finally, to offering support, advice and guidelines to all who need it. Moreover, KACST expects the utilisation of their ICT services to improve with better management in the university, and additionally, these services will be more active in the near future than nowadays.

6.6. Internet services manager in Saudi Telecommunication Company (STC)

A Senior Internet services manager from STC was interviewed in order to understand the present and future plans regarding Internet services in Saudi Arabia.

The role of STC and Internet Services Providers

STC is developing a high-speed network connecting most parts of the Kingdom together. Currently, the main regions of the Kingdom are covered by this backbone with expansion planned for the remaining regions. Internet Services Unite (ISU) and all ISPs are connected to the national backbone that carries Internet traffic inside the Kingdom and to the International Link. The interview indicated that the role of the STC is to build the infrastructure that will support data transfer in all formats, including the Internet, Telemedicine, e-commerce and other data transfer-related networks. Additionally, the role of the ISP is to sell services to end-users and to authenticate and validate their access to their routes and other applications like data hosting, web page design, promotion advertisement, etc.

Achievements

The Internet services manager was asked to point out what has been done during Phase (1) regarding the Internet and what problems are associated with Internet. He claimed that during Phase (1) KACST was connected to the Internet, which provided a national backbone network. Also, they provided a dial-up access for up to 5,000 subscribers from different cites and connected the seven universities. Moreover, he also emphasised the Internet service was launched in January 1999 including:

- national ATM network and International links connected,
- 5000 ports installed ,capable of supporting 75,000 subscribers,
- PSTN network connected to 6 cities in Saudi Arabia,
- 29 ISPs and 7 universities connected, and,
- dial-up access provided without adding congestion to the PSTN network (via an overlay network).

Phase II, which is also implemented, expands the network to cover more than 91% of KSA. Phase III is under way. This will cover 100% of KSA plus enhancing the services, adding more quality and capacity to the network. The Internet manager revealed that at the time of the interview (February 2000) the following targets had been accomplished:

- 91% of KSA is covered by the Internet and 15,000 ports are in operation,
- There are more than 3 gmbts + 15 EI connections to the WWW,
- Internet network operation centres are in operation (24x7), and,
- Many hospitals, banks, newspapers, companies and Internet cafes are connected with leased lines with different speeds (64 – 128 – 512 etc.).

Following up those targets in May 2000 the Head of the Saudi Net team in STC revealed that Saudi Arabia had achieved 100% Internet coverage by the end of 2000.

Key issues

The interviewee was asked to identify future issues associated with the Internet, together with future plans regarding these issues. He raised the problem of slow downloading time as a concern. In response to this there is a plan to increase bandwidth to 'WWW' and KACST has been asked to improve their route operations. There is limited access from old analogue exchanges, so routing needs to be upgraded where possible and a scheduled replacement program needs to be put in place to remedy this limitation. The number of ISPs in May 2001 is very high for the amount of Internet traffic (26), thus the demand for bandwidth availability is also very high. Finally, a crucial issue is the lack of an appropriate ICT skill-base and trained human resource.

Technical specification

The Internet services manager identified the existing baud rate and bandwidth available routinely throughout the Kingdom. The baud rate is 56 KB/sec and the bandwidth reaches the international standard of 34 MB, expandable to 155 MB.

Resources

The Internet services manager was asked when the information infrastructure would be ready for the hospitals' information system. He emphasised that it is available today but, ICT will be cheaper and faster in the near future. The interviewee was asked if the STC intended to charge for the use of their information infrastructure. He stated that "we have a circles charge but data are the responsibility of others". Finally, the Internet services manager believed that STC will benefit from their investment in health care because of selling more bandwidth for health information system applications.

6.7. Round up of interviews undertaken

From the interviews conducted and reported in this chapter, certain conclusions can be reached regarding the opinions of respondents concerning the current ICT situation within the universities and the Saudi University Hospitals.

It was generally agreed that the provision of ICT resources and services varied a good deal among the universities studied. For example, Internet connection was very limited at KAU and KAUH was not yet linked to its University Computer Centre while other centres, KSUH for example, considered its connections as reasonable. The precise configurations of each university's computer technology are presented in the chapter but this variety was generally seen as a problem since the availability of certain services was patchy and provision uneven. KSU campus and KFU were locally networked, while KAU particularly connected.

Whatever the level of provision, respondents were generally not satisfied with the systems available in their institutions. Computer Directors felt that their resources were insufficient, pointing to a need for more hardware and software in order to meet users' needs and to operate system effectively. University Hospital Computer Department Managers also mentioned that their existing systems did not match their needs and that more network connections were needed, while Deans of Medical Schools confirmed that they felt resources were generally inadequate. However, the Internet Services Manager at STC seemed to be reasonably satisfied with the services provided, stressing the facilities already provided while the respondent from KACST asserted that more resources were available than were presented being used. In contrast, however, both Deans of Medical Schools and University Computer Directors mentioned that they were presently using only 50% of their full capacity. All respondents were eager to see developments and expansion in their present provision, feeling generally that increased use of ICT by a greater number of users was a necessity in the modern age in order for Saudi Arabia to keep up with development in the 21st century.

Respondents focused on a number of problems, which hindered the effective use of ICT in their present situations. Common complaints were a lack of suitably qualified personnel both to operate systems efficiently and to train others in the systems' uses and applications. Training and education among the institutions will be further discussed later, but the issue of personnel, either in terms of an overall shortage, or in terms of those whose skills were inadequate or inappropriate, was a major concern of almost all the interviewees.

Insufficient and/or inappropriate resources were also mentioned by the majority of respondents, together with the concern that, since technological changes are taking place so rapidly, resources often become out-dated quickly or need regular up-dating.

Moreover, most respondents commented on a variety of technical difficulties they faced regarding their present ICT infrastructure. University Computer Directors specifically noted difficulties surrounding hardware and software compatibility and similar complaints were made by other respondents, including problems concerning the maintenance of present systems. Systems were often unreliable, staff did not necessarily have the expertise required to keep them running and maintenance through suppliers was often difficult to come by and/or very expensive. Furthermore, the STC representative admitted that there were problems with the speed at which information was down-loaded (it was very slow), and although there are plans to alleviate this problem in the future, the slowness of the system is still a hindrance at present.

All the respondents recognised that the changes, developments and expansion of the infrastructure and services they desired cost money and there was general concern about funding throughout all the institutions surveyed. Anxieties were voiced generally regarding the levels of funding which were felt to be insufficient to allow the proper running of the present systems, to train sufficient staff to adequate levels of expertise, and to keep up with the pace of technology by expanding and up-grading the systems which are available. For example, KFHC has two connections with hospitals in the USA but wishes to expand this facility while KSUH had a system for teleconferencing which was cancelled due to lack of funds. Not only were the respondents keen to keep up with new technological developments, they felt that their institutions would be left behind if sufficient funds were not made available. Deans of Medical Schools, for example, felt that new high-tech methods for the maintenance of patients' records would considerably aid their ability to provide an efficient and effective service; for instance Dean of Medical School in KFUH was also keen to use smart cards. These advances will not be possible without increased levels of funding. A further problem, which was widely mentioned, was security, with a number of respondents raising issues of confidentiality and the privacy of data.

The respondents from all the institutions were asked about education and training. The respondents indicated that training was available in all the institutions covered at a generally elementary level. For example, universities all offered basic training courses in the use of ICT while hospital departments, while providing basic training, acknowledged that one problem was that staff had different needs and, therefore, some training needed to be highly specialised. In other words, whilst basic training was useful for most users, specialist needs were often more difficult to cater for. Furthermore, some institutions, such as KAUH, had fewer facilities to begin with, and was, therefore, less capable of offering a wide range of training.

Methods of training varied slightly but most institutions offered leaflets, individual tutorials, and/or formal group sessions. Topics covered also varied, bearing in mind the comment above concerning a variety of needs, but generally consisted of basic computer skills, guidelines to the facilities on offer, Internet training etc. University Hospitals also ran courses on entering and retrieving medical data and a small number of computers were available solely to address this need. Training was generally offered both in-house and from outside providers though KACST asserted that these training services were not fully utilised. As a result, all respondents commented on a general lack of skills or awareness of facilities on the part of users. Poor user skills were seen as a major obstacle to the effective use of the ICT facilities available in the institutions.

Further contributory factors to the perception that users' skills were often poor were that several respondents noted a lack of enthusiasm for ICT or negative attitudes towards computer technology. The Deans of Medical Schools, for example, mentioned that some employees were reluctant to change their methods, viewed new technology with suspicion and were therefore not inclined to take part in training in order to enhance their skills.

University Computer Directors and Hospital Computer Department Managers both explained that purchases were made via an IT committee. Demands initially come from departments themselves and are passed to an equipment sub-committee, which, in turn, refers these to the IT committee for acceptance or refusal. Purchases are funded through the university's own budget and are usually made through well-known suppliers, such as

IBM which provides a good support and maintenance service. Each university has its own IT committee and HIS manager is a member of that committee. In KSUH the Vice-Dean usually represents the hospital on the IT committee and HIS manager require to submit a quarterly report to the Vice-Dean. End-users committee was just found in KSU. There is no link with any kind of national policy although universities follow the policy of KACST concerning Internet access and KACST, in its turn, follows international protocols. These policies are monitored to check they are adhered to.

Several problems concerning the policy and organisation structure were noted. For example Computer Department Manager in KAUH was willing to report to the Dean of Medical school. Managers and directors mentioned that it was often difficult to obtain financial support and the lack of co-operation among universities and University Hospitals meant patchy and inconsistent application of policies. Furthermore, Computer Department Managers from University Hospitals felt that top management was often inadequately informed about developments in ICT and its possible advantages. Deans of Medical Schools, however, considered the University Hospitals' Committee, chaired by the Ministry of Higher Education, to investigate a wide range of issues regarding the development of cohesive ICT policies and procedures in the institutions. STC seemed confident that its planning (Phase I and II already being implemented and Phase III now under way) would aid the improvement of ICT services across the Kingdom.

Formal meetings among the University Computer Centres have been on-going since 1999, but otherwise, co-operation and co-ordination is limited even though there is general agreement that working together is essential in the future. All respondents felt that the technology now exists to make co-operation possible and, further, that there was a general willingness to co-ordinate efforts. Some doubts remain, however. KACST respondents noted a varying level of interest among university management bodies although the hospital managers and University Computer Directors seemed enthusiastic regarding links.

6.8 Summary

Evidence from the semi-structured interviews provides supplementary findings to the analyses of questionnaires on issues to be addressed in the future. That is, the issues at each site revolve around technical problems, lack of suitably qualified personnel, poor user skills and insufficient levels of funding for required ICT infrastructure and training.

While the universities and hospitals are dependent on funding in order to plan future development relying largely on co-operation to expand their services, KACST has a strategic plan to update and increase its facilities by linking with industry. Together, KACST and STC plan to provide on-line education and training for all university personnel and members of the public. An increase in marketing functions is also indicated in the strategic plan as it was noted that users were often unaware of what services were available. With such initiatives, together with the development of advice and guidance opportunities, KACST feels confident that greater use would be made of its services in the future.

The STC representative noted the company's intention to upgrade or replace outdated equipment, expand its Internet services and increase the capacity of the LCAs (Leased Circuit Applications). ATM and ISDN services will also give the populace of Saudi Arabia more access to the Internet. The STC respondent asserted that cheaper, faster services would be available in the near future although he could give no indication of the likely cost of these which, since the majority of respondents highlighted insufficient funding as a major stumbling-block, is a crucial factor.

It can be concluded that Saudi Arabia has a rapidly growing economy with a great potential for developing ICT. Findings from the interviews concur with those from the questionnaires in that staff in KFUH and KSUH have more computer experience than those in KAUH. Again, there is a consistency between questionnaire response and interviews which indicate that the underlying reasons for this finding comprise: lack of resources and the fact that KAUH has recently moved into a new building.

A notable difference between questionnaire findings and interview analysis is that the sample of the population interviewed had a more negative view of ICT user experiences than the study population. This bias could have arisen in the nature of the sample interviewed – all were heavy users of ICT and therefore had more occasions for accumulating bad experiences.

The collected findings of the questionnaire, document analyses and interviews contribute to the description of SSM Stage 1: Problem situation unstructured. They are used to define current practice from which systemically desirable and culturally feasible changes will be determined. The methodology of moving from one to the other is described in detail in the next Chapter.

Chapter 7
Application of the Soft System Methodology in Saudi University Hospitals

7.1. Introduction

The previous Chapters highlighted the current situation and noted the most important issues in the University Hospitals in Saudi Arabia studied. This Chapter will apply SSM to ICT in Saudi University Hospitals. It defines the system of interest and issues associated with the establishment of a computer network. This work is placed in a wider context to define the elements of the wider system of interest and the system environment. Collectively, they form stage 1, the problem situation unstructured of the SSM. A rich picture (stage 2 of SSM) is drawn to highlight the issues raised in a structured way. Relevant systems are identified and six are then put forward for further system enquiry. Root definitions (stage 3 of SSM) of all six relevant systems identified are formulated and subsequently tested using CATWOE analysis. This chapter closes with a conceptual model for each of the root definitions (stage 4 of SSM), thus allowing an agenda for change to be cast (stage 5 of SSM).

7.2. System of interest

A computer network system has become an effective way to exchange information. It can provide both internal and external benefits to any organisation by speeding up the exchange of data and can reduce cost by avoiding double entry of data. The data collected from the empirical study indicates that Saudi universities have each built their own computer network systems without co-operation among themselves.

Respondents also expressed concern about the lack of skilled IT staff, lack of funding, technical issues, lack of training and lack of top management support. It was surprising that there is a lack of empirical research on the problems encountered by University Hospitals in their attempts to establish and manage a computer network system.

The central theme of this research is to investigate the current situation in Saudi Arabia regarding the establishment of a computer network system to exchange medical information electronically. As a result of this research, a novel information system has been proposed. This is termed 'Saudi University Hospitals Network System' (SUHNS). The proposed system will enable Saudi University Hospitals to exchange medical information, knowledge, and expertise for better health services provision. SUHNS will link all Saudi University Hospitals together. It should form part of a proposed Saudi National Health Network System (SNHNS). It is anticipated that the proposed SUHNS will bring about the following advantages:

1. better co-operation between university hospitals in exchanging medical information, knowledge, and expertise,
2. eliminating time, cost, distance and volume barriers, by providing remote access on-line to services, specialists, care and information needed,
3. conducting telecommunications and electronic conferences among special interest discussion groups, (e.g. videoconferencing, teleconferencing),
4. connecting national information resources efficiently and effectively,
5. providing health care professionals with 24 hour on-line access to relevant information from patient records,
6. providing around-the-clock access for patients to access their own medical records,
7. providing on-line education and training in informatics for clinicians and managers,
8. disseminating medical information in general,
9. giving medical and nursing staff instant access, at their desks or at the bedside to the most recent medical research and treatment practice,
10. ensuring smooth flows of information both vertically and horizontally,

11. sharing knowledge and other medical services, by providing every health care professional with on-line access to the latest knowledge (state of the art) on treatment, and the information they need to evaluate the effectiveness of their work and to support their professional development, and,
12. providing fast, convenient, accurate, and up-to-date general information (e.g. advice on hygiene, fitness, life style and health) for the public through an on-line information service.

7.3. Stage 1 SSM: problem situation unstructured

According to the soft system approach, stage one and two are concerned with finding out as much as possible about the problem situation and from as many different affected people as possible. Many different viewpoints will be investigated and it is crucial to acknowledge as many of them as possible, as mentioned in Chapter 4. A clear picture was gained through direct observation (see Chapter 2) as well as through data and information collected at each of the sites visited. Problems and issues were discussed intensively at every opportunity in the fieldwork. Soft and hard information regarding the organisations and individuals, such as number of staff, organisational structure, reporting channels, line of responsibility, was collected as well.

The first stage of SSM involves the examination of the background of the problem. This can be achieved by taking note of the literature reviews undertaken (Chapter 3 and Chapter 4), and data and information from the empirical study (Chapters 5 and 6). An understanding of the wider aspects of Saudi Arabia also aids this stage of analysis. This includes for example, the cultural issues that dominate technological change.

Wider aspect of Saudi Arabia

Saudi Arabia is the largest country in the Middle East. It is located in Southwest Asia, and has an area of about 865,000 square miles. The country is divided, geographically, into five major regions. In 1990, the population was estimated at seventeen million. However, about four million of the population were foreign employees. It is one of the richest developing countries in the world.

The political system of government identifies the nature of the State, its goals and responsibilities, as well as the relationship between the ruler and citizens. The King, who also acts as Prime Minister, ensures the application of the Shari'ah, the State's general policy and supervises the protection and defence of the nation. The King appoints the Crown Prince. Members of the Council of Ministers assist the King in the performance of his duties. In defining the relationship between the ruler and the people, the system emphasises the equality of all Saudi citizens. All citizens are also equal before the law.

The Ministry of Health is the government agency with overall responsibility for healthcare in the Kingdom although a number of government agencies provide health care services directly to their employees. The National Guard, the Ministry of Defence and Aviation, and the Ministry of the Interior and University Hospitals provide primary, secondary and advanced levels of health care directly for their staff and segments of the general population. High-level specialised health care is provided in the Kingdom by specialist hospitals. University Hospitals provide primary and specialised healthcare services, conduct essential health research and provide medical education programs.

The Saudi government is committed to providing a high standard of healthcare and disease prevention in Saudi Arabia. The Ministry of Health has made progress during the past 30 years. Nowadays the Ministry's strategy is to give the people and residents of Saudi Arabia the best system for healthcare and to improve healthcare for everyone. The Ministry is working towards establishing a national database to store and retrieve information, which could be used for planning and improving healthcare.

Ministry of Higher Education

The Ministry of Higher Education was established in 1975 to address the needs of higher education in the country and to carry out the improvements that were needed. The rapid growth in higher education has been accompanied by a number of problems, which are limiting the overall effectiveness of the higher education system. The Ministry of Higher education takes full responsibility for Saudi universities.

Saudi Universities

Saudi Arabia has eight universities. All Saudi universities are funded and supervised by the Ministry of Higher Education. The three universities that have hospital attachments will be covered in this study: King Saud University, King Faisal University, and King AbdulAziz University.

King Saud University

King Saud University was founded in 1957 as the Riyadh University and renamed in 1982. It has more than 2,500 teachers and more than 31,000 students. It is one of the first institutions of higher education in Saudi Arabia. It has on its register more than a quarter of all the Kingdom's university level students (male and female) and more than one-third of all the Kingdom's university and administrative staff. There is also, a College for Graduate Studies, a centre for Women's University Studies and Arabic Language Institute, a centre for Continuing Education and an Institute of Languages. There are Colleges of Administrative Sciences, Agriculture, Agriculture and Veterinary Sciences, Arts, Computer Sciences, Dentistry, Economics and Administration (in Al-Qasim), Education (also in Abha), Engineering, Allied Medical Sciences, Pharmacy, Science and Medicine (also in Abha and Al-Qasim).

King Saud University Hospital (KSUH)

King Saud (Khaled) University Hospital was established in 1982 as a University Hospital and started with 29 clinics and a capacity of 297 beds. It has developed over the years into a modern hospital and its capacity and number of beds has increased. Today there are 870 beds in operation. There are 13 departments. It is one of the largest hospitals of its kind in the Middle East region. Roughly 50% of activities are devoted to patient care and the remainder to education and research. The University Hospital has an established academic computing network.

The King Faisal University

King Faisal University in Dammam and Hofuf, was founded in 1975 and has some 500 teachers. The total student enrolment in 1999 was 8,126. It has eight faculties and more than 11,000 students. It has two campuses, the first campus in Hofuf in Al-Hasa, which comprises the Faculties of Agriculture, and Veterinary Medicine and Animal Resources. The second campus is located in Dammam and consists of the Faculty of Engineering and Faculties of Medicine and Medical Sciences (established with the educational co-operation of Harvard University).

King Faisal University Hospital (KFUH)

King Faisal University Hospital was established in 1981 as a University Hospital with a capacity of 430 beds. In 1997 it was extended and more departments were opened. Today there are 16 departments such as outpatient clinics. There are a number people including faculty members working within the hospital. Approximately 640 are physicians engaged in patient care, education and research. KFUH has well established computer facilities and possesses a fully integrated hospital information system, which is the only one of its kind in the Gulf States.

King Abdulaziz University

King Abdulaziz University was founded in 1967. It was established initially as a private university and converted to a state university in 1971. It has 2,071 teachers. It has the following faculties: Arts and Humanities, Dentistry, Earth Sciences, Economics and Administration, Education (in Medina), Engineering, Marine Sciences, Meteorology, Medicine, and Allied Sciences. The University awards Master's degrees in Earth Sciences, Economics and Administration, Education, Humanities, Marine Sciences, Meteorology and the Environment, and Sciences. It awards Doctorates in Earth Sciences and Education.

King Abdulaziz University Hospital (KAUH)

King Abdulaziz University Hospital (KAUH) was established in 1977 as a University Hospital with a capacity of 36 beds. It has developed over the years into a modern hospital and increased its capacity to 274 beds in 1997. Today there are 315 beds in operation but as the actual capacity is 797 beds, the institution is prepared for a significant further expansion. There are 23 departments with 1,134 people working within the hospital. Approximately 790 are medical staff, 128 of these are physicians and 14 are pharmacists. Approximately 50% of activities are devoted to patient care and the remainder to education and research.

7.4 Stage 2 SSM: problem situation structured

This is the stage where the problem situation is expressed in order to get the rich picture. Data about expectations and opinions of end-users, concerned organisations and their managers opinions were collected. The survey employed questionnaires, which were directed to the information users, and semi-structured interviews that were directed to hospital computer department managers, university hospital managers, university computer centre directors, and information suppliers (KACST & STC).

After the collection and analysis of data, the application of SSM was continued. During the analysis stage the starting point is thinking about the 'problem content' and 'problem-solving' system. The role of the 'problem-solver' here explains the problem content system and then applies SSM to take action to solve the problem or to explain it again on behalf of the problem owner. The relationship between the problem solving and the problem-content systems is depicted in Figure 7.1.

In this study the researcher who has experience with Saudi organisations and has knowledge of information systems occupied the role of the problem-solver. Other key roles include the research supervisor Professor Ron Summers, who contributes his experience with the methodology, system modelling, information system, and health informatics. Professor Checkland also contributed his experience with SSM in his continuing writings. The researcher, as the problem-solver, has some resources such as the combined experience of the participants, evidence from the survey and a scholarship for 3 years. However, the constraints on the problem-solver include satisfaction of the requirements of higher education and the submission within a limited time period.

Information users, information professionals and information suppliers, in general Saudi Universities, occupied the role of the problem-owner. The determination of three elements (structure, process and climate) as summarised by Checkland (1981) leads to the questions, which are central to the problem situation relating to, for example, the notion of the Saudi University Hospital and the role of problem owner(s) and attitudes.

The answers to such questions were either obtained from the interviews or suggestions from the researcher himself based on general knowledge. These responses lead us to the rich picture.

An important point in the present study was the identity of the client. In most of the previous studies (e.g., Bember, 1985, Al-Hasan, 1992, Goossen, 2000 and Suhaimi, 2001) the client organisation who commissioned the work clearly owned the problem and

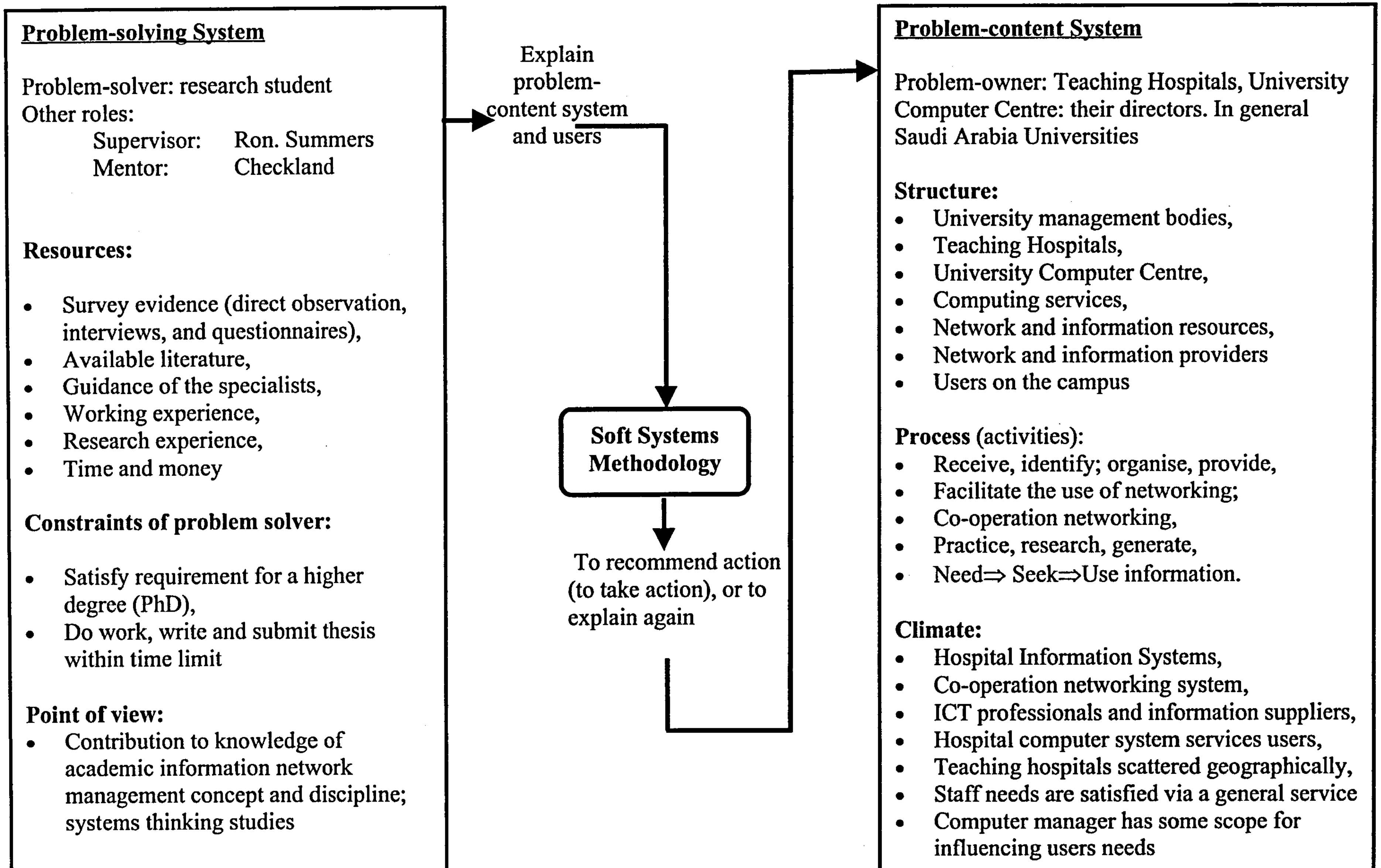


Figure: 7.1 The relationship between the problem-solving system and the problem-content system was responsible for taking action to solve it. In this study there are problems, which cannot be owned in this sense. According to Checkland, the 'client' is someone who wants to know or do something and commissions the study. The implication is that he can cause something to happen as a result of the study. The client does not exist in this sense in the present study. Instead there are several partial clients, each displaying some of the above characteristics to some degree which when taken together constitute 'the client'.

In this study the client exists but in a diffuse form, not as a single person or organisation. These partial clients are the researcher, university hospital professionals (e.g., physicians, nurses, managers), patients, the public, the Saudi government and the real-world University Hospitals. The researcher commissioned the study by selecting the problem initially, but is not in a position to take action as a result of it. The ICT profession may take action when it becomes aware of the study, but is not required to do so.

It is true that the University Hospital Managers and University Computer Centre Directors or the Saudi government may take action and they could commission a follow up study if they wish to do so. Again they may have taken action as a result of this study because they are most likely to derive benefit from it. This view is further explored in Chapter 8. Therefore, the present systems study concludes with recommendations about possible changes to improve the problem situation, which are based on the output of the comparison stage followed by discussions and debate with key people (change agents) about changes and action to improve the problem situation.

The 'problem situation structured' is represented by the formation of a 'rich picture'. According to Elliott and Starkings (1998), a rich picture diagram aims to highlight the primary purpose of the organisation at high levels and to identify the issues which matter and are of concern in the development of an efficient and effective information system. As mentioned in Chapter 2, a rich picture should take into consideration all issues related to the system's environment and boundaries. However, it should address people, organisation technology and both internal and external political issues. It should include both hard facts and soft information about the organisation's situation.

A rich picture uses graphics and symbols to express the issue within the system boundaries. Key elements in such a diagram include, for instance, organisational structure, formal role leadership and communications channel, as well as informal elements such as conflict or the mutual perceptions of the people who are involved in the rich picture. There are various ways of compiling a rich picture, and different people do it in different ways. More precisely, in this study the diagram highlights the participants who are affected in this research. Those participants include university management bodies, university computer centre managers, university hospital managers (Deans of medical schools), hospitals computer managers and medical and computer staff.

In this study structures of the problem situation contain the following main actors: University management bodies, university computer centre managers, university hospital managers, hospitals computer managers and medical and computer staff. All those actors are problem 'owners'. Current problems and expectation of some of the actors are represented in think bubbles. Moreover, external perspectives, which affect the problem situation, such KACST, STC, the Ministry of Health, private hospitals and Ministry of Higher Education etc. are represented.

In terms of process there is more communication between all these actors. There is need to organise network services and educate end-users to gain the required knowledge and skills to use campus facilities effectively. Moreover, there is a need to provide information and network facilities in order to exchange medical information for educational and health care purposes. However, there is evidence of conflict between actors, as illustrated from facts available via the available literature, evidence from the survey and direct observation.

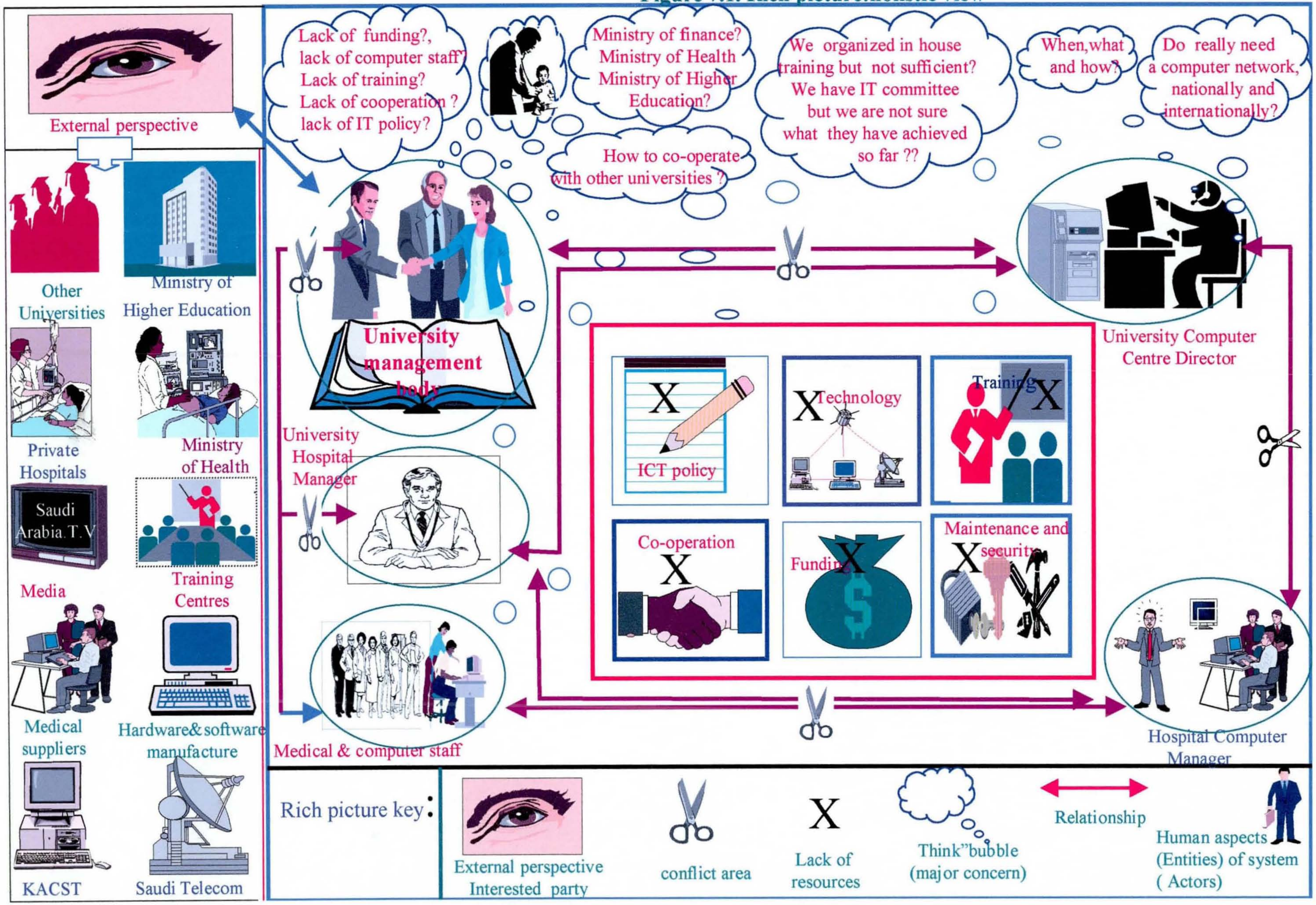
Consequently, in this study data collected via different methods (e.g. interviews, observation, etc.) are represented in the rich picture and summarise the problem situation that increases its understanding. Drawing the rich picture has proved to be a particularly effective way of representing issues concerning the problem situation in Saudi University Hospitals. The rich picture drawn from the evidence provided is shown in Figure 7.2.

Elliott and Starkings (1998) believe that there is no universal set of symbols and any picture that seems to be appropriate can be used. Therefore, in this research, a human figure is used to represent the key actors in the system. Scissors indicate some form of conflict and think-bubbles indicate the major concerns of the participants with the computer network system.

The most important issues were gathered in one box and linked to each actor via think-bubbles, which indicate their major problems. More to the point, a case with X and a dollar sign indicate a lack of money, while shaking hands with X point towards a sign of lack of harmony or co-operation and communication. Blank paper and a pencil with X implies the lack of an ICT policy. A computer and satellite with the X sign means lack of technology. A group of people sitting in front of empty screen with the X sign indicates a lack of computer training programmes. Technician tools (e.g., screwdriver, wrench, hammer, etc.) and a lock with keys and an X indicates a lack of maintenance and security and finally, X sign means a lack of resources. Some of the actors are represented according to their characteristic features, such as those wearing doctors' coats and using computers describe medical and computer staff respectively.

Those parts of the environment that affect the problem situation, such as the influence of external perspectives, are represented in the diagram by big eyes. STC was considered because the STC role is to build the infrastructure that supports data transfer in all formats including the Internet, Tele-medicine, e-commerce and other data transfer-related network and to sell services to the end-users. Additionally, KACST is responsible for technology policy and acts as the Internet gateway. The Ministry of Health and private hospitals consider the university as the main resources for research and technology,

Figure 7.1. Rich picture:holistic view



which will improve health care in Saudi Arabia. All universities attain their budgets and support via the Ministry of Higher Education. However, hardware and software manufacturers, training centres and medical suppliers are watching development in order to sell their services and products

7.5 Stage 3 SSM: Root definition

In the previous stage, the rich picture allows for an improved understanding of the problem situation. This stage of the SSM provides a systemic way of viewing the expressed problem situation. Relevant systems are the constructs that allow the expression of this systemic perspective. A relevant system is not a system to solve the problems inherent in the situation from which it stems nor is it a system that will be designed and implemented in the real world. In fact, its function is to provide an alternative way of seeing the problem situation which, when developed further, will provide the analyst with a way to improve the problem situation. In the case of this study, theoretical systems are proposed that seem relevant to the development of a computer network system for Saudi University Hospitals. The system does not deal with an existing computer network system, rather gives an insight into what will be possible in the future.

In this stage, the analyst will be able to produce insights into the problem situation by investigating different ways of looking at what is going on, what the issues are and what the system aims to achieve. This is done, not in a strictly mechanistic way, but by taking account of the persons who could be affected by the system and who could affect the system in some way. Root definitions can be used to define issues and systems. It is essential for the systems analyst to know precisely what human activity system is to be dealt with and what issue is to be tackled. The root definition is a precise description of a human activity system, It is the point at which it is necessary to choose a way of viewing the problem situation. This is done by naming some notional systems, which seem to the analyst to be relevant to improving to situation. However, there are two different types of systems that can be described by a root definition, primary task and issue-based systems.

In this study the primary task is to create a computer system to transfer medical information between Saudi University Hospital in order to improve health care and improve the higher education system. Matters of concern and subjects of dispute are also captured by the SSM in this study. For example, Saudi culture, regulations, social and political pressures, end-users acceptance, system success and failure, technology change, network infrastructures, hardware/software, security, confidentiality and resource constraints are considered.

In order to know whether the root definition regarding each identified relevant system is complete, Checkland's CATWOE test is used. As result of the initial step in Stage 3, six relevant systems emerge:

- strategic management relevant system,
- funding relevant system,
- communication relevant system,
- technology relevant system,
- maintenance and monitoring relevant system, and,
- end-user training relevant system.

The formulation of the root definition can proceed for each relevant system identified. An overarching root definition has also been attempted, formulated as follows:

"A Saudi Universities owned computer network system for University Hospitals to facilitate the exchange and sharing of distributed medical information in all of its forms, by means of providing national and global high speed access to information for concerned users in order to achieve improved healthcare standards set by the Government."

Therefore, the root definition is tested against a group of elements known by the mnemonic CATWOE. This defined checklist is for, Customers, Actors, Transformation Process, Weltanschauung (Worldview) Owners and Environment. Invoking the CATWOE for a national computer network system for University Hospitals in Saudi Arabia, results in:

C: University hospital professionals (e.g. physicians, nurses, paramedical, medical technicians, managers, pharmacists, and computer staff), patients and the public.

A: Computer network and ICT professionals (System administrators, network administrators, network technicians, programmers and systems analysts).

T: The need for transformation from a manual operation to an electronic operation.

W: The need for adequate computer network system that offers and exchange all medical information in order to meet users' needs and to improve health care and the education system in higher education in Saudi Arabia.

O: Ministry of Higher Education and University management bodies.

E: Environmental constraints: Saudi culture, regulations, social and political pressures, speed of growth of technology, university regulations and policy, network infrastructure (existing network), hardware and software, human computer interactions, financial situations, budget constraints, hackers and software viruses.

7.5.1 Strategic management relevant system

Finlay (2000, p.16) defined strategic management as

> *"the process of managing the mix of goals and strategic pathways that serve to define what the organisation is (or wishes to be), where it's going, when it wants to get there and how in general it is to get there. It also includes the processes of monitoring and controlling the strategy of the organisation".*

For Saudi University Hospitals to establish a computer network infrastructure they should assemble a strategic management team. This team would help to co-ordinate planning, procurements, and implementation of the new network. The team should comprise key people in each site. The team should also consist of internal and external technical professionals, engineers, data services professionals, and telecommunications organisations. Efforts should be divided and subcommittees should be created such as medical committee, technical, administrative etc. The most important success factor in this ambitious project is the chairman of the board's vision and strong leadership.

The root definition of the strategic management relevant system is as follows:

> **"A strategic management team owned co-ordination system to provide a vision for computer network system by means of consensus decision-making in order to achieve a strategic plan for successfully establishing a computer network system between Saudi University Hospitals".**

A CATWOE analysis reveals:

C: University management and Hospital ICT professionals

A: Strategic management team and Hospital ICT professionals

T: Lack of co-ordination → co-ordination effort

W: Strategic management team have correct skills and experience; consensus decision-making is useful; strategy can be planned

O: Strategic management team

E: Saudi culture, regulations, social and political pressures, technology change.

The main requirements of the strategic management team can be defined as follows:

- establish an effective decision-making team that comprises actors from concerned universities, government, industry, and external consultants;
- to have effective decision making tools to facilitate consensus decision-making; and,
- to have each actor conversant with the latest ICT technologies
- to establish measures of effectiveness.

7.5.2 Funding relevant system

Funding is the most important factor for the success of any programme. Since the Gulf War in 1991, funding in Saudi Arabia for any project has decreased. Thus the university management body has had to reassess its budget in order to establish a computer network. In spite of this, the university management body should make special arrangements to cover capital expenditure and running costs for the network.

The root definition of the funding relevant system is as follows:

> **"A Saudi University owned system to procure the necessary financial resources for the proposed system by means of allocating a flexible operating fund in order to achieve sufficient support to enable the continued viability, planning, to procurement, implementation and support of the proposed University health net"**

A CATWOE analysis reveals:

C: University computer staff and Hospital ICT professionals

A: University financial management committees and Hospital budget holders

T: lack of financial support → well-funded activities

W: It is necessary for the University to establish and manage the system and its costs; to investigate the feasibility of alternative sources of finance

O: Saudi universities.

E: Saudi culture, regulations, social and political pressures, technology change, security and confidentiality, and budget constraints.

The main requirement of the funding conceptual model can be set out as follow:

- to determine sources of funding,
- to procure finances,
- to provide a flexible operating funds,
- to drive financial performance measurements, and
- to gauge the viability of University health net.

7.5.3 Communication relevant system

People need to communicate for several reasons, for example, to convey commands, information, education, skills, knowledge to others so they can be in position to act appropriately. However, all organisations need a communication network system to function properly. Communication can be one way or two ways: top down or bottom up, as well as laterally across the organisation. It is important for conveying the organisation mission, aims and objectives (Beardell and Holden 1997). Nonetheless, the survey indicates that a lack of communication and co-ordination was one of the most important problems among universities in Saudi Arabia. University Hospitals spend a lot of money on fax and phone expenses. Therefore, University Hospitals, in order to undertake this project should invest capital assets toward a new network infrastructure designed to limit the cost of communication yet provide flexibility for a fast response.

The root definition of the communication relevant system is as follows:

> **"A Saudi Universities owned computer communication system to deliver information at the right time in the right place by means of an integrated health information system in order to achieve effective communication across organisational boundaries within and between hospitals and the community".**

A CATWOE analysis reveals:

C: Hospital ICT professionals, Hospital staff, patient and public

A: Hospital ICT professionals and hospital staff

T: Poor communication $\rightarrow$ effective communication

W: Health information provides benefit; information can be shared; and resources are available

O: Saudi Universities

E: Saudi culture, regulations, social and political pressures, technology change, network infrastructures, security and confidentiality, and budget constraints

The main requirements of the communication model can be defined as:

- identify information and knowledge needs of a cross section of staff and patients(end-users),
- identify end-user software applications,
- organise services required to communicate electronically across organisational boundaries,
- deliver an effective communication mechanism, and,
- provide access to electronic networking .

7.5.4 Technology relevant system

Technology is playing an increasing role in Saudi society. Alter (1997) defines technology as computer hardware and software, scanning devices and telecommunication equipment. In this study, this definition has been adopted.

The root definition of the technology relevant system can be organised as follows:

> **"A Saudi Universities owned computer network system to provide a seamless connectivity and integration of data (voice + video + text) among University Hospitals by means of efficient sharing of information resources and communication channels in order to achieve an improvement in healthcare".**

A CATWOE analysis reveals:

C: Hospital ICT professionals and patients
A: Hospital ICT professionals
T: manual document management → electronic document management
W: Electronic document management system provides benefit; health is improved as a consequence of transformation; health outcome can be measured
O: Saudi Universities
E: Saudi culture, regulations, social and political pressures, technology change, network infrastructures, hardware/software, security and confidentiality.

The main requirements of the ICT model can be defined as follows:

- combine all data streams for efficient delivery to users,

- provide seamless connectivity between different data communication protocols,
- establish unified communication standards, (provide seamless connectivity between different platforms) or commit to an integrated hospital information system, and,
- understand the existing network infrastructure and the need to share resources.

7.5.5 Maintenance and monitoring relevant system

Once a new system is operational, it will be inevitable that changes will be required over time. All systems, if they are to be run efficiently, need to be monitored and maintained. Laudon and Laudon (1998, 2000) define maintenance as changes in hardware, software, documents, or procedures to a production system to correct errors, meet new requirements, or improve processing efficiency. Usually maintenance can be of two kinds (hardware and software) and can be costly. For example, Hussein and Hussein (1997) state that it is estimated that maintenance work consumes more than half of the resources available in an IS department. Therefore, to take full advantage of any system and make it run cost-effectively, it should be monitored and maintained professionally. The new system should be monitored and maintained without interruption. However, maintenance and monitoring should be organised with university computer centres and hardware and software suppliers, as maintenance support must be available anytime, anywhere. Universities should have their own maintenance team to carry out their daily tasks and improve their network services:

The root definition of the maintenance and monitoring system relevant system is as follows:

> **"A Saudi Universities owned system to maintain and monitor the effectiveness of the hospital computer network by means of hospital ICT professionals and university computer centre professionals in order to achieve a reduction in down time".**

This reveals the following CATWOE analysis:

C: Hospital ICT professionals, Hospital staff, Patients
A: Hospital ICT professionals, University computer professionals
T: Less effective $\rightarrow$ more effective computer network system
W: Use of performance monitoring is seen as beneficial; sufficient resource is available to maintain standards
O: Saudi Universities
E: Saudi culture, regulations, social and political pressures, technology change, network infrastructures, hardware/software, security and confidentiality.

The main requirements of the maintenance and monitoring conceptual model can be set out as follows:

- monitor performance,
- establish quality assurance criteria,
- determine problems and obstacles encountered,
- provide security privileges,
- assess and adjust network services, and
- prepare and organise IT specialists for network activities.

7.5.6 End-user training relevant system

The proposed computer network system will serve a wide spectrum of users. Each sector may have a specific need for information. Appropriate end-user training is very important for the effective use of the proposed distributed information system. In order to take full advantage of the new computer system, all University Hospitals should design adequate training programmes to keep their staff up to date in technological (and other) developments. Different training programmes should be designed to meet different end-users' needs. Induction courses also must be available to new staff to make them prepared to perform their new tasks.

The root definition of the end-user training relevant system is as follows:

> **"A Saudi Universities owned system to provide relevant end-user ICT training by means of defined computer training programmes that accord with University information policy and regulations in order to achieve the level of competency, required knowledge and skills for hospital and computer staff".**

A CATWOE analysis reveals:

C: Hospital and computer staff
A: Hospital and computer staff and ICT trainers
T: Adequate skills-set and competencies → enhanced skills and competencies
W: Computer training offers an enhanced understanding of technological change; this is desirable due to the explosion in medical ICT
O: Saudi Universities
E: Saudi culture, regulations, social and political pressures, technology change, network infrastructures, hardware/software, security and confidentiality, and budget constraints

The main requirements of the end-user training and education model can be outlined as follows:

- provide sufficient training tools and facilities,
- provide instruction guidance and manuals,
- provide suitable courses to cover specific topics, and
- provide well-qualified lecturers.

7.6 Stage 4 SSM: Conceptual Model

The fourth stage of the methodology is to build appropriate conceptual models of the human activity systems developed in the root definitions. According to Bocij *et al.*, (1999) and Checkland and Scholes (1990, 1999) this stage is a logical model of the key activities and processes that must be carried out in order to satisfy the root definition produced in Stage 3. It is, therefore, a representation of what must be done rather than what is currently being done. However, such a model should contain the minimum number of necessary activities to be the one named in the root definition.

The model displays the activities expressed by verbs connected in a logic-based order. The basic activities that can be defined by verbs in this study are as follow. Identify, organise communicate, deliver, and provide (Figure7.3). It was necessary to investigate end-users needs at the first stage to point out the minimum essential activities.

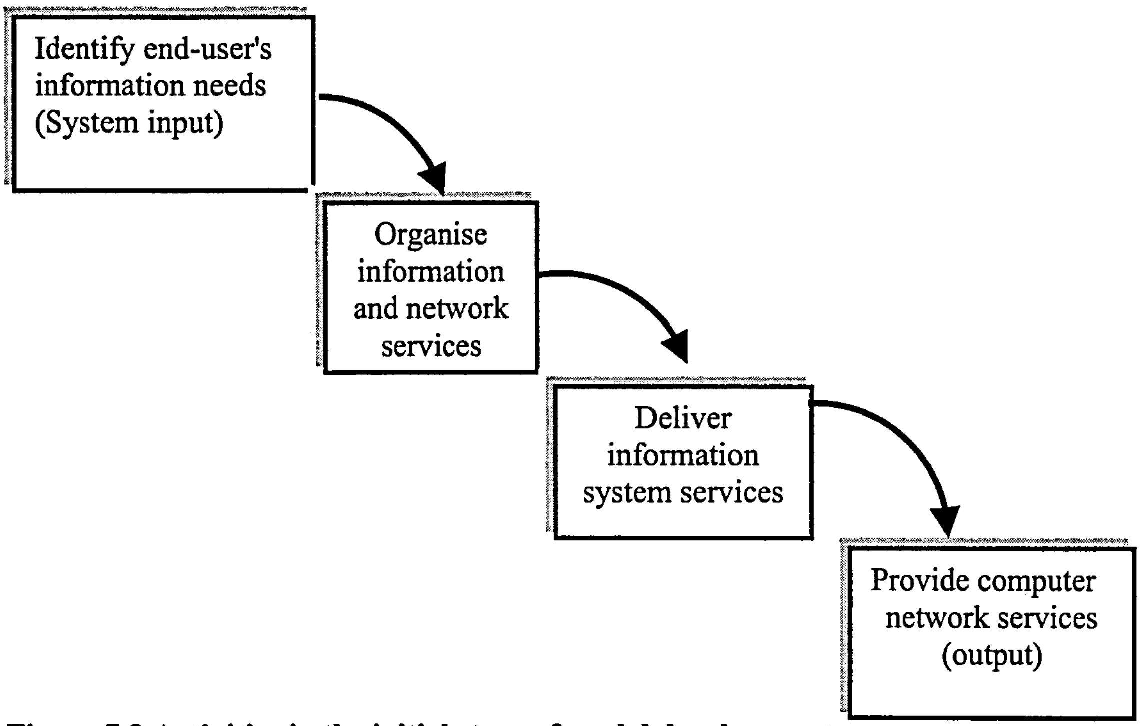


Figure 7.3 Activities in the initial stage of model development

At the second stage of modelling it is necessary to consider other activities that are expressed indirectly by basic activities and combine them together. Consequently, more detail will be offered in terms of the change required in Chapter 8. After the conceptual models are completed they should be checked by using appropriate guidelines and by using formal system models.

Looking back at the relevant systems leads to six conceptual models, one for each theme, that define how activities should proceed (see Figures 7. 4 to 7.9).

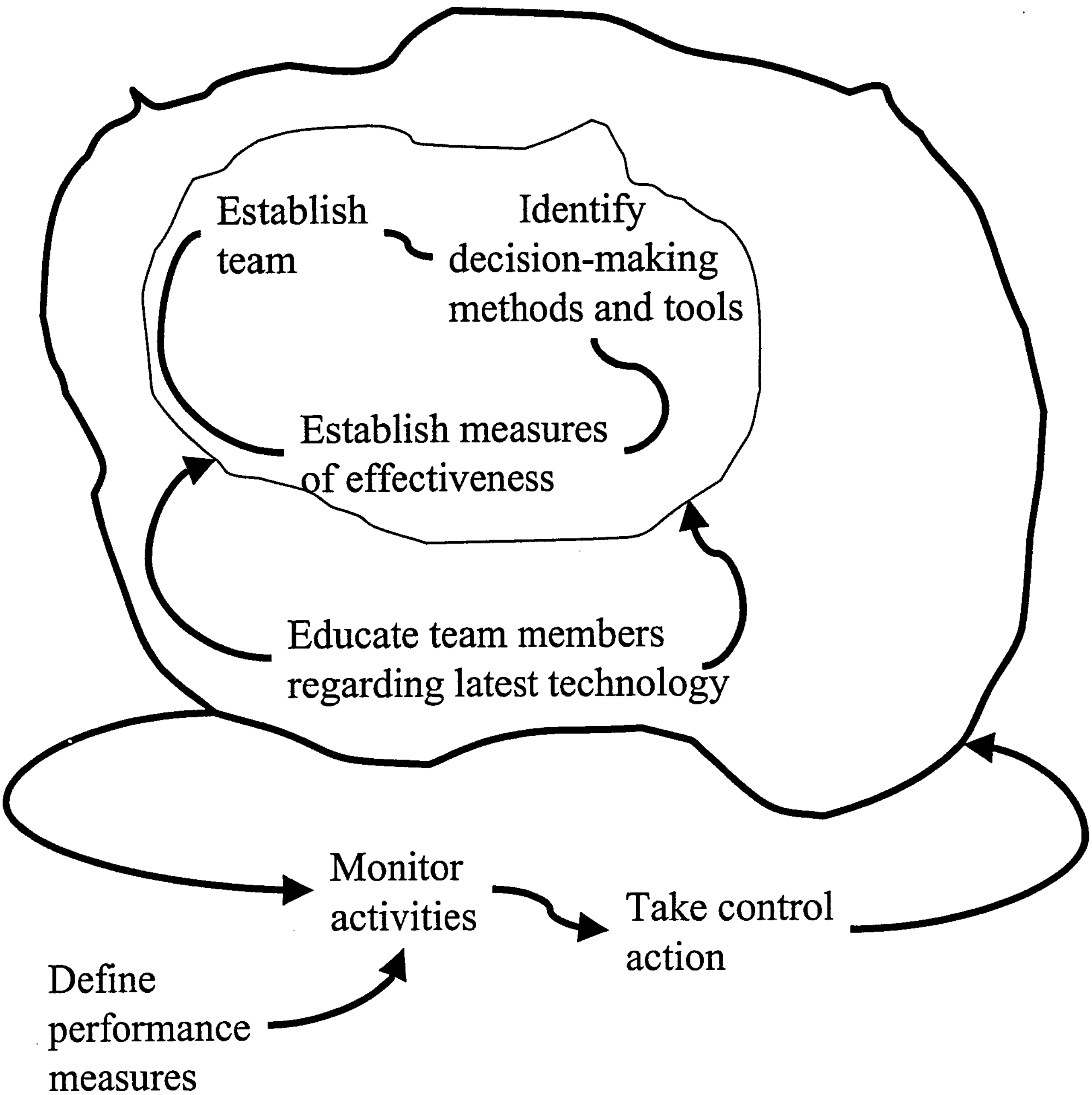


Figure 7.4: Conceptual model - Strategic Management Relevant System

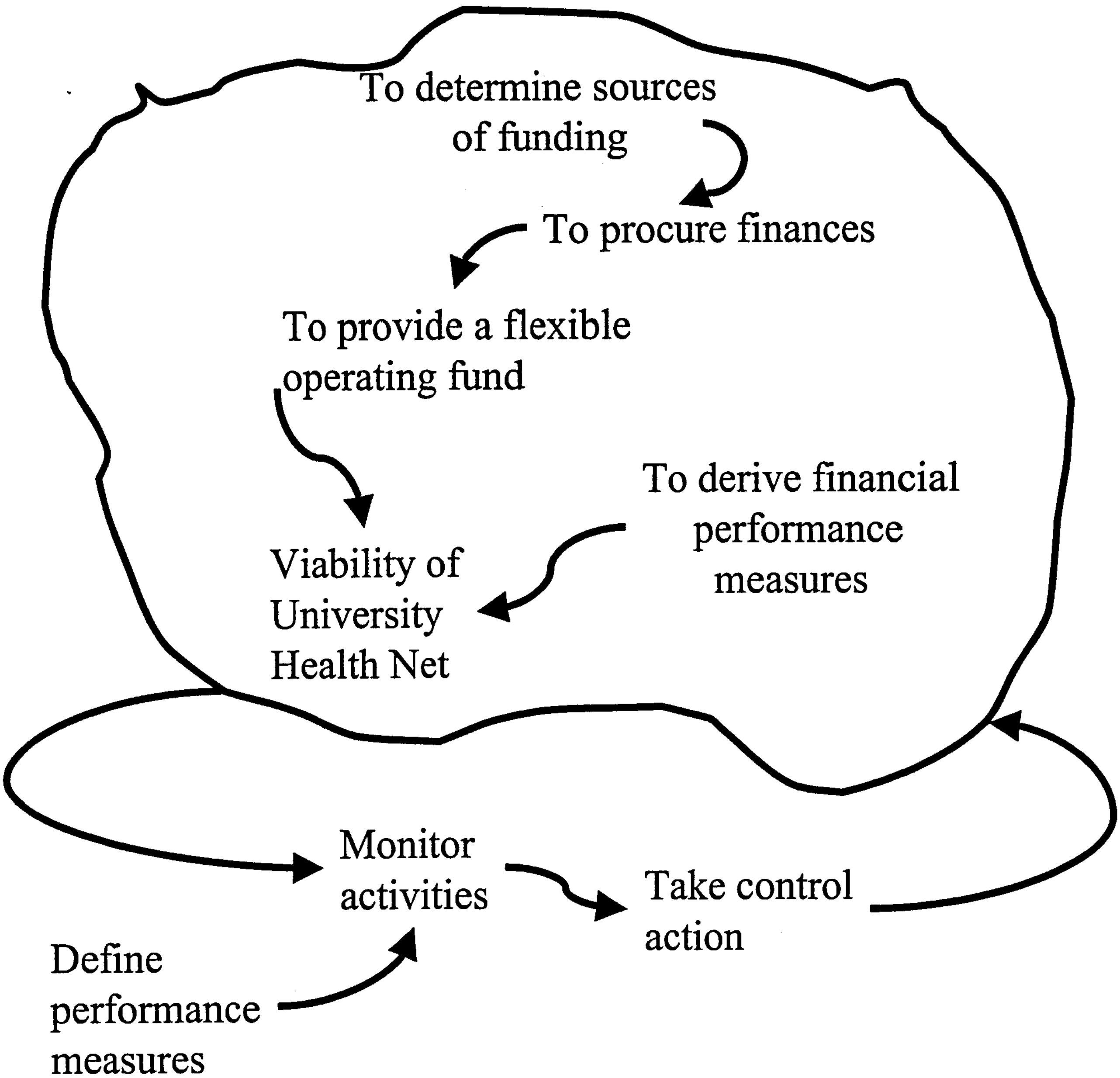


Figure 7.5: Conceptual model - Funding Relevant System

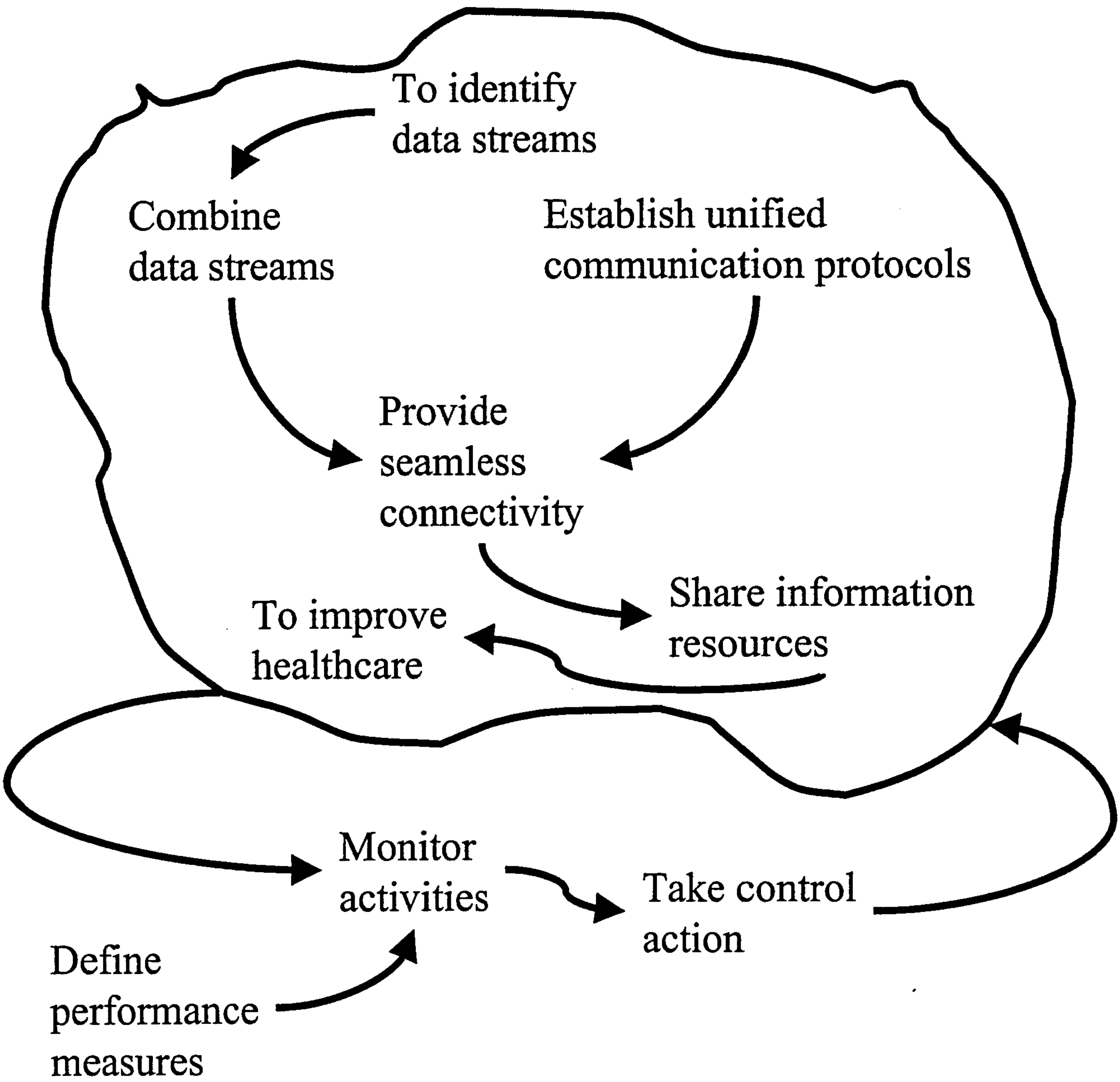


Figure 7.6: Conceptual model - Technology Relevant System

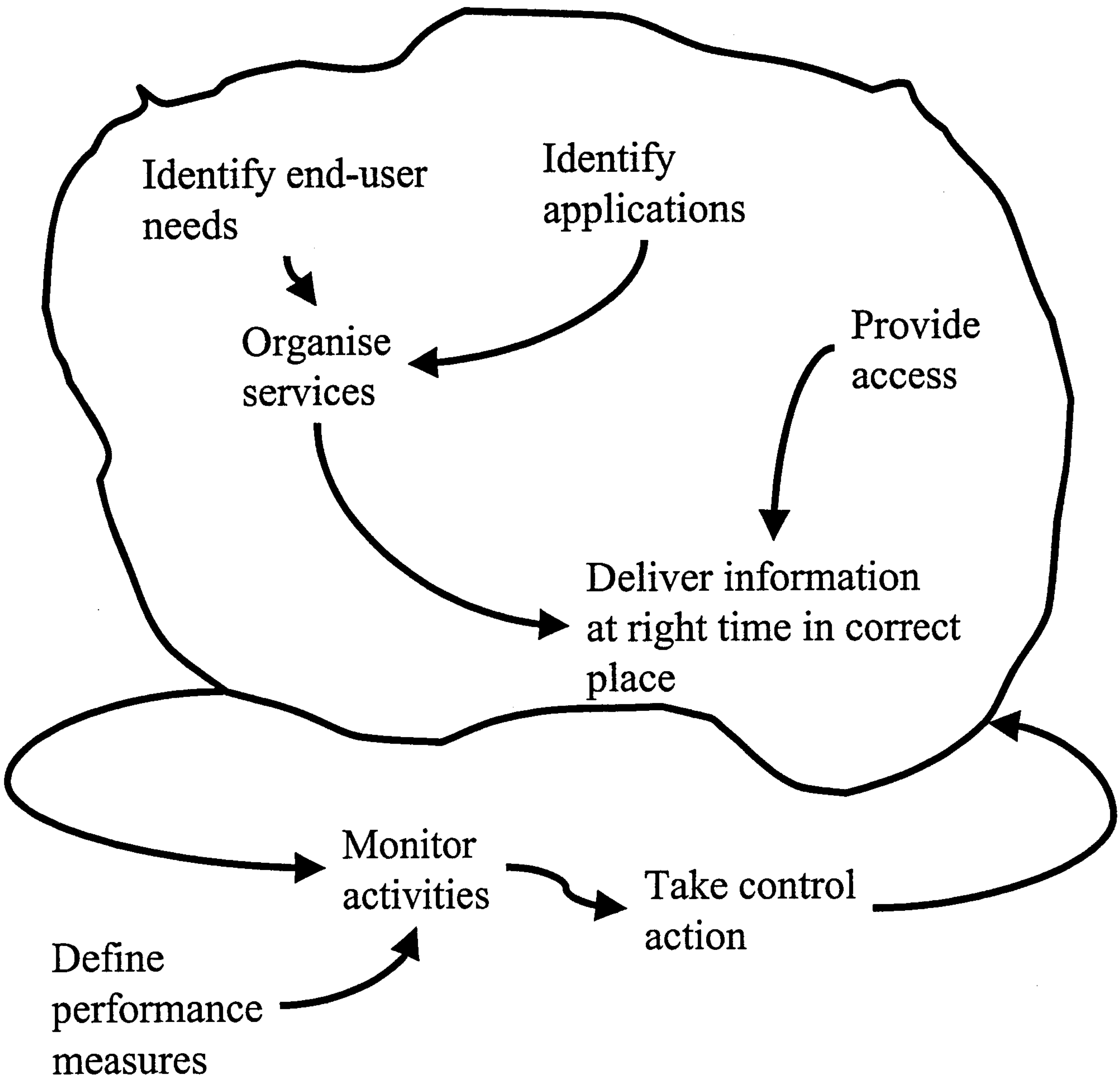


Figure 7.7: Conceptual model - Communication Relevant System

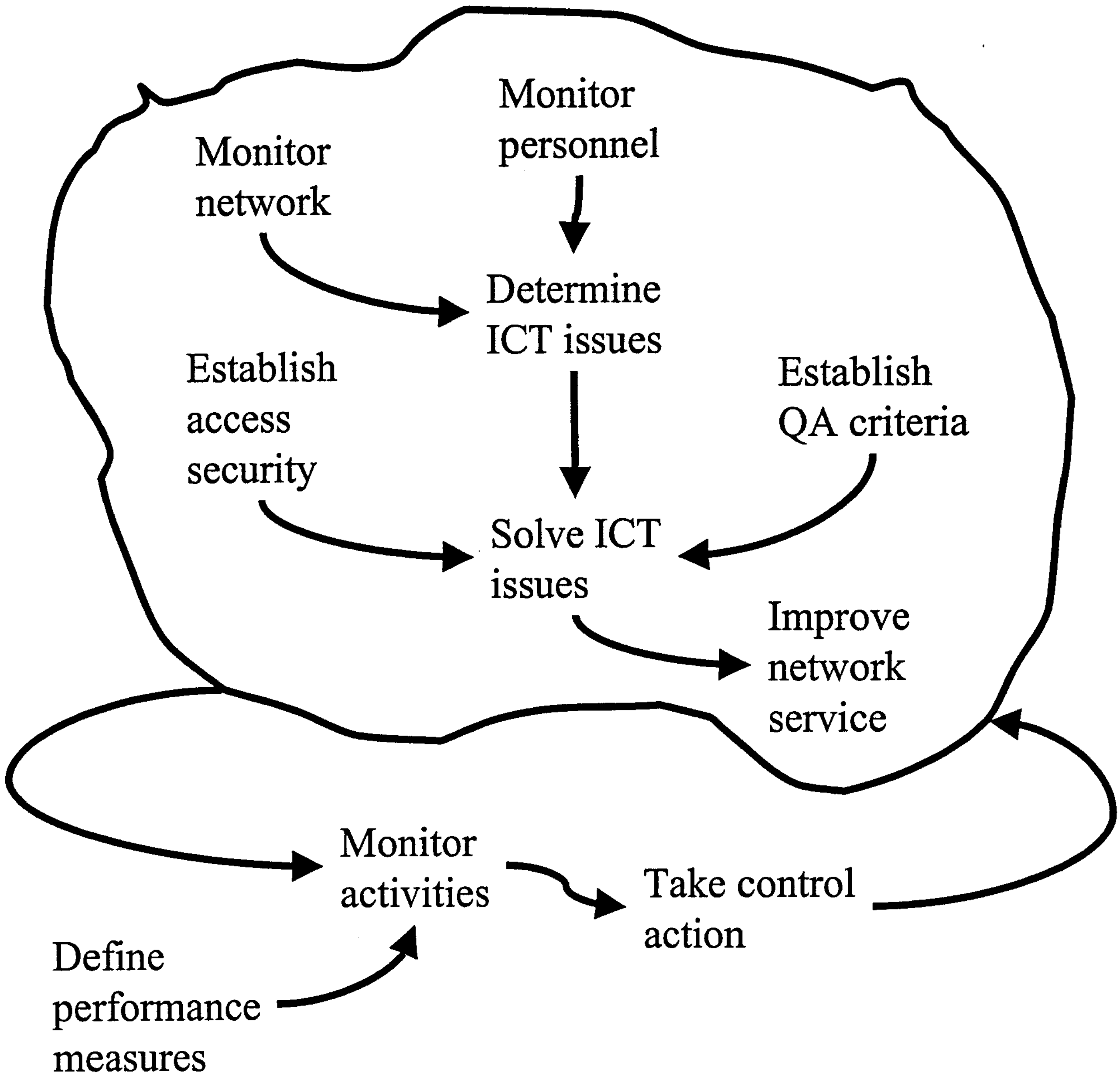


Figure 7.8: Conceptual model - Maintenance and Monitoring Relevant System

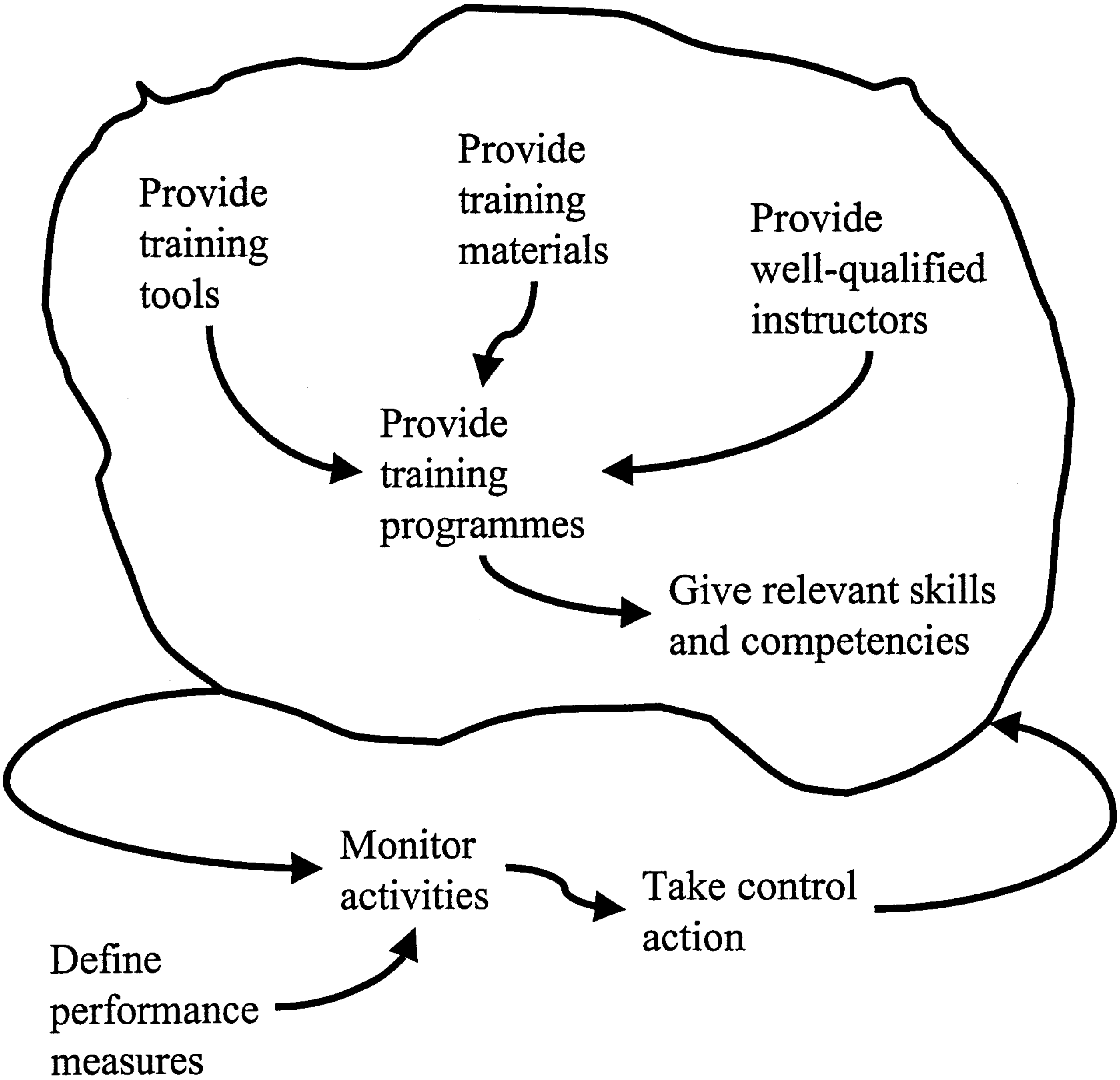


Figure 7.9: Conceptual model - Training Relevant System

7.7 Stage 5 SSM: Comparison of model with real world

The purpose of the comparison stage is essentially to generate debate, which could lead to a set of recommendations regarding change in order to help the problem situation. In fact, analysts are not concerned with the problem solution in the first instance but with problem identification, as a basis for debate about feasible and desirable change to the client's organisation. In this stage, in which the representation of the real world (rich picture) implemented in stage 2 will be compared with the conceptual model as produced in stage 4. More precisely, what should happen can be compared with the reality of what actually happens.

In order to compare the conceptual model with the real world, the activities in the models should be taken a set of questions such as, "Does this happen in the real world?"; "If this happens how are we involved in it?"; "What is our experience?"; "Why are we doing it that way?"; and "Is there a particular reason to do so?" . To simplify this process an 'agenda for change' in the form of a Table has been constructed for each relevant system. The headings of each Table are 'Activities in conceptual model (stage 4)', 'Present in real world situation (stage 2)' and 'Comments'. This allows discrepancies between the real and model worlds to be identified at a glance. The comments give a brief explanation that will be enlarged upon in the next stage of the methodology (Chapter 8).

7.7.1 Strategic management relevant system

Activities in conceptual model (stage 4)	Present in real world situation (stage 2)	Comments
1. Establish an effective decision-making team.	In the universities visited for this study, IT committees were not working properly except in KSU. However, there was no co-operation or any kind of communication or co-ordination between Saudi universities.	An IT committee should be organised in each site. Also a project management team should be established. This team should be created to represent universities, industry and concerned government organisations These team should be created to co-ordinate planning, procurement and implementation of the new computer network system.
2. To have effective decision-making tools to facilitate consensus decision-making.	No	Need to establish.
3. Establishing measures of effectiveness	Partially	Quality assurances are in place in some sites, but not all. They are regarded as important by relevant few people in the organisation
4. To have each actor conversant with latest technologies.	Partially	Some executives staff were familiar with the latest technology an ICT while some do not perceive ICT as a strategic tool.

7.7.2 Funding relevant system

Activities in conceptual model (stage 4)	Present in real world situation (stage 2)	Comments
1. Determine sources of funding.	All universities depend on the Ministry of Higher Education, partially represented. Private sector finance is missing.	Since the Gulf War in 1991, Saudi organisations are suffering from a lack of funding.
2. To procure finances.	Public sector funding is partially represented. Universities may need to organise to pressure government for funding.	Private sector participation is needed.
3. To provide a flexible operating fund.	Partially.	System development cost could be shared between government and private sector.
4. To derive financial performance measures.	No	There are different approaches to estimate performance – e.g. crude measures such as project costs; and more derived measures such as rate of return on investment.
5. Viability of University health net.	No	Requires commitment and leadership from senior management in each site to establish the required financial resources.

7.7.3 Communication relevant system

Activities in conceptual model (stage 4)	Present in real world situation (stage 2)	Comments
1. Identify information and knowledge needs of a cross section of (end-users).	End-users were identified as physicians nurses, paramedics, computer staffs, pharmacists, medical administrators, technicians, and other	End-users should be identified clearly since each category of end-users makes particular demands, has particular skills and may need special application.
2. Identify end-user applications	To some degree	University hospital should obtain or make available in-house general-purpose software (e.g., word processing) and special software to meet the needs of medical staff. All universities found that they had developed some software but that this was not comprehensive.
3. Organise services required to communicate across organisational boundaries	Each university offers reasonable information services for their staff. Some resources were moderately available	Some information resources were partially available. More services were needed such as remote access as presently the services do not meet with end-user satisfaction.

4. Deliver effective communication	Each university deliver reasonable information services for their staff.	Each site requires to deliver more information resources and make it available for all staff
5. Provide access to network service to provide information	KSU and KFU were fully networked whereas KAU needs time in order to be fully networked	KAU needs to speed up their efforts and make network services accessible for all staffs include medical staff everywhere in the university campus. Also, the public should have access to public information (eg., advice, diseases, hygiene, fitness) Furthermore, each site needs to upgrade their network system to support the enormous applications involved and to increase their network capacity.

7.7.4 Technology relevant system

Activities in conceptual model (sage 4)	Present in real world situation (stage 2)	Comments
1. Combine all data streams for efficient delivery to users	Partially	Integrated information system is needed.
2. Provide seamless connectivity between different data communication protocols.	Each university has different computer configurations but all include mainframes, PCs, networking and application software	Connections between university campuses are required. However, the HL7 protocol is required to exchange medical information.
3. Establish unified communication standards, (Integrated information system)	Universities visited were fully networked on their campuses except KAU, which was not yet fully networked.	A central database should be created. Information, image, and video files can be stored for future retrieval.
4. Understand network infrastructure and sharing information resources	Network infrastructure in Saudi does not attain a suitable standard. University Hospital do not share information resources	KACST and STC should Make greater efforts to upgrade their networks. Also, each university should upgrade its campus network. There is a need for commitment from ICT professionals in each site, and adequate ICT in each university hospital.

7.7.5 Maintenance and monitoring relevant system

Activities in conceptual model (Stage 4)	Present in real world situation (stage 2)	Comments
1. Monitoring performance	Partially	Committees to monitor ICT performance do not exist in some universities and not working properly in others without monitoring and measuring performance, there is no commitment to improve the services and keep up-to- date.
2. Establish quality assurance criteria	Partially	Some of these activities have been carried out they are not yet complete. For example, KSUH has a quality assurance team while other universities have not yet had such a committee in place though they plan to do so in the near future.
3. Determine problems and obstacles encountered	Incompletely	Universities have already defined some problems regarding their future plans such as a lack of ICT staff and, lack of co-operation and co-ordination.

4. Provide security privileges	Partially	Security is extremely crucial because this network will pass on medical information, which means this information is very sensitive. Patient confidentiality and privacy should be protected, especially some end-users may access medical records from remote locations.
5. Assess and adjust network services	Incompletely	In some universities their services were not up to date. Network services must also be updated and evaluated regularly in order to modify services in the light of rapid changes in technology.
6. Prepare and organise ICT specialist for network activities	Incompletely	However there is shortage of ICT staff. However, at least 6 people are needed at each site, these are: 1. Project manager 2. System administrator 3. Network administrator 4. Network technician 5. Training manager 6. System analyst

7.7.6 End user training relevant system

Activities in conceptual model (stage 4)	Present in real world situation (stage 2)	Comments
1. Provide sufficient training tools and facilities	Partially	Each university offers training courses for all staff and they encourage them to use ICT effectively. However, these activities were not sufficient and not up-to-date for many reasons (money, personnel, technology).
2. Provide instruction guidance and manual	Partially	Some of these activities already done but they were not sufficient and are not up-to-date.
3. Provide suitable courses to cover specific topics	Present some extent in some universities whilst it was limited in others	Each university offers training courses, but there are huge problems because different users have different needs and often courses are not offered in the useful or relevant areas.
4. Provide well-qualified lecturers	Partially	All universities suffer from a lack of skilled ICT staff. External expertise is needed to contribute new ideas to the institutions.

7.8 Summary

This Chapter applies SSM to ICT in Saudi University Hospitals to examine data collected via questionnaires, interviews, written documents and observations in order to achieve a rich picture. Major issues in Saudi University Hospitals were defined as part of the methodology They are multidimensional, which can be summarised as organisational issues (culture, political, environment, management, and finance), technical issues (hardware and software) and people issues (attitudes, end-users training, health and staff evaluation).

This work is placed in a wider context to define the elements of the wider system of interest and the system environment. Collectively, they form stage 1, the problem situation unstructured of the SSM. A rich picture (stage 2 of SSM) is drawn to highlight the issues raised in a structured way. The element of structure, process, environment and other issues were examined carefully for designing the problem-solving and problem-content system. The difference between the three roles of the client, the problem-solver, and problem owner was clarified.

A Root Definition of the whole model of the proposed system was formulated and six relevant subsystems were identified. The relevant systems that emerged were strategic management, funding, communication, technology, maintenance and monitoring, and end-user training. Further, root definitions for each relevant system were established and tested using CATWOE analysis. This Chapter continues with a conceptual model for each of the root definitions (stage 4 of SSM). The agenda for change for each conceptual model (stage 5 of SSM) closes the Chapter. The purpose of the agenda for change is to generate debate, which could lead to a set of recommendations regarding change in order to help the problem situation.

In order to simplify this process, a Table has been constructed for each relevant system. This allows discrepancies between the real and model worlds to be identified at a glance. The comments give a brief explanation that will be enlarged upon in the next stage of the methodology that will explain relevant systems in more in details (Chapter 8).

Chapter 8
Change and Implementation

8.1. Introduction

The preceding chapter shed light on the fundamental requirements for the proposed computer network system. Therefore, this chapter will discuss in more detail the basic concept of the proposed network system. The questionnaires, interviews, document analysis and observations have led to some ideas about possible change that have been agreed by key people. More precisely, this chapter will focus on stage 6 and 7 of SSM, in which change that is both systemically desirable and culturally feasible is identified, followed by actions to improve the current situation. Once output is specified an integrated conceptual model that links all of the relevant systems is identified.

8.2 Stage 6: Feasible and desirable changes

The next two stages, after the comparison of the real world with the conceptual world, are the definition of culturally feasible and systemically desirable changes (stage 6) and action to improve the problem situation (stage 7). The debate must involve participants from the problem content system. Possible changes or future plans will be discussed in terms of feasibility and desirability. Gaps in the analysis may appear as unrecognised constraints come to light. Once the changes have been agreed they can be implemented and may give rise to a new set of problems. There are different ways to carry out stage 6. We could conduct a structured discussion with the actors, such as problem owners and problem solvers, to identify ideas about possible changes, which are systematically desirable and culturally feasible. This will generate a list of possible changes that could be made to improve the current situation. Also, we could carry out analysis based on the sort of agenda constructed in chapter 7. We will use both ways because there are complex issues and no clear ownership. A summary list of culturally feasible and systemically desirable change is presented below, according to activities of each sub-system.

Table 8.1 Strategic management relevant system		
Activities	**Systemically desirable**	**Culturally feasible**
A. Establish an effective decision-making team	Yes	Yes
- To establish a nationwide strategic team	Yes	Yes
- To co-operate between IT committees at each hospital site	Yes	Partially
- To improve the quality of co-operation activities	Yes	Yes
- To co-ordinate roles between IT committees and a nation-wide strategic team	Yes	Yes
- To communicate between hospital-based teams and a nation-wide team	Yes	Yes
- To establish sub-project committees such as technical and medical committees	Yes	Yes
- To involve external experts	Yes	Yes
B. Identify decision-making methods and tools	Yes	Yes
- To identify methods for consensus decision-making	Yes	Yes
- To determine tools such as PERT or Gantt chart	Yes	Yes
C. Establish measures of effectiveness	Yes	Yes
- To establish individual performance measures	Yes	Yes
- To set up team performance measures	Partially	Yes
- To improve the quality of co-operation activities (network services)	Partially	Yes
- To review performance measurement regularly	Yes	Yes
D. To have each actors conversant with latest technologies	Yes	Yes
- To increase training programmes for all staff	Partially	Partially
- To recognise ICT as a means of providing strategic management	Yes	Yes
- To gain experience from external expertise	Yes	Partially

Table 8.2 Funding relevant systems		
Activities	**Systemically desirable**	**Culturally feasible**
A. Determine sources of funding	Yes	Yes
- To obtain funding from Ministry of Higher Education and Ministry of Health	Yes	Partially
- To convene private sector to participate	Partially	Yes
- To give priority and adequate funds	Yes	Yes
B. To procure finance	Yes	Yes
- To allocate budget	Yes	Yes
- To diversify funding by raising money	Yes	Partially
- To pressure government for more funding	Yes	Partially
C. To provide a flexible operating fund	Yes	Yes
- To share project cost between public and private sector	Yes	Yes
- To provide funds to ensure network long-term running	Yes	Yes
D. Defining financial performance measures	Yes	Yes
- To estimate project cost	Partially	Yes
- To establish end-user training cost	Partially	Yes
- To establish project management cost	Partially	Yes
- To obtain quotations from potential suppliers of expensive equipment	Yes	Yes
E. Viability of university heath net	Yes	Yes
- To use cost-benefit analysis	Partially	Yes
- To understand the contribution of the new system	Yes	Yes
- To add up all the project costs	Partially	Yes
- To obtain commitment from senior management	Yes	Partially

Table 8.3 Communication relevant system		
Activities	**Systemically desirable**	**Culturally feasible**
A. Identify information needs across section of staff	Yes	Yes
- To identify proposed system end-user	Yes	Yes
- To decide each end-user category needs	Yes	Yes
- To consider human factors in the system design stage	Partially	Partially
- To define the main methods used to gather information	Yes	Partially
- To involve end-user in system development stages	Partially	Yes
B. Identify end-user application software	Yes	Partially
- To determine general software application	Yes	Yes
- To identify special software to meet healthcare professional's needs	Yes	Yes
- To prepare general and special software applications	Yes	Yes
- To make software application in-house	Partially	Yes
C. Organise services required to communicate across organisational boundaries	Yes	Yes
- To make network services available	Yes	Partially
- To enlarge the number of services	Yes	Yes
- To meet end-user satisfaction	Partially	Partially
D. Deliver effective communications	Yes	Yes
- To provide full-text, abstracts, etc.	Partially	Yes
- To provide all kinds of services	Partially	Partially
- To provide around the clock access for patients to access their own medical records	Partially	Partially
- To provide fast, convenient, and up-to-date general information	Yes	Yes
E. Provide access to network	Yes	Yes
- To make access available to network for staff anywhere on the campus	Yes	Yes
- To make access available to network for staff and public out of campus	Partially	Partially
- To divide network into private and public site	Yes	Yes
- To upgrade network system in each hospital site	Yes	Yes

Table 8.4 Technology relevant system		
Activities	**Systemically desirable**	**Culturally feasible**
A. Combine all data stream for efficient delivery to users	Yes	Yes
- To identify different forms of information	Yes	Yes
- To determine basic channels of transmission	Yes	Yes
- To create and maintain a national database	Yes	Partially
B. Provide seamless connectivity between different platforms	Yes	Yes
- To identify different data communication protocols	Yes	Yes
- To provide communication protocols	Yes	Yes
- To share scarce information resources	Yes	Yes
C. Establish unified communication standards	Yes	Yes
- Create central archive system for future retrieval	Yes	Partially
- Store information, image in central database	Partially	Partially
D. Understand network infrastructure and share information resources	Yes	Yes
- To investigate current network infrastructure	Yes	Yes
- To identify effectiveness of existing information activities	Yes	Yes
- To extend and upgrade current network	Yes	Partially
- To gain experience from outside expertise	Yes	Partially

Table 8.5 Maintenance and monitoring relevant systems		
Activities	**Systemically desirable**	**Culturally feasible**
A. Prepare and organise ICT specialist for network	Yes	Yes
- Establishing committee to monitor network activities	Yes	Yes
- Improve network services in each hospital site	Yes	Yes
- Identifying number of ICT specialists in each site	Partially	Partially
Monitoring performance network	Yes	Yes
- To identify gaps between end-user needs and existing network services	Yes	Yes
- To assess end-user's attitudes and their satisfaction	Partially	Partially
- To build a monitoring committee in each hospital site	Yes	Yes
- To write mission statement of the monitoring system	Yes	Yes
C. Establish quality assurance criteria	Yes	Yes
- To obtain customer satisfaction	Partially	Partially
- To build a quality assurance team in each hospital site	Partially	Partially
C. Establish measures of effectiveness	Yes	Yes
- To establish bench-marking activities to assess the effectiveness and efficiency of information services	Yes	Yes
- To request vendors (computer suppliers) to test hardware and software	Yes	Yes
D. Provide security for network	Yes	Yes
- Dividing network into two parts (public and private)	Partially	Yes
- To give different individuals different levels of privileges for using the computer	Yes	Yes
- To give different individuals different level of access to specific data files	Yes	Yes
- To make data meaningless to protect patient privacy	Yes	Yes
E. Assess and adjust network services	Yes	Yes
- Evaluate and update ICT services on each site	Yes	Yes
- To determine measures of performance	Yes	Yes
F. Determine problems and obstacles encountered	Yes	Yes
- To identify and over come problems (e.g., funding)	Yes	Yes

Table 8.6 End-user training relevant system		
Activities	**Systemically desirable**	**Culturally feasible**
A. Provide sufficient training tools and facilities	Yes	Yes
- To provide space resources (e.g., class rooms)	Yes	Yes
- To provide human resources (ICT staff)	Yes	Yes
- To provide technical resources (PCs, printers, etc.)	Yes	Yes
B. Provide suitable courses to cover specific topics	Yes	Yes
- To organise in house training programmes	Yes	Yes
- To keep staff up-to-date in skills and competencies	Partially	Partially
- To organise different types of training to cover the key areas	Partially	Yes
- To provide educational and training programmes for staff	Yes	Yes
- To offer staff opportunities to attend national and international conferences	Partially	Partially
C. Provide guidance and advisory services	Yes	Yes
- To provide on-line services	Yes	Partially
- To prepare documents and guidance that can be easily understood by all staff	Yes	Yes
- To prepare staff to deal with minor computer problems	Yes	Yes
- To provide special programmes for some employees to develop special skills	Partially	Partially
- To provide a help desk	Yes	Yes
D. Provide well-trained lecturers	Yes	Yes
- To bring consultants and outside experts to participate	Partially	Partially
- To invite training centres to organise computer training	Yes	Yes
- To increase number of qualified ICT professionals in each hospital site	Partially	Partially
- To bring qualified consultants from different sources such as academic and industry	Partially	Partially

The major issues facing each subsystem are highlighted in the following sections followed by discussions with key people identified as change agents. After that, as an outcome of the analysis, recommendations for action for Saudi Universities are presented. In order to improve the current situation in all University Hospitals feasible and desirable change in harmony with the mean activities of each subsystem can be detailed as following

8.2.1 Strategic management relevant system

A. Establish project decision making team.

The decision making team should be created to represent participants universities, industry and concerned government organisations that will be involved in the project in order to achieve the following objectives:

- setting-up the mission and objectives among Saudi Universities Hospitals in a written form to clarify the responsibility between service providers, co-ordinate planning, procurement and implementation of the new computer network system,
- establish mechanisms for collaboration and co-ordination among universities in order to address the highest strategic priorities of their institutions, and,
- set regulations and rules to involve a wide range of University Hospitals in the future.

The decision making team should be composed of university computer centre directors, hospital computer department managers, Deans of medical schools, hardware and software engineers, and representatives of data service and telecommunication organisations. An overall decision making team should be created to help co-ordinate planning, procurement and implementation of the new computer network system. However, the decision making team should take this proposed project entity and break it into bite-sized sub-project. Sub-project teams such as a technical sub-team, medical sub-team, administrative sub-team and budget sub-team should be created. Each sub project team should be responsible for specific tasks.

Furthermore, external expertise can contribute new ideas to the organisation. So, external experts are necessary to participate in this project. Essential technical skills or expertise, which are not available internally, should be secured from outside the organisations because they are expected to be up-to-date with the latest technology.

It is good practice to distribute management tasks but a project leader should be appointed to take sole responsibility. Therefore, a vice-president (the project leader) with a strong technical and project management background should chair the decision making team. All the decision making team members should meet the following requirements: they should be highly experienced, should participate in setting goals and establish target dates, and have a history of good working relationships with each other. The decision making team should be in influential positions in decision-making structures of each university, and their meetings should take place frequently, (e.g. monthly).

B. To have effective decision-making tools to facilitate consensus decision-making

The decision making team meeting is an important opportunity to exchange information and to establish open attitudes and shared feeling of responsibility. Niels *et al.*, (1990) suggested that shared feelings of responsibility in all projects, however, require commitment and knowledge. Participants must make an active effort to give the project the best possible opportunity to succeed. Participants meetings should be held frequently, notes should be taken and discussions should be documented. The roles and expectations of each participant must be explained as clearly as possible. The project leader should have experience in exploiting and utilising each actor's experience. He should facilitate the tasks and act as catalyst. Furthermore, the project leader should be able to adopt different techniques and methods such as brainstorming to generate, exchange and organise ideas.

Technology offers great opportunities to communicate easily without leaving locations. Instead of moving every time to a common location, decision making team members could remain where they are and use technology to co-ordinate, convey messages, ideas, and the flow of information, thus speeding up decision-making. Members, therefore, should use the following telecommunication applications to facilitate their duties: e-mail, voice mail, fax, teleconferencing, electronic data exchange and videoconferencing. These tools and technologies will enable the project leader to encourage participants to express their ideas and use their time efficiently. Moreover, the decision making team could focus on set trigger questions, such as: 'What are the issues involved in establishing a computer network system over the next five years?'. On the other hand, the decision making team should have influence in their organisations.

According to Laudon and Laudon (1998, 2000), if a project is large, formal planning and formal control tools can successfully manage the project. Some software tools are available for resource allocation. Project management software packages, such as Microsoft Project, can be used to assess and manage the project. Two traditional techniques of project management are critical path methods (CPM) and project evaluation and review technique (PERT). In fact, project management techniques can help managers identify bottlenecks. They can also help the system developer divide implementation into smaller, more manageable segments with defined, measurable businesses results (Fichman and Moses, 1999). Finally, University Presidents should be aware of the activities of teams and should provide tangible and intangible support at every opportunity in order to achieve this project.

C. To have each actor conversant with the latest technologies

ICT has become more powerful and its use has spread throughout organisations. Galliers *et al.*, (1999) state that organisations have used ICT as a strategic weapon. Although ICT has recently become a major advantages and disadvantage for organisations because it changes so rapidly. Nowadays, it is difficult to keep up-to-date with the rapid changes in

ICT. However decision-makers in Saudi University Hospitals should have good experience in technology and its ability to promote their institutions.

Laudon and Laudon (2000) state that if a project team is unfamiliar with the hardware or software proposed for a project, it is likely that the project will experience technological problems or take more time. Therefore, the decision making team needs to be aware of the technological skill base of the project management team and be aware of potential ICT problems. This can be achieved via appropriate appraisal mechanisms and it follows that the decision making team should be familiar with the latest ICT.

D. Establishing measures of effectiveness

The proposed system intends to serve different end-users; each end-user category needs different applications. Therefore, universities need to identify gaps between end-user needs and what is provided. In order to achieve this, universities should establish a mechanism for the continuing analysis of effectiveness and efficiency of information provision. Measure of performance would include cost, speed, relevancy etc. Each university should prepare a system to measure the performance of their campus network and their ICT staff. Furthermore, measurements should cover academic programme support, administrative support, end-users satisfaction, availability and effectiveness of information and network services as well as accessibility and partnership between institutions in higher education.

General criteria, such as system reliability, timeliness, accuracy, cost, functionality, and ease of operating should be identified, however, each university should have some mechanism such as end-user committees or an IT committee and quality assurances criteria to monitor network services in order to provide effective services. Some methods such as end-user surveys (questionnaires and interviews) and benchmarking activities are needed on a continuing basis to help assess the effectiveness of network services on campuses. In each hospital site an appropriate committee should review performance measurements regularly (e.g. every six months).

8.2.2. Funding relevant system

A. Determine sources of funding

As a not-for-profit organisation, the university consortium will seek funding primarily from the Government, namely the Ministry of Higher Education, and the Ministry of Health. In addition, the consortium will seek to diversify funding by raising money from the private sector to supplement government funding. Discussions with key people reveal that private sector would be willing to contribute to this project. It is recognised that there will be an on-going commitment to maintain the suggested information system, so regular funding is likely to be captured from the same providers.

B. To procure finances

According to Moore (1997), there is a much stronger sense of partnership between the state and the private sector in East Asia. This is equally true in Saudi Arabia; therefore, the proposed system linking major sites should be funded by government and private sectors since both will benefit from the advantages that the proposed system offers. Both sectors should participate in building the SUHNS. Government should finance through its Ministers of Higher Education and of Health. The private sector, for example, can finance and implement some components of the proposed system such as network hardware and software system. SUHNS will have significant benefits on education and research, which will have far-reaching benefits for the health care services as well as for academic institutions. As a result, STC and other private sectors may also view participation in funding the system in terms of investment, in the sense of gaining expertise for employees and usable infrastructures.

C. To provide a flexible operating funds.

Building information system that connects two or more organisations, or one organisation that operates in different nations, can be very complicated. In order to establish such system its requires a significant amount of money and effort to study, plan, design and implement the new system. In our case the first stages of setting up the system will require a considerable injection of funding and, therefore, the system will accrue running costs. As such, it is not enough simply to find sufficient finance for setting up and also to ensure its long term running. An adequate resource in terms of money is necessary especially in the initial stages. Therefore, government and private sectors should participate in sharing the costs of establishing the proposed system. For example, Saudi government should participate through increases in university funds and facilitate various efforts. STC should provide free communication line for research use. Also, hardware, software, and such items could be financed or provided by computer companies.

D. Defining financial performance measures

Cost estimates are usually needed for all projects – these can be crude or refined. Estimates of project costs are necessary for management decisions and control actions that need to be taken down the line. Dennis (2000) recommends different approaches to estimate project costs as follows:

- ball-park estimates are those made before a project starts, when only vague outline information is available and all details of the work have yet to be decided. They are also used when information is available, but there is insufficient time for its proper consideration,
- comparative estimates are made by comparing work to be done on the new project with similar work done on previous projects,

- feasibility estimates can be derived only after a significant amount of preliminary project design has been carried out. Quotations must be obtained from potential suppliers of expensive equipment or services,
- definitive costs cannot be done until most design work has been finished, all the major purchase orders have been placed at known prices and actual work on the project construction or assembly is well advanced.

Setting budget and time frames for large project is really difficult to estimate it accurately. However, the first stage in the cost estimating process is to complete a list of every known item that is going to cost a significant amount. Unfortunately in this case, it is very difficult to estimate the network cost accurately since the price of network equipment changes frequently. Also, the information, which is required, is in many different places. However, the following list represents the primary cost components, which should be accounted for in order to estimate the roughly total network cost:

- training and human resources cost,
- software development costs,
- LAN equipment and access charge cost,
- transmission equipment costs (e.g., multiplexes, modems),
- computing support (e.g. mainframe, PCs, applications software),
- project management costs, and,
- lines and station equipment rental and purchase costs.

E. Viability of University health net

Financial viability is crucial for the introduction of any project. The viability of the proposed programme can be modelled using an appropriate methodology, such as that invented by Beer (1985), or use techniques like cost-benefit analysis. These analyses will allow the investigation of planning and procurement of resources as well as provide a developmental analysis of progress. Crucially, missing elements can be identified and planned 'in' to design reviews.

Cost-benefit analysis is a technique that attempts to express all cost and benefits of a project, be they direct or indirect, financial or social, in term of a common monetary unit. Cost-benefit analysis involves adding up all the cost of a project (tangible and intangible). However, in some case a simple cost-benefit analysis may be not sufficient and not easy especially with large project (Gupta, 2000, Laudon and Laudon 1998). Many factors such as speed of decision and customer satisfaction cannot be measured in term of money.

The proposed project is costly because of the expensive equipment required and the time and effort involved in setting up and running the proposed system. Like any other system the cost depends on several factors such as the effect of the decision on the organisation, the number of users. We can categorise this project costs as follow: hardware cost, software cost, services cost, telecommunication cost and personnel cost.

Saudi University Hospitals should understand the contribution of the new system. In other words, it is important to answer the question " what costs and benefits will the proposed computer network system provide".

Saudi Universities should make sure that the proposed system benefits exceed costs. The proposed system will derive great value to all Saudi University Hospitals, Higher Education and as well as the health care sector. Some of the benefits of this project were listed in Chapter 7. Discussions with key people (change agents) bring to light that the Ministry of Higher Education and the Ministry of Health are very keen to invest in such project and they are willing to contribute heavily. All strongly believed this project's benefit exceed costs and is worth investment in this project.

8. 2.3 Communication relevant system

A. Identify information and knowledge needs of a cross section of staff (end-users)

The Saudi University Hospital network is intended to serve a spectrum of users. Each user may have different needs at different times while using different applications. The network can best serve these users when the expected usage pattern is accounted for in the initial design phase of the proposed system. System analysts and system designers should focus on end-user needs, both general and specifically. Newman and Lamming (1995) recommend that it is best not to forget that using an interactive system is a human activity. Thus, it is necessary to make sure that this usage is consistent with the human user's physical and cognitive abilities and with his/her social environment and habits. Therefore, the first step here is to identify the end-users who will be affected by the proposed system and their needs. It should be ensured that all end-users and their needs are identified clearly.

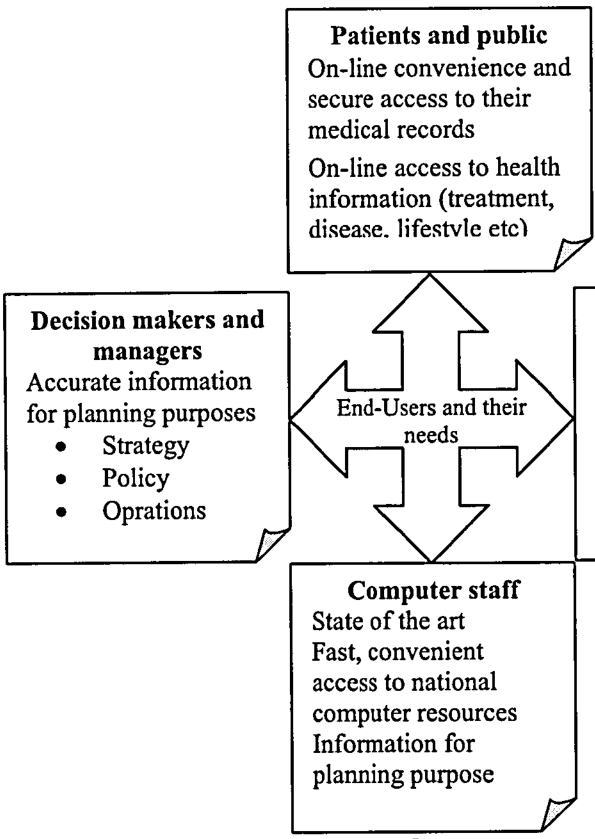


Figure 8.1: End-users profiles and their needs

The proposed computer network should serve distinct populations. A finding of this research is that the population that will use the proposed system comprises Physicians, Nurses, Paramedics, Administrators, Pharmacists, Computer staff, Medical technicians and others (Figure 8.1).

There are four main methods used to gather information about an object system and its information system: documentation review, observing the system in action, interview candidate sample, and questionnaire survey.

B. Identify end-user applications software

Applications software is a set of step-by-step instructions that enables a computer to perform a specific task and is used to control, co-ordinate, and manage different hardware components in an information system (Gupta 2000). As mentioned previously, the Saudi University Hospital network is anticipated to work for a variety of users, and each user category needs different applications. Each University Hospital should ensure that all software applications required must be obtained, either by being built in-house or bought off the shelf. However, they have to ask what kinds of applications are needed. It is believed they need at least to have the following: Hospital patient system, Nursing system, Laboratory systems, Pharmacy systems, and Medical record systems. In addition certain applications should be available such as, tele-medicine, teleconferencing.

End-users also make specific demands, bring specific capabilities as potential users may need particular skills and expertise, or may need special applications. Consequently, the system designer should recognise all of these needs. For example, a physician may want to see a past X-ray image of a patient. The physician can easily scan the database to view the image, print it or download it all altogether, while at the same time talking by phone with another X-ray specialist who is also viewing the same image. Generally speaking, University Hospitals should acquire or build in-house, general-purpose software (e.g., word processing) and specialised software to meet the needs of medical staff (e.g. Tele medicine) - see Figure 8.2.

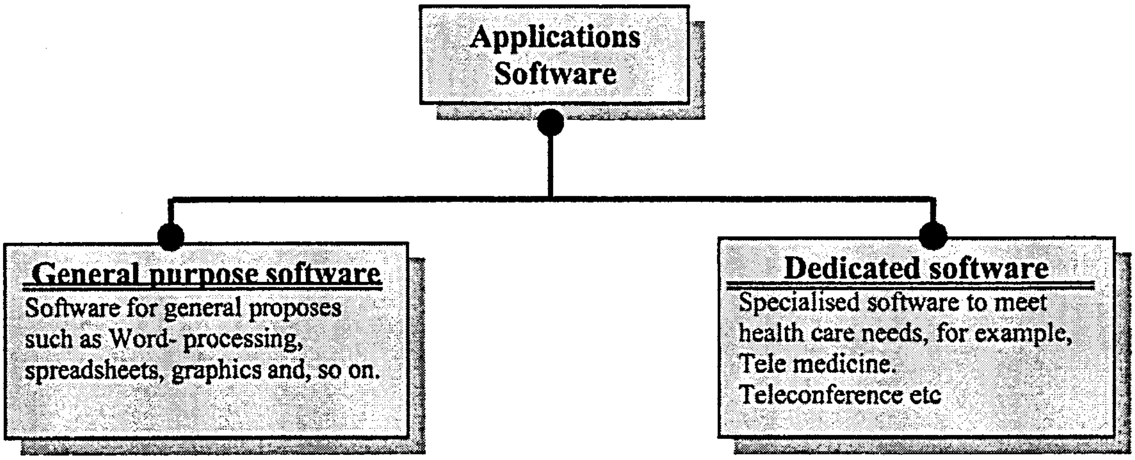


Figure 8.2 Types of application software required for the proposed system

C. Organise network services

Organising the network service is a very important factor in network. Therefore, each University needs to develop its network, and provide access to network services and make their servers available to their users. The University also needs to enlarge the number of services and variety of electronic sources available In fact, incorporated and organised information services are fundamental for easy use via the computer network. Therefore, Universities should provide effective and sufficient services for their end-users. Moreover, the current network services, which are available, should be reorganised to be heavily dependable on remote access and move toward a fully digitised, real-time computer network. It is recognised that in this soft systems analysis, further issues such as security and confidentiality are raised. Solutions to these issues can be achieved in later stages of the study, outside the scope of this work. All Universities need to offer private and public information services to facilitate network for end-users and satisfy their needs.

D. Deliver effective communication.

Each University needs to deliver information to their end-users effectively. Information itself should be accurate, consistent, complete and timely. New systems to facilitate and improve communication between information units and end-users are very important on University campuses. So far, Universities need to provide a range of networked academic information such as full-text, abstracts and image databases. Each University needs to provide and deliver services as follows:

- provide health care professionals with 24 hour on-line access to relevant information from patient records,
- provide around -the- clock access for patients to access their own medical records,
- provide on- line education and training for medical staff,
- give medical and nursing staff instant access at their desks or at the bedside to the most recent medical research and treatment practice,
- provide fast, convenient, accurate, and up-to-data general information (e.g. advice on hygiene, fitness, lifestyle and health) for the public through an on-line service,
- deliver accurate and up-to-date information about the services they offer, and,
- offer additional support and advice, and guidelines to all who require it.

E. Provide access to network

Each University should develop its campus network and provide access to network services both on and off campus. However, Universities need to provide access as follow:

i) each site needs to upgrade their network system to support vast applications and to increase its network capacity. Moreover, each site should be fully networked with access available anywhere on the campus. The bandwidth for those applications needs the international standard of 34 MB, expandable to 155 MB.

ii) offer wider access: Universities should make access available for medical and computer staff from offices and halls anywhere on the campus, and for authorised staff who are away from the hospital-based terminals, and,

iii) each site needs to make access easy for external users to obtain information, such as public health, information on disease, lifestyle and support services. In other words, the network should provide facilities for dual roles: a private network for passing medical data electronically; and a more public health oriented service that allows full access from all locations.

8.2.4 Technology relevant system

A. Combine all data streams for efficient delivery to end-users

University Hospitals deal with different forms of information (imaging, x-ray, laboratory data, voice, video, and text), and have a wish to share this information with the right person, at the right time, and in the right place. There are four basic channels of transmission: telephone network, LAN for text and pictures, video conferencing networks, and, although not electronic, an overnight delivery service (courier services).

The usefulness of these channels is compromised due to high cost, inefficient use of time, and low speed. A solution for the above will be the converging of these channels into a single channel that will, among others things, guarantee timely delivery of all these forms of information, reduce costs and improve set-up and connectivity speeds.

B. Provide seamless connectivity between different platforms

Connectivity is the ability of the various computer resources to communicate with each other through network a device without human interaction. It also allows for application portability, interoperability and scalability (Turban *et al.,* 2001). University Hospitals currently use different data communication protocols, software and hardware, which makes the sharing of information very difficult at best. A solution to the above problem would be the establishment of a protocol independent data communication network that will extend the usefulness of testing investments in university information systems.

The Open System Interconnect (OSI) model was developed for linking different types of computers In reality, two computers using TCP/IP would be able to communicate even if they were based on different hardware and software platforms. Like TCP/IP, OSI enables a computer connected to a network to communicate with any other computer on the same or different networks, by establishing communication rules that permit the exchange of information between dissimilar systems (Laudon and Laudon, 2000).

In order to exchange medical information, Health Level 7 (HL7) is used. This is a protocol that is used to allow medical computers from different vendors to communicate with each other (James, 2001). It's supported by most system vendors and used in the majority of large US hospitals. Shoichier *et al.*, (2000) believe HL7 is the most successful among standards for its syntax and authoritative standards for medical information exchange between health care providers. Therefore, researcher recommends HL7 to be used for transferring medical information among University Hospitals in Saudi Arabia.

C. Establish unified communication standards.

According to Laudon and Laudon (2000), enterprise systems promise to create a single integrated data corporate base environment that gathers data on all the key business processes. Medical research in University Hospitals requires the exchange of bandwidth intensive applications such as imaging and video. An image or a video, once produced, can be stored in a central archiving system for future retrieval (see Figure 8.3).

This database will hold frequently accessed information for faster downloads. This database will have: documents, image files, video files, tutorials and patient information. Chapter five noted that many of the questionnaires survey respondents felt that some

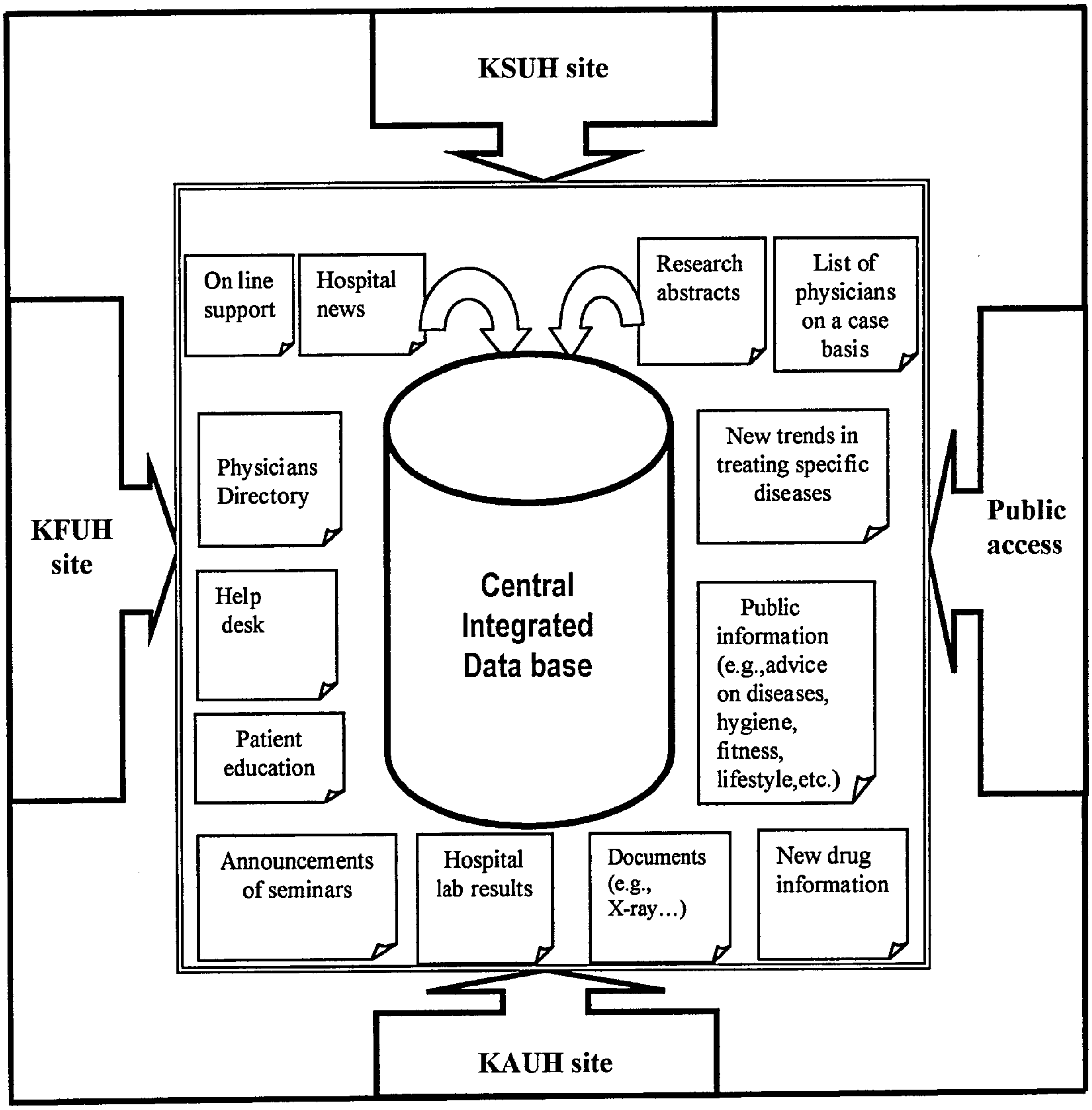


Figure 8.3 Proposed central integrated database

information should be shared, such as new drug information, new trends in treating specific disease, announcements for seminars, hospital lab result, and hospital news.

D. Identifying and understand existing network infrastructure and sharing information resources

The aim of this study was to describe the existing infrastructure and to identify the needs for new technology, standards and upgrading of hardware and software, and Internet connection. Nevertheless, the current network systems infrastructure had to be investigated in order to understand what it would be needed to replace and expand these. Participating universities need to understand the current situation together with the people and obstacles they encounter both in and outside the university campuses. This survey indicates that poor infrastructure is one of the major issues in Saudi Arabia.

8.2.5 Maintenance and monitoring relevant system

A. Prepare and organise ICT specialists for network activities

The function of ICT specialists is the maintenance and technical support of users. Those ICT specialists must be identified to maximise the availability and reliability of the network while promptly responding to system outages and interruption. Universities need to prepare ICT specialists for network activities to plan, design, troubleshoot and implement the network in addition to planning for future expansion. ICT specialists should work with system managers and network suppliers to resolve problems in a timely way. Therefore, number of ICT staff needed is not easy to define precisely because it depends on the network capacity and university size. However, derived from the average picture based on the interview and documents analysis research recommends that at least six people are needed at each site. These are project manager, system administrator, network administrator, network technician, and, training manager, system analyst.

B. Monitoring and measurement of performance

It is very important to understand the operational activities required to meet the current service needs of the diverse user population. Gaps can be identified between end-user needs and their expectations and the on-going service that is available. General criteria including flexibility, performance, reliability, functionality, interoperability and ease of operation should be identified. Each University should have a committee to monitor and measure the performance of its services. Also, each university should adopt new techniques, such as internal audit of performance criteria as measured against benchmarks, to improve computer network services.

C. Adopt quality assurance criteria

Universities should establish procedures for continuing analysis of effectiveness and efficiency. Moreover, benchmarking activities are required on a continuing basis to assess the effectiveness and efficiency of the information services on each site. Also, universities should request the vendors (computer suppliers) to test and verify each hardware and software element in the network as it is installed to meet quality assurance criteria. As well, universities should make sure that the vendors are providing identical versions of their products and those versions will not become out of date before installation. There is a solution available for this issue – to ensure that all upgrades can be implemented across platforms.

D. Provide security privileges

The proposed Saudi University Hospitals Network would allow the exchange of vast amounts of information, which ranges from public information (on disease, health, and lifestyle, etc.) to more sensitive information. For example, different end-users may access medical records from remote locations. However, confidentiality and patient privacy must be respected and protected. Therefore all computer users must be uniquely identified. Moreover, each University Hospital must divide its site into two parts:

- a public site that could be seen by the public (disease, lifestyle, etc.)
- a private site that is hidden from the external world (accessed only by authorised personnel such as physicians, nurses, etc.).

As has mentioned in the literature, medical information is more sensitive than other types of information. Therefore, physical security is very important. Medical information in Saudi University Hospital should be restricted and patient confidentiality must be respected. Figure 8.4 summarises four aspects of access control.

Control technique	**Example**
Enforce manual data handling guidelines	• Lock desks • Document and manuals should only be shared on a need-to-know basis
Define access privileges	• Different individuals should have different level of privileges for using the computer • Different individuals (eg., physicians, nurses, patients) should have different level of access to specific data files
Enforce access privileges	It can be done via • Some thing you know(Password or PIN) • Some thing you have(ID card, Key ,token card) • Some thing you possess(Digital signature, finger print, eye, voice recognition)
Make data meaningless to unauthorised people	Data encryption

Figure 8.4. Access control to patient data, computers and network.

E. Assess and adjust network services

Monitoring of network services and evaluation are required as soon as the new system becomes a live and has end-user sign off. After the system becomes live some, problems and shortages of new services will be encountered. Therefore, assessment and evaluation of ICT services on the campuses is needed before developing new ICT services mechanism. Such a mechanism will encourage end-users to participate to improve the network service. Also, network services must be evaluated continuously (e.g. every six months) in order to modify and upgrade services to meet end-users expectations.

F. Determine problems and obstacles encountered

This study finds some evidence that there are a number of problems involved in establishing a national computer network among Saudi Universities. Technical problems revolve around hardware and software compatibility. Organisational and behavioural problems were also mentioned during the interviews. This study found that 74% of respondents rated lack of training as one of the major problems in using computers on campuses. Also, poor co-ordination (56%) management and lack of IT staff (both 49%) were rated as particular issues of note. Interestingly, lack of funding rated only 39%. Accordingly, Universities, in order to make effective plans need to understand and evaluate their current situation, technology capability and resource limitations (e.g., funding technology, ICT staff and other manpower).

8.2.6 End-user training relevant system

A. Provide sufficient end-user training tools and facilities

According to Drury and Smith (1999), there is a continuous need in any health care organisation for its employees to keep up to date and develop their knowledge and skills with the intention of providing and maintaining quality patient care. This is equally true in Saudi Arabia. Therefore, all Universities should encourage their staff (existing and new) to use new technology effectively. Obtaining experience of new technology will lead to improvements in their skills. Furthermore, staff should be encouraged to subscribe to a professional association in order to keep up-to-date. Universities should prepare and make available all the tools that will facilitate the work - classrooms, projectors, computers, printers, etc., should be available to carry out the training.

B. Provide instructions, guidelines and manuals

The survey indicated that the majority of staff in Saudi University Hospitals rely on their colleagues to resolve their computer problems. Consequently, all University Hospitals should prepare documentation and guidelines that can be easily understood by all staff. This approach will permit staff to deal with their daily computer problems themselves. Eason (1998) identified several ways currently in use for promoting training for occasional end-users, such as manuals, on-line help, and hotline support. In addition to tutorial programmes, guidelines, and help desks for all staff, individualised instruction might be needed on all sites. For example, Hussein and Hussein (1997) indicated that individualised attention might be given when an employee needs to develop a specialised skill not needed by others, regardless of its high cost. Indeed providing instructions, guidelines and manuals will enable end-users to handle minor problems by themselves and will improve the productivity of organisations concerned.

C. Provide suitable courses to cover specific topics

For the system to become operational, a number of users must be trained in how to use the system to meet their functions' needs. Also the success of any system depends on the skills of the people who use and operate it. University Hospitals should sponsor, design and organise training programmes to provide staff with background knowledge, skills, and up-to-date information needed to support hardware and software. According to Sprague and McNurlin (1998), end-users need five types of training: information systems concepts, quick start, refresher aide, help in overcoming difficulties in advanced use, and explanation of the assumptions behind the models they plan to use. Moreover, Comac (1999) asserts that a successful project should offer staff a comprehensive training and development program covering the key areas of information management, information system and information security. Accordingly, all University Hospitals should design and organise or sponsor training programmes to cover a variety of areas. Figure 8.5 suggests the authors ideas of what should be covered in end-user training programmes.

Topics	Physicians (Patient facing)	Nurses/paramedical staff (Patient facing)	Computer staff (Back room)
1	Technical terminology	Technical terminology	Medical terminology
2	Basic skills, word processing, etc.	Basic skills, word processing, etc	State of the art in ICT
3	Information security	Information security	Information security
4	Information retrieval	Information retrieval	Computer communication
5	Computer access and data entry	Computer access and data entry	IT application in Medicine
6	EHR & EPR	EHR & EPR	Information confidentiality
7	Telemedicine and Tele-care (Tele-health)	Information handling	Telemedicine and Tele-care (Tele-health)
8	Legal and ethical responsibility of ICT	Information management	Data warehousing
9	Web	Web	Web
10	Produce medical reports	Produce medical reports	Troubleshooting
11	Dealing with minor computer problems	Dealing with minor computer problems	Data protection
12	Management of change	Management of change	Management of change
13	Visualisation and image retrieval	Initiating administrative reports	Data modelling, coding, and system analysis
14	ICT in context of medical applications	ICT in context of medical applications	ICT in context of medical applications
15	Using e-mail	Using e-mail	Using e-mail

Figure 8.5 Authors indications of what topics could be included in training programmes in Saudi University Hospitals.

C. Provide well-trained lecturers

Training programs should be designed to provide staff with the necessary knowledge and skills to use computer systems in way that is appropriate to their occupation and the service needs of the patients. Different skills and experience are required. Also, tasks should be given to the right person. Therefore, Eason (1998) advises that if computer skills are required, then computer specialists should tend to do the training. It is assumed that consultants and outside experts will bring new knowledge to the organisation. For that reason, all Universities should attract consultants and skilled people from external sources either nationally or internationally. The author suggests that expertise from outstanding universities, computer companies, hardware and software suppliers, training centres etc, should be invited to organise and conduct workshops, seminars, lectures.

8.3 Stage 7 SSM: Taking action

According to the Checkland approach, the final stage of the SSM is taking action. In light of the data analysis a list of possible changes are arrived at with the purpose of improving the current situation and recommending further steps, which must be taken to bring the national computer network system to life. There is evidence that issues in Saudi University Hospitals are multi-dimensional, which could be summarised as follows:

- Organisational issues (cultural, political, environmental, management, and financial),
- Technical issues (hardware, software, network capacity, connectivity, database and telecommunications), and,
- People issues (attitudes, end-user training, health and staff performance, and evaluation).

Different factors play a critical role and have a great impact on the use of ICT in Saudi University Hospitals. Furthermore these issues vary from University to University, so any recommendations should be modified to fit each University' situation.

The proposed and constructed system model is composed of six systems. This conceptual system model might be taken as a model for an idealised University Hospital in Saudi Arabia. Since the situation differs from each university, the model is built on the average picture derived from the study. The author strongly believes that the total conceptual model covers the major issues such as funding, technology, training and maintenance. Also, it can be used as the basis for establishing a national computer network system.

From an external perspective, the study indicates that the Government should pay more attention to and focus its effort on the key issues to implement the proposed system by upgrading the existing communications infrastructure to provide links that support high-speed data exchange among all universities. KACST and STC should take the lead by adopting ICT and should try to help universities to take further steps toward effective implementation and utilisation of ICT in all Saudi organisations. Also, KACST should develop more training programmes to increase end-user awareness among the Saudi academic community in particular and Saudi society in general. However, the Ministry of Health should be involved in such a project in order to improve health care and obtain the experience necessary to build a national health information system, linking the entire country eventually. Computer companies (hardware and software) should be involved by finding ways to sell and market their services and products. Universities, private training centres, government organisations, such as the Institute of Public Administration, are recommended to provide computer courses and training programmes.

In this study the types of change that arise as a result of analysing the problem situation can be summarised in the following manner: Change in structure, procedure, policy and attitudes. It is clear that some of the statements can be equally placed in more than one category – this has been avoided although it is recognised that the classification is subjective.

8.3.1 Change in structure:

- University Hospitals should make organisational changes to fit in with the new system. For example, Hospital Computer Managers should report to the Vice-Dean instead of reporting to the Head of the Maintenance Department (KFUH, KSUH) or the Head of Administration (KAUH),
- united IT committee for all Saudi universities should be formed,
- Saudi government should create committee to plan a national health network,
- computer training room lay out in some hospitals should be changed.
- KACST and STC should address communication problems and make ICT infrastructure more effective,

8.3.2 Change in procedure:

- project management team should be created to set missions, policies, and priorities and to secure the necessary funding commitment,
- there is a need in all Saudi Universities to enter into collaborative relationships with other organisations engaged in similar computer projects nationally and internationally to take advantage of their experience,
- effective management and more applicable training programs are needed to exploit computer and related technology effectively,
- different ways of training techniques and methods, such as distribution of leaflets or individual tutorials, are needed to encourage hospital staff to use the available technology,
- receive, organise and provide information for teaching and research,
- provide and organise network facilities for teaching and research.

8.3.3 Change in policy:

- each University Hospital should resolve their issues (technical, behavioural, organisational),

- hospital Computer Departments should provide more training courses to encourage staff to use the available technology,
- employment policy in each university should be changed,
- ICT experts are needed on each site,
- new policy should be formed to implement electronic patient records.

8.3.4 Change in attitudes:

- end-user (physicians, etc.) involvement and top management support are needed,
- convince staff to use the hospital computer systems,
- considerable attention is needed to obtain patient consent and convince them to fill in the consent form,
- barriers and issues between administrators and physicians should be resolved,
- more management training programs are required to avoid resistance to change and negative attitudes toward computers,
- participation and end-user involvement include physicians are very important in system development in order to convince end-user to implement and use the system,
- give staff an opportunity to share their perception and experience of their system problems.

8.4 Integration of conceptual models

The proposed system will involve a stepped approach to full implementation. The first stage comprises linking all three Saudi University Hospitals in a corporate Intranet. Following this, it is proposed that this corporate intranet be connected to all public and private hospitals in Saudi Arabia, forming a clinical WAN. Finally, this WAN could have its own Internet domain name that would allow all clinicians to register with the network. Combining the six relevant systems results in a systemic view of the computer network system proposed for Saudi University Hospitals after Phase 1 above. (see Figure 8.6).

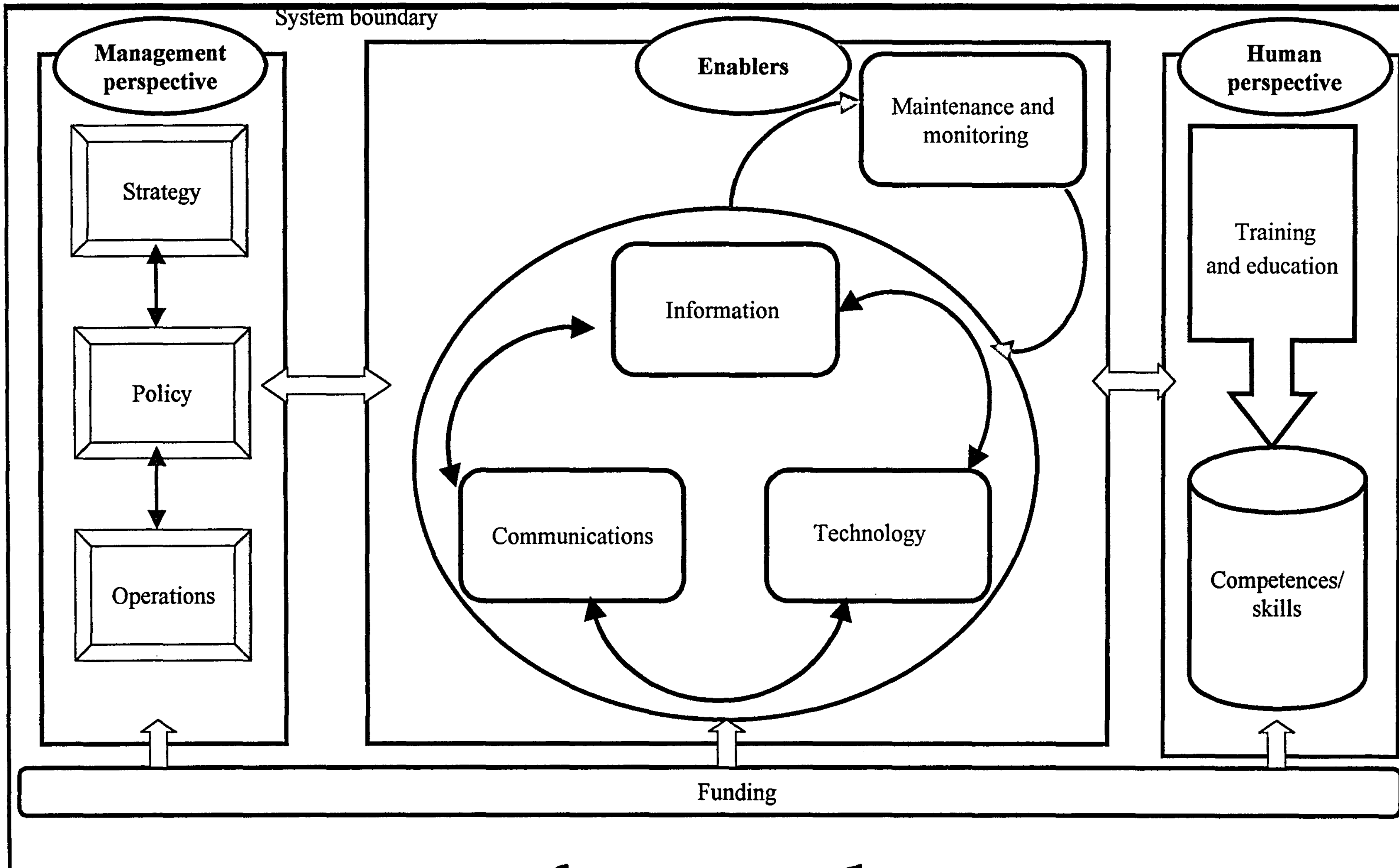
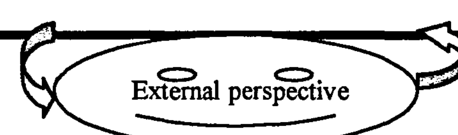


Figure8.6 Conceptual model of the entire system



It is clear that the non-existence of this kind of computer network system results in the failure of the exchange of medical information among Saudi University Hospitals. It also minimises the sharing of medical/technical experience and knowledge due to the lack of information exchange. Usually, computer networks are built through co-operation and co-ordination among organisations. Thus, to establish a national computer network for University Hospitals it is essential that Universities co-operate at all levels such as strategic planning, policy, connectivity, network management and operation, end-user training and so on. However, specialised committees and work groups are needed to oversee and look after planning, development and operation of the new network. Larry and Tom (1990) advise the application of the following generic rules that will facilitate the project and ensure success:

- assign responsibility to the subproject level,
- religiously maintain baseline requirements,
- integrate vendor sub-teams within the overall project plan,
- control contract and network modifications,
- develop a negotiations plan, and,
- draw on the organisation's diverse areas of technical expertise.

As stated earlier, in order to facilitate the suggested work and ensure success, a committee structure that includes strategy, policy and operational detail is recommended. The Strategic Planning Committee should have overall responsibility to co-ordinate the sub-committees, as explained below. (See appendix k)

Strategic planning committee: This committee should consist of Vice–presidents of concerned institutions, representatives of involved organisations such as KACST, STC, the Ministry of Planning, Ministry of Health, Ministry of Higher Education and Ministry of Interior. Their main tasks would involve approving the strategic plan and allocated budget, as well as over-seeing the following sub-committees, described below.

1. *Technical committee:* The main task of this committee is to evaluate, test and implement the network hardware and software. It consists of university computer centre directors, hospital computer department managers, external computer consultants, and representatives of KACST and STC.

2. *Medical committee:* This is composed of university hospitals managers, hospital computer department managers, consultants in IT application in health care, and representatives of medical staff (physicians, nurses, etc.).This committee would emphasise on medical issues such as patient confidentiality and privacy.

3. *Administrative committee:* This committee comprises hospital administrative managers of concerned institutions, representatives from the Ministry of Higher Education, Ministry of Health, Ministry of Planning, KACST and STC. They will primarily concentrate on administrative issues (co-operation and co-ordination).

4. *Financial committee:* This committee is composed of financial managers of concerned hospitals, representatives of the Ministry of Higher Education and the Ministry of Finance. Their task is to approve the project budget and to find alternative support.

Furthermore, external expertise is essential to implement successful system. Therefore, expertise from industry, either nationally or internationally, should be invited to participate. As was seen in Chapter 4, developed countries such as the USA and the UK, have already set out and implemented successful hospital information systems. Therefore, lessons should be learned, and experience should be used in order to avoid the errors and mastics, which they had made (see also Chapter 9).

University Hospital Managers and information systems executives at each site are needed to take the lead in helping to change hospital cultures and process. They could prepare a general strategy that demonstrates how a network infrastructure can help to meet strategic objectives, including fast response and reduced overheads. They will help to bring their organisations networks into the strategic phase of network maturity and will reap the benefits of this positive change. There is an acute shortage of qualified and skilled manpower in the area of computers in general. A lack of skilled ICT staff was found to be critical issue. Therefore trained and skilled people are required to plan, implement, operate and support the new system. However a certain number of ICT professionals are required in each University Hospital.

8.5. Discussions with key people identified as change agents

A clear picture was gained through direct observation and through data and information collected at each of the sites visited. Discussions were held with key people (see appendix D) about the objectives of the proposed system and how Saudi universities in general, and University Hospitals in particular, can benefit from it if such system will be implemented in the future. The expected impact of the proposed system to bring about change was discussed in more detail in these discussions. Problems and issues were discussed intensively at every opportunity in the fieldwork. Deans of medical schools believe that the proposed system is an excellent idea and would appreciate the health gains. They also see that their ultimate goal is to establish a national health network. In general, although the project is viewed as highly ambitious, all the deans of the medical schools are willing to support and give enough help to investigate the problems and issues that might be encountered in the future.

Change agents such as University Computer Directors indicated that, due to the revolution in technology and mature growth in computer networks, it is now possible to connect all Saudi universities electronically. In terms of manpower, Saudi Universities have qualified staff in computer-based technologies, who have pursued their higher studies in advanced countries. These are the people who will facilitate and guide the universities to adopt and implement technology and exploit it efficiently. Regardless of this fact, the number of professional staff who have experience and/or a reasonable knowledge to operate and use the technology is still limited. Therefore, external ICT professionals are needed. Some issues are expected to be encountered such as lack of ICT professionals with general skills, insufficient funds, lack of co-operation and co-ordination among Saudi universities and other organisations.

Furthermore, visits made to some private and public hospitals, charity organisations and computer companies to gain first hand experience of their work, to discuss issues and look for an opportunities to share experiences (see appendices E & F). Discussions were held with senior managers and ICT professionals regarding what is going on and what are their future plans to use ICT. Also, issues associated with ICT in their organisation in particular, and in Saudi Arabia in general were discussed briefly.

The Saudi Arabia government started the preparation of a comprehensive long-term national plan for ICT for the period of 2000-2020. This plan establishes an advanced national information base capable of ensuring continued success of the development plans and programs and making optimum use of ICT. It indicates that a future expansion of ICT utilisation in Saudi organisations can be anticipated. The seventh national plan encourages all organisations to adopt and use ICT. (Ministry of Planning, 2000)

Discussion of my results led to some ideas about possible changes, which were agreed by key people to be systemically desirable, technically possible and culturally feasible and would improve the current situation in all University Hospitals. As has been mentioned in this study there is no clear ownership and the client exists in a scattered form, not as a single person or organisation such as the Saudi government or the University Hospitals and managers. It seems that the University Hospital Managers and University Computer Centre Directors that have been investigated could take action if they wished by commissioning the required work. They may take action as a result of this study because they are most likely to derive direct benefit from it. Consequently, the present systems study concludes with recommendations about possible changes to improve the problem situation. This is based on the output of the comparison stage followed by discussions and debate with change agents about changes and actions to improve the situation. Such changes were agreed, by the actors to be both systemically desirable and culturally feasible

8.6 Implementation of the strategic plan for this project

Implementation refers to all organisational activities, which work toward the adoption, management and reutilization of an innovation (Laudon and Laudon, 2000). Usually implementation requires hardware, software, communication lines and manpower. In order to ensure a successful implementation of the proposed system, this project will be implemented in phases (Figure 8.7). The implementation plan includes the following.

- Plan scope: This stage will be composed of strategic planning and the implementation plan. Strategic planning should be presented to and approved by the concerned institutions and involved organisations. The implementation stage should start immediately after the strategic plan has been approved.

- Technical assessment and system design criteria: This phase consists of the evaluation of various networks technologies (hardware and software) It also includes the design of a network model and detailed specifications of the network including the standards to be used. General criteria should be considered such as reliability, flexibility, performance, ease of operations and so on. This list of criteria should be used to evaluate and compare the current system against proposed systems.

- Pre-installation preparations: This phase investigates and defines end-users who will use the new system and prepare a list of user requirements (e.g. user surveys). Multiple end-users (e.g. physicians, nurses, managers etc) have different sets of requirements and needs. Information of this kind is very important and critical in estimating future usage patterns.

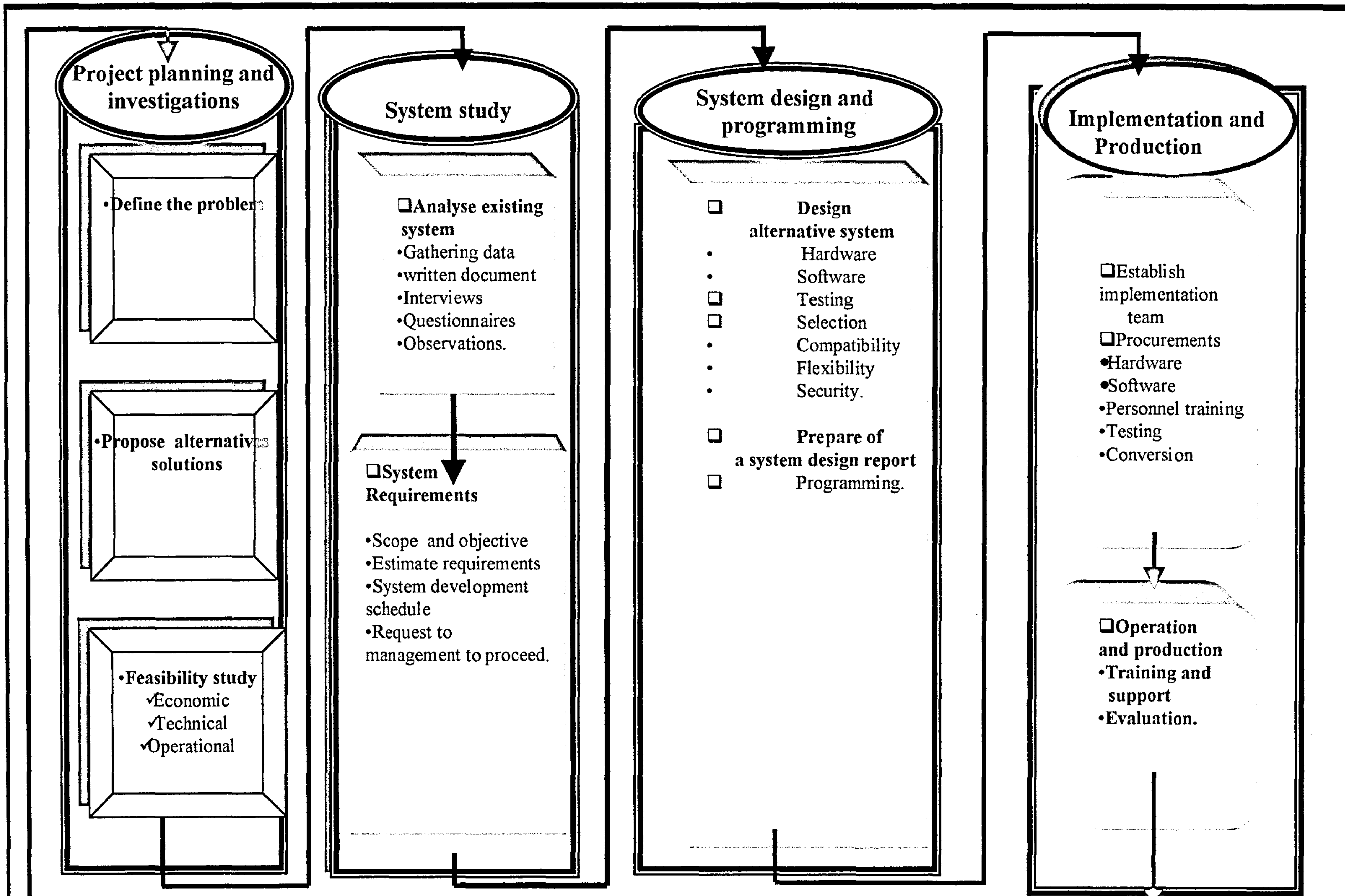


Figure 8.7:System development life cycle for the proposed system

- The implementation approach: This phase consists of the procurement of network hardware and software and the installation and testing of those network components to implement the proposed system. There are different implementation approaches to implement new system (cut over, phases, pilot). As well, the implementation phase will include the organisational structure of the implementation team, and the conditional and final acceptance test plan.

- Operations and production plan: The new system will be in operation and end-users will sign off after the implementation stage is finished. This stage will focus on how to make the transition from implementation to an operations environment. Also, it will concentrate on an end-users support plan, operations training and a training plan (e.g. end-user training for the new system).

8.7 Summary

This Chapter has discussed the basic concept of the change required to achieve SUHNS by considering SSM Stages Six and Seven. A list of possible changes that could be made to improve the current situation were identified according to activities of each sub-system. Discussions with key people were held to discuss the proposed system objectives and how Saudi universities in general, and University Hospitals can benefit from it if such a system is implemented in the future. Visits were made to external parties such as public hospitals, and computer companies to gain first hand experience of their work, to discuss issues and look for opportunities to share experiences. Issues associated with ICT in their organisation, and in Saudi Arabia were discussed. It was concluded from these discussions that changes could be identified, which were agreed by key people to be systemically desirable, technically possible and culturally feasible and would improve the current situation in all University Hospitals.

Linking these six subsystems will provide a model of the integrated system. The situation differs in each Saudi University Hospital, consequently, the model is developed on the average picture derived from the study. The conceptual model covers the major issues and it could be used as the basis for establishing a national computer network system. The study indicates that the government should pay extra attention to, and focus its effort on, the key issues to implement the proposed system by upgrading the existing communications infrastructure. KACST and STC could take the lead by adopting ICT to try to help universities to take further steps toward effective implementation and utilisation of ICT in all Saudi organisations.

The next Chapter brings all the threads of this work together, by discussing suggested change from three perspectives: University view, University Hospital view, and an external perspective.

Chapter 9

Discussion

9.1 Introduction

This study has investigated several issues related to ICT adoption and the use of computers and computer networks in University Hospitals in Saudi Arabia. This chapter presents a summary of findings relating to the main questionnaires, interviews, direct observation and document analyses. Those can be discussed from three different perspectives: a University Hospital point of view, a University perspective, and external perspectives.

9.2 University Hospitals' Perspectives

9.2.1 Use of computers at work

To investigate the use of computers in Saudi University Hospitals several metrics were used, for example, availability and types of computers used at work (stand-alone or networked). Availability and use of computers at work show that there are significant numbers of medical staff using computers at work (87%). Out of this number 10% used a stand-alone PC. This study also examined the accessibility and use of the Internet by medical staff. Findings show that the percentage using the Internet was low. This indicates that the medical staff had limited access to the Internet connectivity. Findings shows that only 50% of KAUH was networked at the time that the data were gathered, and it is also worth noting that personnel from KAUH are the most infrequent users of computer networks. In contrast, some University Hospitals have achieved considerable levels in the adoption and use of computer and related technology. However, Hospital Computer Managers remain dissatisfied because the computer systems did not match all their needs, although computer facilities were not fully exploited.

9.2.2 Use of computers at home

The use of computers at home and accessibility to the Internet by medical staff were examined in this research study. This study shows that the majority of medical staff (53%) uses a computer at home. More than half of those were male (55%). In terms of network connection of those with home computers (43%) used stand-alone equipment. However, this study indicates that the majority of medical staff and others do not have access to the Internet from home and connection to the Internet from those who had it was very rare. Physicians are more likely to own a PCs than rest of the subject group. 60 physicians out of 94 own a computer. This high figure of PC ownership and network use at home was not expected prior to this survey. Hospital Computer Managers and some physicians on different sites indicated that using computers and the Internet in Saudi Arabia by physicians is now fashionable and 'state of the art'.

9.2.3 Using computers and computer applications

When investigating the use of computers and various applications, it was found that medical staff had only recently been introduced to these functions. However, use of computer applications was very high except for the Internet and email, both of which showed low levels of use. This indicates that staff have limited access to networks or connection to the Internet was very rare. It is believed that this is because the Internet is still in its early stages in Saudi Arabia, though it is expected that University Hospitals will adopt and use this technology in the near future. It is also worth noting that some universities used computer networks facilities more often than others for activities such as electronic mail, word-processing, data transfer and the Internet. Nevertheless, this survey showed generally lower levels of those activities in KAUH. Generally, there is great interest and enthusiasm in Saudi Arabia to use computers and computer networks, not only from the office but also from home. This finding was backed up by anecdotal evidence from the interviews with key staff members.

9.2.4 Medical staff attitude towards computers

Of all the studies reviewed in the literature, only two were conducted specifically to determine the attitudes of physicians and nurses towards the use of computers in Saudi Arabia. It was discovered that medical staff had a positive attitude toward computers since 55% of them were very happy, while only 5% were moderately uncomfortable. Since this study indicates a positive attitude towards the use of computers among medical staff, further expansion of computer use in University Hospitals can be anticipated.

9.2.5 Computer training and computer training satisfaction

The findings of this study indicated that the majority of medical staff (72%) had received computer training but of those who had received training, a large proportion (74%) were dissatisfied with the training they had received. Therefore, effective management and more applicable training programmes are needed to exploit computer and related technology effectively. The majority of medical staffs were happy and enthusiastic about using computers either at home or at work, regardless of having limited access to the Internet. Due to rapid changes in technology and the low level of satisfaction with computer training programmes, each University Hospital should trains their staff in computer applications if it aspires to cope with new technology and provide excellent services for patients.

9.2.6 Co-operation, efforts needed and other issues

This study was pioneering in representing an initial attempt to fill the gap noted in the literature. It provides descriptive information regarding the current situation, experiences and expectations of hospital professionals and computer centre directors toward the establishment of a national computer network system to exchange medical information. There was also a lack of empirical research on establishing and managing computer networks in Saudi universities.

This study found that KAUH lags at least 10 years behind in computer use and related technology for medical purposes while other University Hospitals have already made extensive use of computers and have thus obtained reasonable knowledge and experience. However, medical staff in each university had insufficient ICT knowledge, experience and skills to manage and use computers efficiently to take full advantage of their hospital information systems.

The study indicates that there are political barriers between administrators and physicians. Every University Hospital experiences and suffers from a variety of problems such as technical, behavioural and structural issues. Moreover, end-user involvement (physicians, nurses, etc.) and top management support were needed to develop and implement a successful hospital information system. Hospital Computer Departments provide training courses to encourage staff to use the available technology but they have several limitations such as funding, technology, and lack of ICT staff.

Lack of training was viewed as the major problem in using computers on the university campus. Lack of co-ordination was also seen as a significant issue, whilst poor management and lack of ICT staff were further issues. Therefore, more attention should be paid to computer training programs, as well as co-ordination and co-operation among Saudi universities. Each hospital has difficulty in computerisation and managing the large amount of work. Creating co-operation and co-ordination among University Hospitals is vital to exchange knowledge and experience for the benefit of the Saudi education and health care system.

9.3 Universities' perspectives

From a university perspective, the following points have emerged from this study. KSU and KFU had the most advanced computer systems and computer facilities. Also, they had strategic plans to upgrade their own systems to cope with rapid change of technology with the intention of offering excellent computer facilities to their users in their campuses. In contrast, the KAU campus network was found to lag behind when compared with the KSU and KFU. Indeed KAU is still taking the initial steps to implement their computer network system. Also, it suffers from insufficient funding and a lack of ICT professionals to run the system.

All universities suffer from lack of personnel who have a background in computers and computer networks and who were willing to improve themselves and participate effectively. At the same time there was a lack of co-operation and co-ordination among Saudi universities to exchange knowledge and experience for the benefit of the higher education system. Each university suffers from a lack of experience and knowledge in the operation and use of computers. Appreciation and understanding of the computer role in improving education system varied from university to university.

University Computer Centre Directors expressed their concerns regarding hardware and software compatibility issues, shortage of ICT staff, and also security issues. The study found that establishing a national computer network system was viewed as important in improving the higher education and health care systems. Actually end-users are including physicians, felt that participation and user involvement were very important in system development in order to implement successful computer network system. On the other hand, there is an urgent need to address communication problems in all Saudi universities since there is an insufficient infrastructure with regards to communication. In terms of IT committees the study indicates that in KSU the IT committee was found to be proactive while others failed to function effectively. Furthermore, there was no IT user committee to monitor the computer services in all universities to measure and evaluate ICT performance on the university campus.

Computer training programs were not sufficient and there were difficulties in training due to different staff having their own needs and requiring specialised training to meet those needs. Also, the cost of training and a lack of training consultants were problems, which were difficult to solve. There was resistance to change and negative attitudes toward computers in particular and toward change in general among staff in all the universities. The current use of computers and computer networks in all Saudi universities positively correlated with future plans to realise and adopt computer technology. Study indicated clearly that future expansion of computer adoption and utilisation in each university can be anticipated. Each university had a variety of organisational structures and experienced behavioural and technological issues as other organisation in Saudi Arabia, such as limitations of funding, favouritism, bureaucracy, and lack of motivation.

The Internet has become an indispensable resource for all kind of business and it has received much attention both in academic studies and managerial practice in Saudi Arabia. Unfortunately, KAU is far behind in its use of the Internet and some staff are not making use of it. It was found that all universities depend heavily on foreign computer and software companies (e.g. IBM, Microsoft) rather than Saudi companies to develop computer software. However, there is a need in all Saudi Universities to enter into collaborative relationships with other organisations engaged in similar computer projects nationally and internationally to take advantage of their knowledge and experience. It was necessary to establish project management team to set missions, policies, and priorities and to secure the necessary funding commitment for a national computer network system.

9.4 External bodies perspectives

From an external point of view, the following points have emerged. It was found that there is inadequate information infrastructure, lack of regulation and weak ICT infrastructure in the country overall. The study revealed that the Internet connections in Saudi were first embraced and used in higher education and research institutions. However, Internet connectivity is still relatively low and the Internet access cost is very high comparing with other Gulf countries (eg., Bahrain). Recently, the Internet has become an area of considerable interest as Saudi organisations move to adopt it.

However, adoption of the Internet in Saudi Arabia has been slow because of social, religious and cultural consequences. Those problems are more likely to be more important rather than technical issues.

The Saudi government is very concerned about the negative aspects of computer use that conflict with the Islamic faith, as Saudi Arabia is the ideal model and leader of Islamic countries. Further, the majority of the Saudi population is religious and conservative by nature. Therefore, the government appointed a national committee to consider the advantages and disadvantages of public access. As result, KACST conducted several studies on how to avoid the negative aspects of the system before its introduction to avoid the mistakes committed by some Arab countries as mentioned in the literature (see Chapter 3). Additionally, this study found that there is evidence that Internet network connectivity in Saudi would also encounter some organisational, behavioural and technical problems.

Supporting services provided by private and public bodies such as STC and KACST were insufficient. Each university expressed its dissatisfaction that the slow downloading of some applications from the Internet via KACST, which acts as the Internet gateway. For example, there were difficulties in downloading applications and problems in transmitting work that contains images, graphics and/or scanned pages. STC has significant difficulties adjusting to another kind of organisations due to the fact that STC has just transferred from the public sector and therefore has the problems of the old system together with those of the new. The study indicates clearly that there was a lack of co-operation and co-ordination among Saudi universities, between KACST and STC, and among Saudi organisations overall. KACST also has several problems regarding its own organisational structure and as well as technical problems with the Internet since it acts as the Internet gateway.

9.5 SUHNS-like systems in advanced countries: experiences.

There are similarities between the proposed SUHNS system of this study and the UK's NHSnet and Wisconsin's WHIN system in the USA. Essentially, these applications have been the first national (NHSnet) and state-wide (WHIN). Thus, SUHNS will be able to take advantage of being a 'follower' in the technology race. Barriers to progress in both systems have been identified, such as lack of knowledge in the operation and use of technology, poor training and education, the challenges of integration and lack of standards, lack of funding and high cost of ICT, resistance to change, organisational and technical problems, information security and patient confidentiality.

There are important differences in implementation. For example, NHSnet was a UK Government initiative that was implemented in 'top down' mode, compared to the 'bottom up' approach taken in this study. The top-down approach breaks system whole into subsystems. Each subsystem is then further broken down until a subsystem cannot be broken down any further. Users study the system starting from the highest level to the lowest level of detail, from the general to the specific, from the abstract to the more detailed. This approach helps users see both the 'big picture' and the system into more manageable system units. In contrast, the bottom up approach starts from the lowest level to the highest from most specific to more general. Indeed, there are both advantages and disadvantages to both methods and much can be learned by noting the successes and problems experienced by other nations which have attempted to implement such systems into their health services.

For example, in the case of the NHS in the UK, a number of significant successes are claimed by Bellingham (NHS Information Authority Chairman) and Bell (Chief Executive) in the NHS Annual Report 1999/2000. In this report, it is noted that success depends on the ability to supply easy access to accurate information when it is needed. Furthermore, the system must support and facilitate the administrative procedures, which are involved in the efficient running of the NHS; such as ordering tests, referring patients and booking admissions. In order to achieve the level of service required, the report asserts that close collaboration with stakeholders is vital and that six areas are of greatest important in such collaboration. These are access to information; information for personal health; information for population health and service management; knowledge management; information for organisations and businesses; and ways of working with information. The NHS has separated project management from people management and has also focused efforts on education and training in order to meet the new challenges of technology.

It is the intention to connect all general medical practitioners to NHSnet by 2002 and to implement a working Electronic Health Record by 2005. Furthermore, the National Electronic Library for Health is already in operation and the NHS portal site, nhs.uk is also up and running. This gateway manages to link NHSnet with the Internet and provide a single point of entry to all the NHS web sites. New data standards have been issued and healthcare terminology, combining two world terminologies, SNOMED RT and the Clinical Terms Version 3 (Read code), is being developed as result of working jointly with American pathologists. Moreover, HL7 is now becoming the recognised international standard for passing medical information electronically, with majority of large US hospitals, also in Australia, Germany, Japan, New Zealand and the UK.

However, inspite of the optimism voiced in the NHS Annual Report, there are a number of difficulties and problems from which those who seek to implement new systems can learn.

SUHNS is proposed as an integrated medical communication system that incorporates these factors. By being a technology 'follower', expensive errors may be avoided. For example, the Department of Health in the UK spent £4 million on buying the rights to use Read Codes as a means to codify medical information, only to find that they cannot be adopted. Grimson (2001) argues that a great deal of money has been wasted in the organisation of the new system. He argues stakeholder involvement is essential; a campaign of change management is necessary if the user community is to be truly involved. However, he asserts that change management has been left to local NHS organisations when a more centrally driven action is necessary. Furthermore, although the IfH (Information for Health) document acknowledges the need for culture change, there are no explicit explanations to suggest how this will come about. He concluded that inadequate emphases is put on change management and that as result, there are a medium to high risk in delivering the overall aims of IfH. In short, Grunson argues that a co-ordinated effort is required, as the IfH is vague on a number of areas including action on creating record standards as data are often scattered.

Information system integration is a major problem and the challenge in health care is no less and probably more demanding, than in other domains. Hasselbring (2000) claimed that it is increasingly difficult to draw a line around an application system and say that you own and control it. In many application areas, data are distributed over a multitude of heterogeneous, often autonomous information system, and exchange information is not easy. In UK strategy those system integration cost remain high, both in the implementation and maintenance phases.

A major problem in the UK system is that it is disaggregated, i.e. NHSnet is a communication channel; EHR/EPR is the patient record management structure. Also, the problems surrounding data are noted by Dignam (2001) who sees two major areas of concern: firstly that medical records stored on electronic systems may not be secure and secondly, that legal action might be taken against the health service should the level of service prove unacceptable because data are lost, destroyed, or for some reason, become inaccessible. As a result, he asserts that the NHS must take risk management much more seriously. Furthermore he claimed the health care sector has not take full advantage of experiences gained from the business sector.

SUHNS should therefore establish partnerships and enter into collaborative relationships with other national and international organisations engaged in similar projects to take advantage of their experience. On the other hand, Saudi Arabia is a unique country in terms of culture, religion, etc.; therefore, adapting ICT will have to be done with caution. SUHNS must take into account the cultural differences, meaning that the suggested changes must be applicable to Saudi culture. Consequently, culture and social issues should be considered.

Both Pearce and Young (2001), and Folmer (2001) emphasise the need for changing attitudes within the NHS if the new system is to be successful. In order to achieve this, they emphasise the importance of training for staff. They believe that there is still a considerable amount of work that needs to be done in term of policy and culture change. For instance, Former states providing access to technology is only one side of the coin. The whole change process hinges on the way we use the IT and information to help the NHS improve patient care. It is clear that the system itself is not enough; the ability to use it effectively and efficiently is of greater importance. Education and training development is vital for the successful implementation of IfH, Gibbs (2001) believes that the NHS needs to invest in education and training development to support clinicians and managers in reengineering the clinical processes.

Thus, the issues raised by the implementation of NHS net in the UK have provided many points for SUHNS. It is clear that those who will develop SUHNS can learn a great deal from experiences in the UK. In doing so, common errors will be cut drastically because of the reactive nature of the work to be undertaken.

9.6 Expected problems of a general nature

Following from the three views defined above a set of problems of a general nature can be formulised as follows. Respondents expressed future concerns about the lack of adequate top management support to deal with problems involved in running and managing the proposed national computer network system. Technical problems, associated with both the quality of services and hardware and software compatibility, are likely. Furthermore, some IT directors expressed concern that top management might be not adequately informed about the difficulties which might be encountered in establishing the proposed system. However, top management support, end-user involvement and the degree of success in getting the system up and running are very difficult to anticipate.

The study revealed that problems associated with the use of a national computer network system would possibly lead to a change in organisational structure in each university. Also, the study indicated that integration of the existing scattered and isolated systems is not an easy task because it might lead to significant organisational change in workflow, communication patterns and internal processes. Furthermore, integration may perhaps lead to a change in the balance of power among departments within the hospitals.

Physicians are powerful players in the hospitals, while ICT specialists are conversant in IT in medicine. This might lead to a potential conflict in who owns the system and controls it. The study indicates that it will be not easy task to estimate network cost because information is found in many different places and the cost of ICT can change very quickly. University Computer Centres Directors also remarked on the shortage of consultants who will deal with such issues. The reliability of the system and system security were also mentioned.

The study anticipated several technical problems. Most of these revolve around hardware and software compatibility issues. In fact, the technical problems are interrelated with organisational and personnel issues as set out below:

1. technical issues (hardware, software, database, telecommunications, etc.)
2. organisational issues (cultural, political, environmental, management, etc.)
3. people issues (attitudes, training, health, evaluation, performance monitoring)

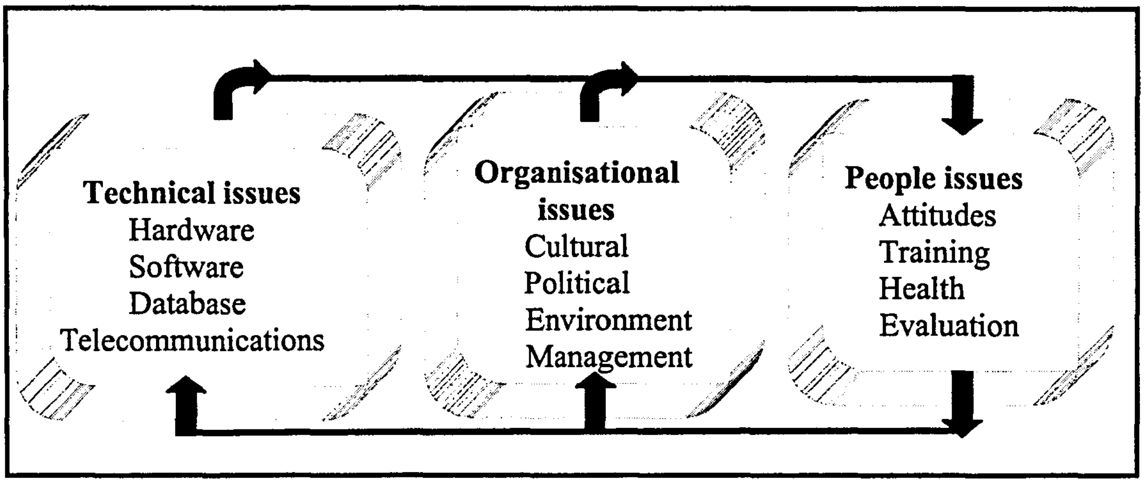


Figure 9. 1. Interrelated problems in Saudi Arabia Universities

Clearly, the anticipated technical issues are only one part of a large system that includes organisational and people issues. Indeed, the main barriers to progress of forming a national computer network system could be cultural and political rather the technical issues.

As can be discovered from the literature and fieldwork, this study is a pioneering study, which represents an initial attempt to fill the gap in heath care information systems in developing countries. Moreover, this is the first time that SSM has been applied to plan and implement a national computer network in institutions of higher education in the developing countries overall, and to Saudi Arabia specifically, to exchange medical information among clinical professionals. The problem in this project was highly complex because many people and many organisations 'own' the problem and are involved in some way and somehow. Chapters 7 and 8 provided guidelines to plan and implement a national computer network but the success of the project cannot be guaranteed due to the rapid change in ICT. Also, the conceptual models provide general guidelines and recommendations, which can be applied to other academic institutions or health care organisations with a little adaptation and adjustment to fit their situation.

9.7 Summary

This chapter has summarised the main findings of the questionnaires, interviews, observations and analyses of relevant documents from a University Hospital perspective, a University perspective and an external perspective.

From a University Hospital viewpoint, considerable enthusiasm for the use of computers and advanced technology was shown, with evidence taken from the questionnaire responses, interviews and the direct observation studies. Anecdotal evidence and references in the literature further demonstrate this. However within the interview sample, Saudi University Hospital staff were largely dissatisfied with the training they received and the computer network system left some needs unsatisfied. Although these negative attitudes were recorded, findings from the questionnaire analysis showed that staff remained positive about actually using the computer-based systems. Some political barriers were found to exist which prevent the provision of adequate services. Further problems were seen to be a lack of co-ordination within and between Saudi University Hospitals, as well as issues associated with technical, behavioural ad structural factors.

From a University perspective, all three Universities to which the Medical Schools were affiliated were found to suffer from a lack of suitably qualified personnel in the ICT field. Computer Directors expressed concerns regarding hardware/software compatibility, and security issues. Difficulties surrounding the cost and provision of training were also mentioned although there was general agreement that establishing a national computer network system was an important priority. One solution to the issues raised could be the formation of a strategic committee to encourage effective inter-university co-operation and other institutions. This strategic committee could consist of stakeholders from relevant organisations from which a sub-committee could be created to examine and develop different aspects of the new computer system.

Finally, from an external perspective, it was found that the information infrastructure in Saudi Arabia is inadequate for implementation of SUHNS. The cost of the Internet is high while connectivity is still relatively low. Support services provided by both private and public bodies are insufficient. This Chapter has investigated the example of the NHS Information Authority in the UK, in its setting up of a computerised health information system. Lessons may be learned from the critical success factors as well as the identified shortcomings of this system (see Section 4.4.1).

It is clear from the literature that this study can be considered as pioneering. It sets out to provide an attempt to fill the knowledge gap that exists in healthcare information systems in the developing countries. The study is a first application of SSM to understand the problem situation surrounding the planning and implementation of a national computer network systems in institutions of higher education in developing countries in general, and Saudi Arabia in particular.

The integrated conceptual model provides the basis on which technological and organisational change is predicated. This offers an opportunity for technology transfer of the application to other domains with only a little amount of adaptation and adjustment to fit their situation. It is concluded that it would be technically possible, systemically desirable and culturally feasible to connect all University Hospitals electronically to exchange medical information.

Chapter 10
Conclusions and Recommendations

10.1. Summary of the study

The principal aim of this study was to investigate the provision of a computer network system to link Saudi University Hospitals electronically in order to exchange medical information. This study contributes to knowledge and understanding of the issues surrounding the introduction of ICT to Saudi University Hospitals. It is clear that, as well as technical issue, there are also issues of culture, attitudes, and organisational structure. These various issues have been studied with respect to the existing literature base and empirical evidence has been collected via questionnaires and interviews. The needs, attitudes and expectations addressed fulfil the first objective of the thesis.

ICT is not a new concept for Saudi Arabia, as there is an existing ICT base, together with a developing information infrastructure. However, this study has found based on comments from interviewees, poor organisation and co-operation leading to an ineffective use of scarce resources. This picture of current activities, together with a description of help and advice methods fulfils the second objective.

While the fulfillment of objective two requires study at the level of the individual, to fulfil objective three requires a study of the organisation as a whole and how these organisations interact with each other to make best use of their developing ICT resources, concerned organisations must share knowledge, understanding and expertise. The changes necessary for this to occur are highlighted in Chapter 9 as Stage Six of the SSM. Understanding the multi-faceted change process is a considerable challenge. This study provides an introduction to such change and, as such, fulfils objective three.

To achieve the purpose of this study, an in-depth investigation was made to select the appropriate and best instrument to fit the study's aim and objectives, and a review of previous related studies from 1990 to 2001 was made. To obtain a rich picture of the current use of computers and communication technologies in Saudi University Hospitals, SSM has been used to investigate the existing problem situation and to identify change to improve it. Several issues that affect the planning and implementation of computer network systems were examined.

At the beginning of this project, there existed only a vague picture of the problems. Subsequently, the data that were collected allowed some clarification of these problems, as well as issues relating to them. The problem situation was presented based on the knowledge gained via questionnaires, interviews, action research, and my reading of relevant documents carried out during the survey. This was made highly detailed in order to obtain the richest picture possible in order to achieve a high degree of depth in the investigation. Root definitions were produced from the relevant systems and conceptual models then arose from these root definitions. The problem situation was outlined from the points of view of both information users and information providers. A comparison of the conceptual models and the real world showed significant differences in the opinions of these groups. As a result of the comparison between six derived themes (strategic management team, technology, maintenance, training, funding and communications) and the real world, an agenda for change was established.

Details of each system were designed based on this agenda for change and provided a model on the basis of which recommendations could be made. Changes have been considered in the light of the desirability and cultural feasibility of the system. Recommendations for changes, which were designed to improve the problem situation, were then prepared by studying the experience of academic institutions and healthcare organisations in advanced countries such as the USA and the UK. Finally, recommendations were then made for Saudi University Hospitals with the aim of establishing a nationwide computer network system.

10.2. Major Findings

From the study undertaken, the following major conclusions have been reached.

- Establishing a national computer network system for institutions of higher education to exchange information in all its forms is viewed as being important in improving both higher education system and also the health care system.

- The use of computers by medical staff in institutions of higher education in Saudi Arabia is relatively new. Despite that some University Hospitals have already achieved a considerable level of adoption and utilisation of computers and related technology.

- There is a great interest and enthusiasm in Saudi Arabia for the use of computers and computer networks both from home and from the office. Therefore, the adaptation and use of ICT in the country as a whole can be anticipated in the near future.

- The current use of computers and the positive attitudes of medical professionals towards computers in all Saudi universities is associated with future plans to adopt computer technology. So further expansion of computer usage can be anticipated.

- All Saudi Universities Hospitals suffered from a lack of personnel with sufficient ICT knowledge, experience and skills to manage and use computer efficiently to take full advantage of their hospital information systems.

- Lack of computer training programms and a lack of co-ordination were the major problems in using computers in institutions of higher education followed by poor management and a lack of ICT staff and policies. ICT problems in institutions of higher education are multi-dimensional and interrelated being technical, behavioural and structural issues.

- There was significant lack of co-operation and co-ordination among Saudi Universities in the exchange of knowledge and experience for the benefit of the higher education system. Therefore, greater co-operation and co-ordination among University Hospitals is vital.

- As well the lack of co-operation and co-ordination among Saudi universities, the study clearly indicates similar shortcoming in other Saudi organisations.

10.3. Recommendations

After analysing the results of this study and considering the major findings, the following recommendations can be made.

- The Saudi Arabian government should maintain and expand the infrastructure of the existing national computer network in order to promote a greater level of ICT and to improve access to the Internet.
- The Saudi government in general, and the Ministry of Health in particular, should start immediately to study, plan and implement the SNHNS, taking advantage of the knowledge of experienced countries. Also, it should develop the required administrative and technical bodies that are essential to manage and take care of the SNHNS and to ensure its continuous growth.
- The Saudi government should set out a national security policy and mechanisms to ensure the confidentiality, integrity and availability of information, and it should make this policy consistent with the culture of the country and its aims and objectives.
- The government should also re-evaluate the existing education system with regard to computer education and at all levels. For example in the School of Medicine, at least three or four courses in computer use and ICT are needed for tomorrow's doctors and nurses in order to give them an overview of how to use computers and take full advantage of ICT.

- The government also should encourage and support research and development activities, especially in the field of computer and related areas and should establish a national institution to provide high quality education and training for consultation and support in ICT. The staff of such an institution should be highly qualified and experienced.
- Furthermore the Saudi government should encourage active interaction between universities and businesses in order to exchange expertise in the field of ICT, and it should support the University Hospital network by improving telecommunication systems in the country, as well as providing better levels of funding to enable ICT networks to be adopted more quickly. This would benefit both Saudi academics and the health environment.
- A strategic committee should be established to encourage effective inter-university co-operation among universities and other institutions in order to establish a national computer network system for Saudi University Hospitals.
- The above-mentioned strategic committee should consist of stakeholders from relevant organisations such as KACST, STC universities, the Ministry of Higher Education and Industry. A sub-committee could also be created to examine and develop different aspects of the new computer system.
- University Computer Centres and HIS departments in each university should co-ordinate their activities in order to ensure wider availability and compatibility of hardware, software and network facilities.
- KACST should be actively involved with other Saudi universities to move towards the effective implementation and utilisation of ICT facilities in the country.
- To have an effective computer system, hardware and software requirements, staff and end-users training, and system changes have to be considered

10.4. Future studies

Based on the findings found in this study, suggestions could be made for further research. Future studies need to be carried out in order to explore the following areas:

1. To investigate the provision of a National Health Information Network for Saudi Arabia.
2. To examine issues of data security in healthcare and develop suitable security methods to protect health information in developing countries overall and Saudi Arabia in particular.
3. To examine the impact of computer health information systems on the work of medical professionals in the healthcare sector generally and in institutions of higher education specifically.
4. To examine to what extent computers are being used in both public and private sector hospitals and to examine how the use of computer differs between these two sectors.
5. To examine to what extent the Internet is being used by physicians and other medical staff in University Hospitals and to discover the impact of the Internet on their jobs.
6. To examine to what extent telemedicine is being used in Saudi Arabia and to identify the most important issues involved
7. To examine the problems concerning ICT in the healthcare sector in developing countries such as Saudi Arabia and to compare these problems with those experienced in advanced countries.
8. To examine issues which influence the success or failure of computer hospital information systems in developing countries.
9. To conduct a feasibility study in terms of the economic, technical and operational consequences of establishing a National Health Information System for Saudi Arabia.

10. To investigate the provision of a computer network system to carry out the exchange of administrative and financial information among institutions in the Saudi higher education system.

11. To study and analyse the impact of a developing country's cultural, social and political system on the attitudes of medical professionals toward ICT.

12. To study and analyse the possibility and the impact of implementing a smart card in health care in Saudi Arabia in term of cultural impact, technological requirements and the need for skilled human resources to carry out this ambitious project.

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Appendix A

Formal letter for requesting permission to circulate questionnaires and conduct interviews

Dear Sir, ------------------

I am currently working towards a Ph.D. at Loughborough University. The work involves an investigation of the provision of computer network system to exchange medical information between Saudi University Hospitals. It is hoped that the result of the study will help decision-makers to design and implement better electronic information system that will enable medical staff in Saudi university hospitals to exchange medical information, knowledge, and expertise for better health services provision.

As you know, your University Hospital has considerable experience in the use of computers for information and communication technologies. I would be most grateful for the opportunity to approach you with a request for a short interview that will last around 30 minutes. I do appreciate how busy you are, but your view from the medical perspective will be very important, even if you don't currently use computing technology.

However, I would also appreciate your permission to interview the Computer Department Manager and to circulate a short questionnaire to some of your medical staff (a sample copy is attached).

I assure you that any information that you or your staff may provide would certainly be confidential and used only for this research project.

If you feel you can help me in this way, I would be most grateful, and I will contact you in due course to arrange a mutually convenient time to meet.

Thank you so much for your co-operation.

Yours faithfully,
Saleh Al-Zahrani

Appendix B
Cover letter for survey

Loughborough University
Faculty of science

COMPUTER NETWORK SYSTEM FOR SAUDI UNIVERSITY HOSPITALS

Dear participant:

The attached questionnaire is concerned with the Saudi University hospitals computer network system. The present study is being conducted to investigate the provision of high-speed information network system to exchange medical information.

We believe that investigating the patterns of communication within Saudi university hospitals, especially at this time of rapidly changing environment, will help to assess to what extent available electronic information channels are used. The result of the study, therefore, will help decision-makers to design and implement better information systems that will enable health services in Saudi university hospitals to exchange medical information, knowledge, and expertise for better health services provision.

I would like to assure you that any information you may provide would certainly be confidential and used only for this research project. Therefor, please answer all the questions in the accompanying questionnaire and return it to the secretary of your department.

I would however, like to thank you for your cooperation in this project. I am looking forward to receiving your reply at your earliest convenience.

Yours sincerely

Saleh Al-Zahrani

Appendix C
(Question selected for questionnaires)

COMPUTER NETWORK SYSTEM FOR SAUDI UNIVERSITY HOSPITALS

This Questionnaire has been designed with your precious time in mind. Your experience is important, even if you do not use a computer or computer networks. *All responses will be treated in strictest confidence. Please answer questions by ticking boxes where appropriate.*

Personal Details

1. Where do you work?

KKUH☐ KAUH☐ KFUH☐

2. What is the name of the department in which you work? ____________

3. Job Description:

Physician ☐ Nurse ☐ Paramedical personnel ☐
Administrator ☐ Pharmacist☐ IT/IS computer staff ☐
Medical Technician ☐ ☐ Other, *please specify* ____________

4. What is your highest academic qualification?

Bachelor Degree☐ Medical Degree ☐ Master's Degree☐
Ph.D. ☐ ☐ Other, *please specify* ____________

5. What is your age group?

under 20 years ☐ 20-24 years☐ 25-29 years ☐
30-34 years ☐ 35-39 years ☐ 40-44 years ☐
45-49 years ☐ 50 or over ☐

6. Gender: Male ☐ Female ☐

Usage of computers and computer networks

If you don't use a computer at all, please go to question no14

7. Do you currently use a computer at work?

Yes ☐ No☐

If no, please, go to question no 9

8. What type of computer do you regularly use at work?

A stand-alone computer☐ A networked computer ☐

9. Do you currently use a computer at home?

Yes☐ No☐

If no, please, go to question no 11

10. What type of computer do you use at home?

A stand-alone computer ☐ A networked computer☐

11. How long have you used stand - alone computers (years)?

0 to 2	3 to 4	5 to 6	7 to 8	9 to 10	10+
☐	☐	☐	☐	☐	☐

12. How long have you used networked computers?

Never	0 to 2	3 to 4	5 to 6	7 to 8	9 to 10	10+
☐	☐	☐	☐	☐	☐	☐

13. How often do you use the computer for performing the following tasks?

(Please tick the appropriate box)

Task	Daily	Weekly	Monthly	Never	Irregularly
Word - processing	☐	☐	☐	☐	☐
Sending/receiving (E-mail)	☐	☐	☐	☐	☐
Clinical data transfer	☐	☐	☐	☐	☐
Enter and retrieve patient records	☐	☐	☐	☐	☐
Use of Internet	☐	☐	☐	☐	☐

14. How do you feel about the use of computers?

Very comfortable ☐ Moderately comfortable ☐

Moderately uncomfortable☐ Very uncomfortable ☐

15. Do you ever use a fax machine for obtaining information for your work? Yes☐ No☐

If yes, Nationally only☐ Internationally also☐

16. Do you ever use telephone for obtaining information for your work?

Yes ☐ No☐

If yes, nationally only ☐ Internationally also ☐

If you don't use a computer at all, please omit this question and go to question no18

17. If you face a computer problem during your work, from where/or whom would you like to seek advice?
Please choose the most important option from the following

University Computer Center ☐ Computer manual /documentation ☐

Departmental Colleagues ☐ Hospital computer staff ☐

18. Have you received any computer training? Yes☐ No ☐

If your answer is yes, please specify, for how long?

☐ Days ☐ week(s) ☐ month(s) ☐ year(s)

19. Does the above satisfy all your needs for computer training?

Yes ☐ No ☐

20. What are the problems and obstacles that may be encountered in introducing information and communication technology (ICT) in the university hospitals? *Please rank the most important* three *of the following options according to your opinion by entering numbers as 1,2,3, in the box provided*

Lack of IT staff ☐ Poor management ☐ Lack of coordination ☐

Lack of IT policy ☐ Lack of funding ☐ Lack of training and education☐

Information Provision

21. In general, what type of information should be shared among the university hospitals?

Please tick as many as you wish

☐ Hospital news ☐ Research information

☐ Hospital statistics ☐ Patient record

☐ Physicians' directories ☐ List of physicians on a case basis

☐ Announcements for seminars ☐ Document information retrieval / viewing

☐ Diagnosis ☐ Medical Society announcements

☐ Prognosis ☐ Therapy

☐ Toxicology ☐ Epidemiology

☐ Hospital lab result ☐ New trends in treating specific diseases

☐ Drug formulary ☐ New drug information (contraindications,etc.)

☐ Patient education ☐ other *please specify* ______________

22. Do you take into consideration confidentiality and security when you send medical information to another university hospital?

☐ Yes No ☐

23. Within the next five years, do you expect the university hospitals in Saudi Arabia to use sophisticated technology such as video conferencing or Telemedicine?

☐ Yes No☐

If yes Nationally☐ Internationally also☐

Comment: please add relevant comments if you have any. However, you can contact me via my e-mail S.Al-zahrani@lboro.ac.uk or Saleh2666@yahoo.com

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I would be very grateful if you could return this questionnaire to **the secretary of your department** (using the attached envelope) at your earliest convenience.

THANK YOU VERY MUCH FOR YOUR CO-OPERATION

Saleh Al-zahrani, Ph.D. Student
S.Al-zahrani@lboro.ac.uk
Department of Information Science
Faculty of Science,
Loughborough University.

Appendix D

Questions selected for interviews

University Computer Center Directors interview

A. Current ICT services:

1. Do you think that ICT resources (hardware, software applications, etc,) which are available in the computer center match all the information needs of the university users? (Academic staff, medical staff, administrative staff)
2. What kind of services does the computer center provide for University users?
3. Do you feel the potential of your service is being fully exploited?

B. ICT policy, Plan, Funding;

4. How is your ICT policy decided? Does it have links to the national policy?
5. How is your plans funded?
6. What sort of ICT policy do you have to purchase new ICT equipment (ICT of all kinds)?
7. Do you have committee for purchase ICT equipment, if yes what is the committee structure?
8. Due to rapid technology change, how are any changes to policy implemented?
9. How do you monitor your ICT policy?

C. Computer networks and networks services:

10. To what extent is the computer center networked to other faculty in the university such as university hospital and so on, in other word what are LANs/ WANs connections on the camp now?

D. Training and education for new ICT skills:

11. What are your plans for staff training to encourage users to use ICT effectively?
12. What are the problems associated with computer programs training?
13. How do you keep your self and your staff up-to-date in area of computing?

E. Future plans, arrangements, expectations; and information provision:

14. How is the university trying to provide effective communication between the computer center and other campus activities such as University hospital and so on?
15. Are there any cooperation or arrangement between the University computer center and other University computer center?
16. How many technical people are needed in each site from your point of view?
17. What problems do you think will be encountered in case of connecting all Saudi universities electronically? (Acquisition of hardware, software, personnel, maintenance, fund, coordination)

University Hospital manager (dean of medical school) interview

1. Are there any particular factors that you feel holding back computerization in the university hospital?
2. Do you feel the potential of your ICT equipment is being fully exploited?
3. Within the next five years, do you expect the university hospitals in Saudi Arabia to use sophisticated technology such as video conferencing or Telemedicine?
4. Are there any arrangement or cooperation with other University hospitals to exchange medical information, knowledge, and expertise?
5. Do you think its will be possible to connect all university hospitals electronically in order to exchange medical information?
6. What problems do you think will be encountered from medical point of view?
7. How is your plans funded?
8. How is your policy decided for deciding to purchase new ICT equipment?
9. Do you have committee for purchase ICT equipment, if yes what is the committee structure?
10. Does your staff (medical staff, administrative staff) use computer and networks equally?
11. Do you think that ICT resources (hardware, software applications, etc,) which are available in the University hospital match all the information needs of your staff? (Academic staff, medical staff, administrative staff)

Hospital computer department Managers interviews

A. Understanding of current ICT services

1. What computers and terminals (numbers and main types) are available for medical staff within the hospitals?
2. What kind of computer services do you provide for hospital staff via your department?
3. Do you feel the potential of your department service is being fully exploited?
4. Does your staff (medical staff, administrative staff) use computer and networks equally?
5. Does your department link to the university computer center?

B. Computer network situation; Now; Future:

6. What arrangements are there for the use of LAN/WANs? What services will be available from your department?

C. ICT policy, plan, funding:

7. How is your ICT policy decided? How is it funded, Does it have links to the University computer center policy?

D. **Arrangement; expectation; ICT provision:**

10. Do you think its will be possible to connect all university hospitals electronically in order to exchange medical information?

11. What problems do you think will be encountered from technical point of view
12. What do you think the system is aiming to achieve?

13. Do you think the new system will improve user job performance and satisfaction?
14. Do you think the university hospitals have to make organisational changes to fit with new system?
15. Who do you think should own the system? and how should be organised?
16. What type of information should be available to share thorough new system?

E. Training and education for new ICT skills:

17. Do you have a training program for the medical staff and what topics are covered in service now/in future?
18. How do you train the medical staff working in the university hospital?
19. How do keep your self and your staff up-to-date in area of computing?

F. Problems and obstacles:

19. What are the most important problems associated with the use of ICT in the hospital?
20. Do you feel that the existing clinical/healthcare terminology creates difficulties in discussing the system between different professional groups?

King Abdulaziz City for Science and Technology interview

Policy and computer services

1. What is your view of national policy for networking?
2. What general policy is there in Saudi Arabia which effect provision of ICT in higher education, national, and international?

3. What kind of services does KACST provide for university users?

4. Do you feel the potential of your services is being fully exploited?

5. Does every university use your services? Do they make equal use of your service? If not why?

6. What are the limitations on the use of computer and networks in higher education?

ICT provision and expectations

7. What further provision of networked services is likely to take place over the next five years, national and internationally?

8. What is the policy to bring all university up to the same level to take advantage of high technology?

9. Do you expect within five years that Saudi universities will use sophisticated technology (Teleconferencing, telemedicine, etc…)?

10. From your point of view do you think its will be possible to connect all Saudi universities electronically? If your answer is yes to above question, what problems will be encountered? If no why not?

Problems and obstacles

10. What problems can be identify associated with networking of universities with KACST?

Training and education

11. What plans do you have for training to encourage university users to use ICT efficiently?

Internet Services Manager in Saudi telecom Interview

Interviewee:

Position: Internet Services Manager in Sauditelecom.co

Date:

Interview Start:

Finish:

Purpose of interview:

1. To collect primary data in order to understand what has been done in Saudi Arabia regarding Internet services and what are the future plans to connect the Internet to different locations in Saudi and
2. To understand what technical problems are associated with the Internet and what future plans are regarding these problems?

Interview questions

1. What is Saudi Telecommunications role and responsibilities regarding embracing the Internet services in Saudi Arabia?
2. What is Internet services provider's role and responsibilities regarding Internet?
3. What have you done during Phase I regarding the Internet in Saudi Arabia?
4. What have you accomplished so far?

Problems and obstacles

5. What technical problems can you identify which are associated with the Internet? and what is your future plans regarding these problems?
6. What is your future plan to connect the Internet to different locations in Saudi?

7. Technical specifications:

- Baud rate :
- Bandwidth:
- Number of repeaters:

Resources:

8. When will the information infrastructure be ready for the hospital information system and inter-communication?

9. Do Saudi Telecom. Intend to make a charge for the use of their information infrastructure?

10. How will Saudi Telecom. benefit from their investment in Health network?

Appendix E

Informal interviews (Interviews without formal introductions)

Informal interviews and discussions were held with the following people

1. Medical manager at King Faisal university hospital
2. Head of Nursing department at King Faisal University Hospital
3. Assistant of head of Nursing department at King Faisal University Hospital
4. Vice- president for Medical School in each site
5. Head of Nursing department at King Saud University Hospital
6. Head of Radiology department at King Saud University Hospital
7. Head of Medical Records Department at King Saud University Hospital
8. Head of medical records Department at King Faisal University Hospital
9. Project leader, Computer and Hospital Information Centre in King Faisal Specialist Hospital and Research Centre
10. Health Outreach program & business affairs and telemedicine program director at King Faisal Specialist Hospital and Research Centre
11. Dr/Abdallah AL-Salamah. MEDUNET director manager in Prince Sultan Bin Abduaziz Humanitarian City
12. DR/ Abdalaziz Al-Shameke Assistant director manager in Prince Sultan Bin abduaziz Humanitarian City

Appendix F

Some related organisations and sites were visited during the fieldwork to broaden the scope for describing the problem situation.

1. King Faisal Specialist Hospital and Research Center
2. High capabilities technologies CO.Ltd.
3. Batelco jeraisy Ltd.
4. World care Saudi Arabia
5. Prince Sultan Bin abduaziz Humanitarian City
6. Kingdom Hospitals
7. Dalah private Hospital
8. Military force Hospital in Riyadh
9. MEDUNET program

Appendix G

Thank you letter to the Heads each department participated in the survey

Thank you letter

Dear Sir / Madam,
Head of Department,

I am currently working towards a Ph.D. at Loughborough University. The work involves an investigation of the provision of computer network system to exchange medical information between Saudi University hospitals. It is hoped that the result of the study will help decision-makers to design and implement better electronic information system that will enable medical staff in Saudi University hospitals to exchange medical information, knowledge, and expertise electronically.

As you know, last weeks I circulated a short questionnaire to some of your medical staff. The response rate that I got from your department was excellent; therefore, from the bottom of my heart I wish to thank every one for being so kind and helping me so much. I always pray that Allah reward all of you for facilitating this work for me. I am very grateful to you all.

I assure you that any information that you or your staff may provide would certainly be confidential and used only for this research project.

Please pass my thank you letter to your nice staff to show how I do appreciate their assistance in completing an excellent response rate. I am very grateful to you all.
Thank you so much for your co-operation.

Yours faithfully,
Saleh G. Al-Zahrani

KINGDOM OF SAUDI ARABIA
KING FAISAL UNIVERSITY
King Fahd Hospital of the University
Al-Khobar

المملكة العربية السعودية
جامعة الملك فيصل
مستشفى الملك فهد الجامعي بالخبر

ppendix H

etter from Clinical manager at KFUH

#97

February 1,2000
(25 Shawwal 1420)

TO: **Nursing Coordinators/Head Nurses**

FROM: **Mrs. Jean Khwaja** Jean Khwaja
Director of Nursing Services

SUBJ: **Research questionnaires re Electronic Information System**

Please assist fully in this research project which has been approved by the Dean of the Medical College.

1. Distribute the green questionnaire forms to staff on the unit-Nursing Medical and Technical-this can be by Random Selection and should involve staff at all levels
 eg: Consultants,Residents,Interns and Students
 Head Nurse,Staff Nurse etc.
2. Distribute equal no's. of forms between Medical and Nursing/Technical.
3. Appoint the one responsible to collect/receive the forms before Feb.9,2000 and submit them to the Nursing Office.

Please note that Staff should complete 1 Form only

Thank you for your cooperation.

بسم الله الرحمن الرحيم

Royal Embassy of Saudi Arabia
Cultural Bureau
London/UK

المملكة العربية السعودية
وزارة التعليم العالي
مكتب الملحق الثقافي في بريطانيا

الاكاديمية: AHD1

Appendix I

Letter from Saud cultural office in London

افــــادة

يفيد المكتب الثقافي السعودي في بريطانيا بأن السيد/صالح بن غرم الله الزهراني، مبتعث من قبل كلية الملك عبدالعزيز الحربية للحصول على درجة الدكتوراه في مجال ادارة نظم المعلومات من جامعة لافبرا وهو الآن في رحلة علمية بالمملكة لجمع البيانات الخاصة ببحثه للدكتوراه. كذلك يحتاج لاجراء بعض المقابلات الشخصية مع بعض المسؤولين في مراكز الحاسبات الآلية ببعض الجامعات والمؤسسات السعودية. وقد صدرت هذه الافادة بناء على طلبه لتقديمها الى الجهات التالية:

(١) جامعة الملك سعود:
- مدير الحاسب الآلي بمركز الجامعة.
- مدير قسم الحاسب الآلي بالمستشفى الجامعي.
- مدير المستشفى الجامعي/ عميد كلية الطب.

(٢) جامعة الملك عبدالعزيز:
- مدير الحاسب الآلي بمركز الجامعة.
- مدير قسم الحاسب الآلي بالمستشفى الجامعي.
- مدير المستشفى الجامعي/ عميد كلية الطب.

(٣) جامعة الملك فيصل:
- مدير الحاسب الآلي بمركز الجامعة.
- مدير قسم الحاسب الآلي بالمستشفى الجامعي.
- مدير المستشفى الجامعي/ عميد كلية الطب.

(٤) المشرف على الشبكات بمدينة الملك عبدالعزيز للعلوم والتقنية.

(٥) المشرف على خدمات الانترنت بشركة الهاتف السعودية.

نأمل التعاون معه في تسهيل مهمته.

والله ولي التوفيـق..

الملحق الثقافي في بريطانيا

د

عبدالله بن محمد الناصـر

هـ ب

NO. .... DATE: ١٤٢٠/٩/٩ .... ENC. ٤/٨٦١٥

29 BELGRAVE SQUARE LONDON SW1X 8QB - Telephone: 0207-245 9944/5/6 - Fax: 0207-245 9895

Appendix j

Soft Systems Methodology

Soft Systems Methodology (SSM) as developed by Professor Peter Checkland and his colleagues at the Department of Systems Engineering at Lancaster University. This approach originated from the use of the Jenkins approach to problem solving (Jenkins, 1969). Checkland found that the Jenkins approach could not cope with 'messy' situations of, for instance, complex organisational issues.

The systems approach

According to the general system theory, a system is a set of interrelated elements (Turban *et al,* 2001). However, Checkland, (1999) defines a system as a set of interacting systems, some of which do not work very well and can be engineered to work better. Yet Bocij *et al.* (1999) consider a system as a set of elements, such as people and things that are related to achieve goals. In this sense, Loughborough University can be viewed as a system, and the Faculty of Science may be seen as a subsystem of the large system with its own function.

All human actions take place within a wider context or situation. The essential aspect of understanding situation from a system perspective is to consider the system as a whole. One of the most popular descriptions of this system or the holistic view is known as the (SSM), which is generally known as the Checkland approach. A systems approach tends to be an approach to a problem that takes the broad view, which takes all aspects into account, and which concentrates on interactions between different parts of the problem. An approach is the way of tackling a problem, and obviously, a particular approach may be relevant to more than one subject (Checkland, 1981).

A system approach use systems thinking to help in understanding the world and its behaviour. System thinking involves the use of systems concepts (ideas) and system methodologies and leads to construction of models of the system. Soft system modelling is a subjective process because no two people will look at any particular aspect of the world (except hard system) in exactly the same way. A system model is a set of organised assumptions about a particular aspect of the world and the way it works which have been identified as a system. Identifying system is not a purely objective process since the purposes and interests of the researcher will be involved. The system approach is not an attempt to understand every thing about a system, rather its tries to include all factors relevant to the topic or problem under consideration. This helps to highlight requirements of the system. System approach by itself is not a methodology, but involves the use of systems methodologies. Jenkins (1969) states that systems methodology comprises stages of system analysis, systems design, implementation and operation, formulation of the problem or objective is starting point. System approach is not a method, it is a way of looking at a problem. As result of this, finding a methodology, which uses the systems approach to apply to this study was essential Checkland's soft methodology which use system approach was chosen.

SSM has stimulated much interest and also has attracted considerable academic debate regarding its use in wider management problems and information systems issues. Indeed, SSM is not a technique (a method that requires certain procedures to be followed in order in obtain a predictable outcome), but is a set of guidelines for applying system ideas. Although these guidelines help an analyst to approach investigations methodically, they still allow considerable scope for individual interpretation. Since the original group of people who developed this approach was part of the Department of Systems Engineering, much of the activity was developed using characteristics of industry. Only in recent years, has experience outside industry contributed significantly to SSM development (Checkland, 1999). However, during the past two decades since its inception, SSM has had a considerable success as a general purpose problem - solving methodology, tackling the messy or unstructured problems which managers of all kinds and at all levels have to cope within their work. The emphasis of SSM is not on finding a solution to a specified problem, it is on understanding the situation in which a perceived problem is thought to lie.

Distinction between 'hard' and 'soft' problems

In selecting a methodology for problem-solving, a distinction between hard and soft problems is very important. A hard or structured problem is one which is exclusively concerned with a 'how' type of question. This kind of problem is the domain of the design engineer who seeks effective and economic answers on 'how' to provide. For example, 'How can we transfer an objective from point A to B at a minimum cost'? Another example of a hard system is an engineering application or a computer system development. Hard problems are problems characterised by the fact that they can be well defined. It is assumed that there is a definite solution, and a number of specific goals that must be accomplished can be defined. Hard approaches to systems analysis and design have been very successful at developing computer systems that, viewed from a technical perspective, are efficient and effective information providers. However, there have been cases when new information systems have not had user acceptance or seem to be misplaced as solutions to spurious problems (Curtis, 1998). This indicates that an alternative approach is required to capture the human element of a system design. In contrast, the soft or unstructured problem is one that embodies a mixture of both 'what' and 'how' questions. Checkland (1981) believes that the main difference between the 'hard' and 'soft' approaches is that where the former can start by asking what system has to be engineered to solve this problem, or what system will meet this need and can then take the problem or the need as 'given', the latter has to allow completely unexpected answers to emerge at later stages. He thinks the 'soft' methodology is seen to be the general case of which 'hard' methodologies are special cases. These by definition, soft problems are difficult to define. For example, they may have a large social and political component. A good example to illustrate a soft problem is how the transfer of highly sophisticated technology from Western Countries to Saudi Arabia can be achieved. In this case, there are different stakeholders with different perspectives, and interest for example, political, economic, social, cultural issues. These several issues contribute to an unclear picture.

It is often stated that the '*hard*' system thinking is appropriate in well-defined technical problems and '*soft*' system thinking is more appropriate in fuzzy, ill-defined situations involving human beings and cultural considerations (Checkland, 1999). Different approaches have different strengths and weaknesses, different areas of applicability and differing objectives. The aim of this chapter is not to explore the differences between hard and soft systems, but rather to give overview of their interactions. Table 7.1 below shows what can be considered as the main criteria that distinguish between hard and soft problems (Harry, 1994).

Hard problem	Soft problem
Defined	Undefined
Clearly bounded	Fuzzy-edged
Separable problem	What is the problem?
Clear who ought to be involved	Not sure who ought to be involved
Information needs known	Unsure what information is needed
Know what the solution would look like	Not sure what the solution would look like

Table 1. Show the main criteria that distinguish hard and soft problem

Soft system approach applications

SSM has attracted considerable attention and it has been used successfully in several fields. In the early years, it was natural to look for industrial applications of the idea, because, the original group of people developing the approach was came from a department of systems engineering. SSM has been applied to different kinds of studies, but Al-Hasan (1992) claimed that many of the case studies have not been published because they are consultancy projects for companies and organisations.

REAL-WORLD APPLICATIONS OF SYSTEMS IDEAS

'HARD' SYSTEMS ANALYSIS:

Machine-based or hardware-dominant systems approach for 'hard', 'well-structured' problems

'SOFT' SYSTEMS ANALYSIS:

Human activity-based systems analysis for 'soft', 'messy', 'complex' and 'ill-structured' problems

APPLICATIONS OF SYSTEMS IDEAS TO ACADEMIC PROBLEMS:

e.g. Planning, Medicine, Education, Geography, Social work, Ecology, etc.

Figure .1. A map of system ideas (adapted from Checkland, 1990)

Figure. 1 shows a map of system ideas that summarises the views taken, of hard and soft systems and their applications thus far. From a methodological perspective the research question can be formulated as:

"*What kind of system model would be best suited to improve the messy and ill-structured problem situation involved in this study?*".

Description of Soft System Methodology

This study focuses on computer information system problems in Saudi University Hospitals. The problems encountered in Saudi universities are usually unstructured, are often complex and complicated. To resolve this kind of problem, considerable attention should be given to different issues, such as organisational factors, behavioural and human factors, and environmental factors.

According to SSM, the problem-solver defines the problem situation and then uses this methodology to recommend action to improve it. SSM involves a seven stage process of analysis which uses the concept of a human activity system as a means of getting from 'finding out' about the situation, to 'taking action' to improve the situation. Those seven stages are as follows:

Stage One: Expressing an unstructured problem situation

Stages One and Two of the SSM (Figure 7.2) are expression phases, during which an attempt is made to build up the richest possible picture, not of the problem but of the situation in which there is perceived to be a problem. At this stage of a project, the analyst is starting to find out about the study area by talking to the persons and other interested parties involved, reading current and past records and other documents and in. In general, the analyst is trying to develop a clearer picture of what is going on and the factors that influence the situation.

Checkland (1981) believes that, "It will not be possible for any problem-solver, whether an outsider or part of the problem situation, to simply find out about the situation in a neutral manner. The personality traits, experience, knowledge and interest of our investigator will affect what is noticed and what is taken to be significant. The finding out has to be done. Seriously but lightly with this in mind." Facts concerning the situation may be gained by using conventional fact finding methods, such as observation, and information collection about such things as organisational structures, the number of staff employed, processes, location, names etc., together with the interviewing and questioning of individuals and those involved in the prevailing issues.

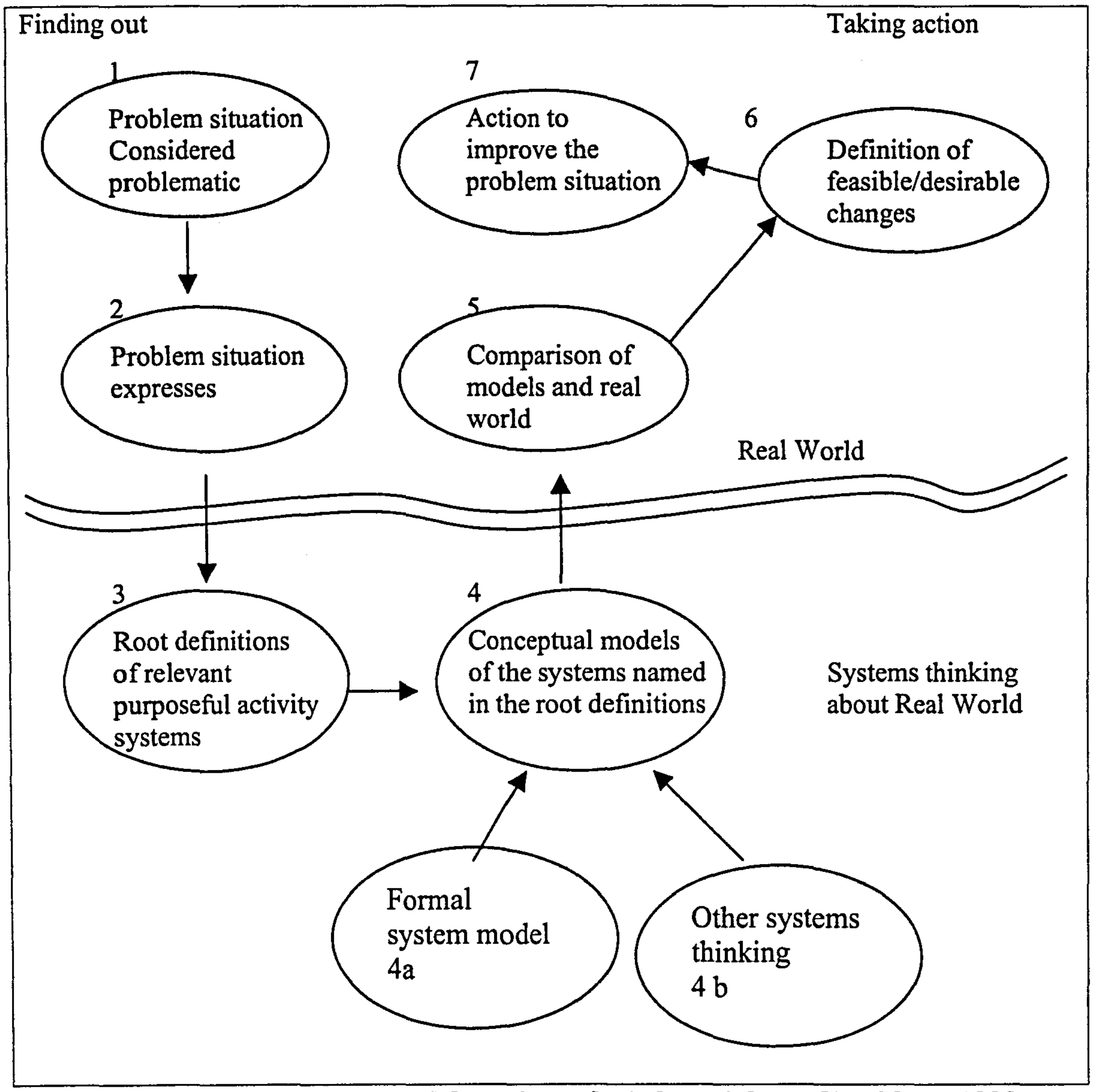

Figure.2 .The soft systems model for this study (adapted from Checkland 1990)

My reading and analyse of document analyses showed that the system elements within the problem situation are comparatively stable and slow to change. In this study elements that represent a physical entity may include location, layout and capacity of buildings and equipment. ICT elements include the type, configuration and capacity of installed hardware and communication networks. Also, information on the organisation, such as staff hierarchies, organisational charts, job descriptions showing the lines of responsibility and reporting are available and are invaluable as an initial 'map' of the organisation's culture.

Stage Two: Representing the structured problem situation

The findings in the first stage are summarised in the second stage, which is referred to as the 'Rich Picture Diagram'. A rich picture is actually self-explanatory and an easy to understand pictorial depiction of an organisation that explains what the organisation is 'about'. One may start to construct a rich picture by looking for elements of structure in the problem area. These may include things like departmental boundaries, activity types, physical and geographical layouts and product types. Having looked for elements of structure, the next stage is to look for elements of processes: 'what is going on'. These include the fast changing aspects of the situation: information flow, the flow of goods and so on. However, Checkland (1981) provides certain guidelines about the content of rich pictures suggesting that they should include elements of structure, process issues (complaints, criticisms, feelings, etc.) and give an overall climate. Elements of structure are defined as features related to physical layout, power hierarchy, reporting structure and patterns of formal and informal communication.

The rich picture should include all the important hard and soft 'facts' of the organisational situation. It is an important technique in which, according to Lewis (1994) rich pictures often present facts in an insightful way and can be used to generate discussions amongst concerned individuals to a degree that is rarely possible using only written text or tables of figures. Also, Avison and Fitzgerald (1995) advocated the importance of a rich picture diagram. They state that the rich picture can help the owners of the problem sort out the fundamentals of the situation, both to clarify their own thinking and decision-making and also to explain these fundamentals to all the interested parties.

In this study, the element of structure, process, environment and other issues will be examined carefully for designing the problem-solving and problem-content system. In terms of the elements of structure, in this case, these can be analysed in terms of computer hardware and software, telecommunications, organisational and technical layout, and information services available electronically for University Hospitals.

On the other hand, in terms of network activities, the focus will be on planning, determining system requirements and the number of ICT personnel needed, carrying out and monitoring the performance of each site. The interaction and relationship between structure and process can also be examined at this stage. Moreover, the arrangements and co-operation among University Hospitals will be reviewed as well as the interaction between KAST and STC on the one hand and Saudi universities on the other. Finally, the components of the University Hospitals' information systems, based on ICT and human beings, will be investigated as well.

Stage Three: Root definition for relevant systems

Stage Three involves naming some systems which look as though they might be relevant to the problem situation and preparing concise definitions of what these systems are. The objective of the root definition is to provide insights into the system. As such, there is no correct root definition, but some attempts provide better insight than others (Naughton, 1984). Root definitions can be generated on the basis of hypothetical systems concerning the eventual improvement of the problem situation by means of implementing those changes, which seem to problem-owners to be likely, desirable and feasible.

According to Avison and Fitzgerald (1995, p.117), "Root definitions can be used to define two things that are otherwise both vague and difficult. These are problems and systems. It is essential for the systems analyst to know precisely what human activity systems is to be dealt with and what problem is to be tackled."

All the same, Checkland and Scholes(1990) defined root definitions as a concise, tightly constructed description of a human activity system, which states what the system is. A root definition is the crux of the methodology. It is the point at which it is necessary to choose a way of viewing the problem situation. This is done by naming some notional systems, which seem to the analyst to be relevant to solving the problem or at least improving to situation. The core of root definition is the transformation process, which transforms some defined input into some defined outputs. However, there are two fundamentally different types of systems that can be described by a root definition, namely primary task and issue-based systems.

In order for the analyst to know whether the root definition regarding the relevant systems is complete or has not been adequately defined, it is necessary to use a set of six criteria identified as the mnemonic CATWOE. It is important to note that SSM does not stipulate that all six of these should be automatically stated in the root definition, but their absence should not occur by default. Patching (1995) noted that: "Careful consideration of the CATWOE (Customers, Actors, Transformation, Weltanschauugen, Owner, Environment) elements ensures that all these relevant factors are made explicit, putting the client organisation in the right perspective."

Customers of the system	The beneficiaries or victims of the systems activities, who are advantaged or disadvantaged by the system.
Actors	The persons who carry out or cause to be carried out the system's activities.
Transformation	The core transformation process of the human activity system. This might be defined in terms of the input and output of the transformation.
Weltanschauugen	The basic beliefs or view of the world implicit in the root definition that give coherence to this human activity system and make it meaningful.

Owner	The persons who have the power to modify or abolish the system.
Environment constraints	The constraints on the system imposed by its environment or a wider system that is taken as given in the root definition.

In this study, CATWOE elements can be developed in the following chapter.
After the relevant systems in the University Hospitals' information systems in Saudi Arabia have been defined, the next step is to build conceptual models for the University Hospitals.

Stage Four: Conceptual models

The fourth stage of SSM is to build a conceptual model, which involves deciding what is the minimum set of activities, which will fulfil the requirements contained in the root definitions. CATWOE is used as a checklist to help ensure that all necessary components are present in the root definition. The conceptual model is intended to define what the relevant system must do or achieve to be the system defined (transformation). Checkland (1981) defines a conceptual model as: a systematic account of a human activity system built on the basis of the system's root definition, usually in the form of a structured set of verbs in the imperative mood. Such models should contain the minimum necessary activities for the system to be the one named in the root definition. Only activities, which could be directly carried out, should be included. The sequence of activities involving in stages three and four will involve formulating the root definition; and assembling the minimum necessary activities with the human activities systems.

Conceptual modelling is an abstract process. The purpose of going into this abstract world of systems thinking is to develop an alternative view of the problem situation. When this alternative view has been developed, the researcher can return to the real world and to test the model. The model is constructed in term of what must go into the system, and it can therefore, be set alongside the real world. According to Avison and

Fitzgerald (1995), the conceptual model is formed from the chosen root definition as follows:

1. form an impression of the system to carry out physical or abstract transformation from the root definition,
2. assemble a small number of verbs, which describe the most fundamental activities in the defined system,
3. develop this by deciding on what the system has to do, how it would accomplish the requirement, and how it would be monitored and controlled,
4. structure similar activities by grouping them together,
5. use arrows to join the activities, which are logically connected to each other by information, energy, material, or any other dependency,
6. verify the model by comparing it against the perceived reality of the problem situation.

Wilson (1993, p.76) advocated that, "It is important for the analyst that there must be one model for each root definition. The first resolution model from the root definition should not contain more than 12 activities, otherwise it becomes difficult to defend them as constituting a minimum, necessary set". Once this version of the model has been constructed, it may be used as a basis for further expanded versions. Some may show activities at more detailed levels, or record all flows in the system, material and abstract; also, noun-based versions of the model may include organisational entities, which might carry out the activities in the basic model. Generally, one way of tackling the model is to start by listing the activities implied by the root definition. The list of activities is then arranged so that each follows in a logical order. This exercise will lead to the drawing of a diagram that traces the logical consequences of following a particular relevant system.

In the previous stage, the major sub-system for University Hospital information systems was determined. However, activities of each sub-system will be expressed in terms of verbs, such as access to the services, service provider and connect in a logically-based order. Each subsystem will be interlinked to provide a final model of information services in Saudi University Hospitals.

Stage Five: Comparing conceptual models with reality

In this stage, the conceptual model is compared with the original problem situation. Once the development of conceptual models has reached the stage where it is acceptable to the analyst, the next stage concerns the comparison of the system definition or the problem situation analysed, and the rich picture of the problem situation which was previously built in Stage Two, alongside the conceptual model created in Stage Four. However, the aim behind the comparison stage is essentially to generate debate, which would lead to a set of recommendations regarding change, in order to help the problem situation. The analyst is not concerned in the first instance with problem solving, but with problem identification as a basis for debate about feasible and desirable changes to the client's organisation.

This stage may cause the investigators to change some of their primary views. For example, in this work, some areas were ignored. For instance an interview with senior manager in charge for Internet services in STC was not at first considered, therefore it was very important to go back and examine this in order to achieve a rich picture.

According to Davies and Paul (1991), two ideas must be borne in mind during this stage. Firstly, that until the process is carried out there is no way of knowing the result it will produce (at any level of detail), and secondly, that the process is crucial to the problem -solving and therefore, it must not be treated lightly.

Four methods of comparison are frequently used at this stage. These are:

a. General discussion,
b. Comparison definition,
c. Historical reconstruction, and,
d. Model overlay.

According to Checkland (1981), it is the comparison stage, which embodies the basic systems hypothesis, that system concepts provide a means of teasing out the complexities of 'reality'. Furthermore, this stage provides the structure and substance of an organised debate about improving a situation thought of as problematical. In practice, it merges into the next stage in which changes with be implemented. In summary, the comparison stage leads into discussion about possible changes, which might be made to the problem situation that has been discovered.

Stage Six: Definition of (debate on) feasible and desirable change

At this stage, a debate on change is carried out in the real world of the problem with concerned actors. It involves consideration of possible changes that could bring about improvement in the situation. The real point is that the models are meant for generating meaningful debate where participants discuss potential improvements that are worthy of consideration. It is necessary to ask to what extent can any changes suggested by the model be implemented, and how important the mismatches between the model and the problem are. The debate stages finally confirm which changes are indeed culturally feasible in this organisation at this time. A stage may then have been reached where it is possible to take action.

The comparison has revealed potential areas of improvement. These form an agenda for the debate so that the actors can consider what changes are culturally feasible and systematically desirable in the process of selecting one or more for further study. Systemically desirable means that any change to be implemented must make sense in system terms. Cultural feasibility asks whether a particular change is feasible for the particular set of actors involved. This stage aims at defining changes, which meet two criteria according to Checkland (1981). They must be arguably systemically 'desirable', as a result of the insight gained from the selection of root definitions and conceptual model building; and they must also be culturally 'feasible' given the characteristics of the situation, the people in it, their shared experiences, and their prejudices.

It is also worth taking account of other factors such as the 'economic' feasibility of the proposed changes, given the current financial situation of the organisation, and whether such changes are technically feasible, particularly when considering automating processes. This, of course, is normal practice when developing proposals or recommendations as a result of any study. Conceptual models, based on the relevant systems, will be developed and will show the feasible and desirable change in Saudi universities. However, desirable and feasible change will be in the form of recommendations and suggestions for future plans to improve the information networks in Saudi universities. In order to improve the situation in Saudi University Hospitals, developments in advanced countries (e.g., the USA and UK), that were mentioned in Chapter 4, will be compared with the computer network services in Saudi University Hospitals. Obviously, the NHS in the UK is far ahead of developments in healthcare in SA but it will be possible to extract benefits from their collective experiences.

Stage Seven: Taking action to improve the problem situation

Finally, Stage Seven, (the implementation stage), involves taking action based on Stage Six to improve the problem situation. When some changes to the problem situation have been identified, then the implementation stage completes the cycle of SSM. Moreover, an iteration of methodology may be needed to develop the conceptual model further to provide a more detailed consideration of the logistics of change (Davies and Ledington, 1991). Once the system's examination of the agreed area of improvement is implemented, solutions must be developed for the chosen problems, using other investigative and problem -solving techniques as required. The methods and techniques used at this stage will, of course, depend on the problem being addressed.

Checkland (1981) also suggested that changes of three kinds are possible, namely:

a. Changes to the structure,
b. Changes to the procedure, and,
c. Changes in attitudes.

Structure is defined, in this context, as those factors that do not change on a short-term basis, such as the organisation and reporting structure, or the make up of functional groups. Procedures are the process involved in reporting and informing the activities of producing, and those related to achieving the aims of the organisation. The less explicit term, 'attitudes', covers changes of influence and the expectations of individuals.

The attitudes of medical staff toward ICT will be examined. In addition, organisational procedures and are reporting structure required to meet the proposal system will be investigated to gain rich picture of how the new system managers will report and to whom? . Moreover, how the new system will change the work process and how this will affect the University Hospital's productivity will also be explored.

Figure. 2 depicts the 'classic' soft systems model that will be used in this study. The systems analysis proceeds sequentially through the seven stages discussed above. A plan of action to improve the problem situation is one of the results of this study and will be discussed in more detail in Chapters 7 and 8.

Appendix k. Proposed committee structure