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FINAL SECTORAL REPORT – HEALTH INFORMATION FLOWS SECTOR (ICT DIFFUSION AND APPLICATIONS)

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Executive Summary

Background and Motivation to Information and Communication Technology (ICT) Diffusion Project

This report represents part of the second Phase of an eight-sector study, commissioned by the Department of Trade and Industry and funded by the European Union, to examine:

i) The likely trajectories for the absorption of ICTs in a range of economic sectors; and

ii) How to adjust the policies and strategies of the government and the domestic private sector to maximise the benefits to South Africa from the insights flowing out of i).

The project builds on existing research work but has at its heart the analysis of a number of 'vertical markets' for ICT, first through a worldwide scan (Phase I) and then through sectoral research in each of the chosen eight sectors.

The sectors selected were drawn from three broad categories – traditional sectors, service sectors, and new economy sectors, as follows:

Traditional

- Platinum Mining
- Automotive Manufacturing
- Clothing Manufacturing Deciduous Fruit Farming

Service

- Cultural Tourism
- Healthcare Information Flows

New Economy

- Biotechnology
- Multimedia

The objectives of the research work were to:

- Generate accurate, objective findings regarding patterns for absorption of ICTs in a range of SA economic sectors, in order to guide South African participants in vertical markets for ICT;
- Provide recommendations for impacting public and private sector policies;
- Guide the government in directing some of its existing and future intervention strategies, including research and development programmes and industrial

development facilities, whether through the science vote or departmental programmes; and to

- Give government more guidance regarding the commitment of funds for human resource development.

Project Research Methodology

The overall approach adopted by the lead consultants was to use Sectoral Experts for the interviewing and primary research, with three ICT coordinators (responsible for up to three sectors each) ensuring consistency across the sectors. An International Consultant was employed to provide an external perspective to the research.

The research methodology for Phase I of this project (The International Scan) involved:

- Defining each of the eight industry sectors;
- Identifying the main players in the value chain; and then
- Performing secondary research on each of the sectors to obtain current data about the diffusion of ICTs into those sectors; and
- Identifying leading-edge applications, as far as possible.

Phase II (Diffusion of ICT in South Africa) involved the use of these sector and value chain definitions to identify the major role players and to set up interviews, based on a structured questionnaire, with selected stakeholders across the value chain.

The questionnaire consisted of both a generic section (i.e. used by all sectors) and a sector-specific section (i.e. aimed only at those interviewees within the sector). Most of the questions relied on the *perception* of the interviewee. A rating scale was typically used, but a number of 'open-ended' questions were included to allow interviewees to express opinions in a less structured way.

The questionnaire was subdivided into six generic sections and one sector-specific section:

1. Background Information (Name, Address, Organisation Size, etc.)
2. ICT Usage (of Technology and Applications)
3. ICT Spending Patterns
4. Sources of ICT Information and Training
5. ICT Adoption: Drivers and Barriers
6. Diffusion of ICT into Organisation/Sector
7. A sector-specific section dealing with issues of importance to the particular sector.

Between 40 and 55 interviews were conducted per sector; these should not necessarily be construed as being representative of the sector, as the selection of

interviewees was often dependent on personal contact from the sector researcher. Also, the responses from those interviewed undoubtedly contained an emotional bias (for example, the desire not to seem technologically backward), which would have influenced the responses. Hopefully, these biases have been minimised through the averaging process

Analysis of the Results

The results from the questionnaires were captured on an Excel spreadsheet and a basic analysis performed centrally. This information was then fed back to the individual sector researchers for further analysis and comment. The generic portion of the questionnaire captured up to 117 separate items of information per respondent (either a rating, a comment or basic data), so that a typical sector analysis involved 5000+ items. These responses were subdivided into various categories (e.g. Large, Medium, Small organisations) as applicable and further iterations performed.

Most of the results were shown graphically for ease of comprehension, although only basic statistical analysis was performed due to the nature of the data.

The Health Sector

ICT has the potential to significantly and irrevocably change the delivery of health care services and patient care, and the management of the health care system around the world. Technologies and applications are changing at ever increasing speeds and so are the dynamics of the business surrounding the implementation of e-health technologies and applications. The Internet in particular presents a valuable opportunity to disseminate quality information to the right people across national boundaries, facilitating access to powerful collaborative tools. In response to this, large numbers of national and international agencies, research organisations, NGOs, etc. continue to carry out studies and develop systems and procedures to exploit the power of ICT in health.

Specifically the developing world suffers from a tremendous burden of disease, in particular Africa, sub-Saharan Africa, and closer, southern Africa. The Economic Commission for Africa (ECA) published a Common Position for Africa's Digital Inclusion in 2001.[1] This document highlighted the fact that ICT can play a substantial role in mitigating some of Africa's problems in the health sector. It can do this by improving access to health services in rural areas, underpinning public education campaigns to promote healthy behaviour, transferring diagnostic information to specialised centres, strengthening the basis for decision making, promoting information exchange among researchers and students, and enhancing the effectiveness of health institutions.

In South Africa various health ICT initiatives are in place—ranging from highly sophisticated systems to rudimentary ones, from basic computerised systems to support patient records for research projects to highly sophisticated computerised diagnostic equipment. In many instances, however, there is a lack of logical

[1] Economic Commission for Africa. *Common Position for Africa's Digital Inclusion: Recommendations of the Meeting on Africa's Contribution to the G8 DOT Force and the UN ECOSOC Panel on Digital Divide, 10-12 May 2001, Addis Ababa, Ethiopia.*

integration or interfacing of relevant systems. The level of ICT diffusion also varies considerably between the public and private sector healthcare services, and with variations within these sectors. Given that the sector has demonstrated a growing demand for ICT and that the efficiency and effectiveness of the health sector has a potentially huge impact on productivity, there is a need to understand the diffusion of ICT within the sector. For this study, *the emphasis has been placed on the role of ICTs in ensuring information flows to support decision making, at facility or practice level, and at district, provincial and national levels, and between these levels, in both the public and private healthcare sectors.*

Research data has been gathered from interviews based on a detailed questionnaire with fifty-two senior representatives of organisations in the public and private health care system in South Africa. Responding to the generic component of the questionnaire, the interviewees noted:

- The health sector in general is geared for the ordinary use of PCs as workstations. They are networked in LANs and WANs and linked to file servers in most of the private sector institutions surveyed, and in some public sector organisations. There are, however, many geographically dispersed clinics and private practices that are not linked to any network. Where physical telecommunication infrastructure is the root cause of such insular cases, the potential of wireless solutions should not be ignored.
- E-mail is widely used, but due to high bandwidth and equipment costs, video over the Internet or Intranets is not generally a viable option at this stage.
- ICT is most commonly used for business support activities (e.g., finance/accounting, data storage and retrieval, personnel management and payroll activities, training), followed by customer service (e.g.: database records of customers, telephone call centres, customer relationship management) and strategy and planning activities (e.g., organisational and strategic planning, knowledge management).
- The use of 'emerging technologies' is generally relatively low; however this is not the case in environments providing specialised health services or for instance doing meta-analysis of health information.
- E-business services are widely used in some components of the private healthcare sub-sector in South Africa, and constitute a potential growth area in both the public and private healthcare sub-sectors.
- The health sector in South Africa, on average, spends less than the norm of the global health expenditure on ICT; the organisations represented in the survey spend slightly more than the norm of the South African health sector's expenditure on ICT and their ICT budgets are growing slightly more than other budget areas. This is consistent with the nature of the organisations represented in the sample, which could generally be regarded as being more extensive users of ICT than the norm for this sector.
- The sources mostly used to acquire/access ICT-related information are: ICT suppliers; in-house training programmes; experts within the company/organisation; consultants/service providers; and the Internet.
- The sources most used for ICT-related training are: ICT suppliers; in-house training programmes; and experts within the company. Comments related to training were more positive than expected, and although gaps were identified, the use of computer-based training seemed fairly widespread. Although there are obviously deficiencies and issues, the overall impression was that this was not a major item on the agenda. The researchers are concerned that some

interviewees may have underestimated training needs and consider this as an area that still needs particular attention.

- On the question whether the interviewees are aware of any government initiatives supporting the use of ICTs in their industry, the following (general) response is worth noting: *"Yes, an extensive roll out of health information systems is being implemented by provincial Departments of Health, although limited funding is restricting this and in some instances results in outdated technology solutions (e.g. DOS-based systems)."*
- Regarding ICT Drivers and Obstacles:
- External economic conditions: 'increased global business opportunities' is viewed as the strongest driver, with 'general economic conditions in the South African health sector' as a negative influence. For the public healthcare sub-sector, 'increased global business opportunities' was interpreted as referring to increased opportunities for accessing technology solutions.
- Supply chain factors: no negative barriers reported. The following were considered as having a positive influence: need for increased organisational efficiency; need to respond to customer requirements; need to improve communications; and, need to reduce paperwork.
- Internal factors: Apart from 'perceived cost of ICTs' there were no negative barriers, while the following were considered as having a positive influence: 'attitudes of Senior Management towards ICT';' general attitude of personnel towards ICT'; and, the 'need for increased computing to do business (R&D and other functions).
- Regarding Diffusion of ICT:
- In terms of almost all aspects, including 'product/service innovation,' 'market innovation,' 'administrative process management,' 'relationship management' and 'resource management,' the organisations surveyed can be considered to be 'early adopters' of ICT. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the health sector globally.

The report contains a variety of schemes suggested to stimulate ICT use.

Apart from bandwidth/transmission issues, there is a need for better integration of health information flows and the establishment of an 'independent' centralised health data warehouse, which can feed data for research purposes, specialised analyses and building commercially-viable information products. There is also a great need to use common standards.

The survey questions specific to the health sector included an assessment of the extent to which the following conditions obtain:

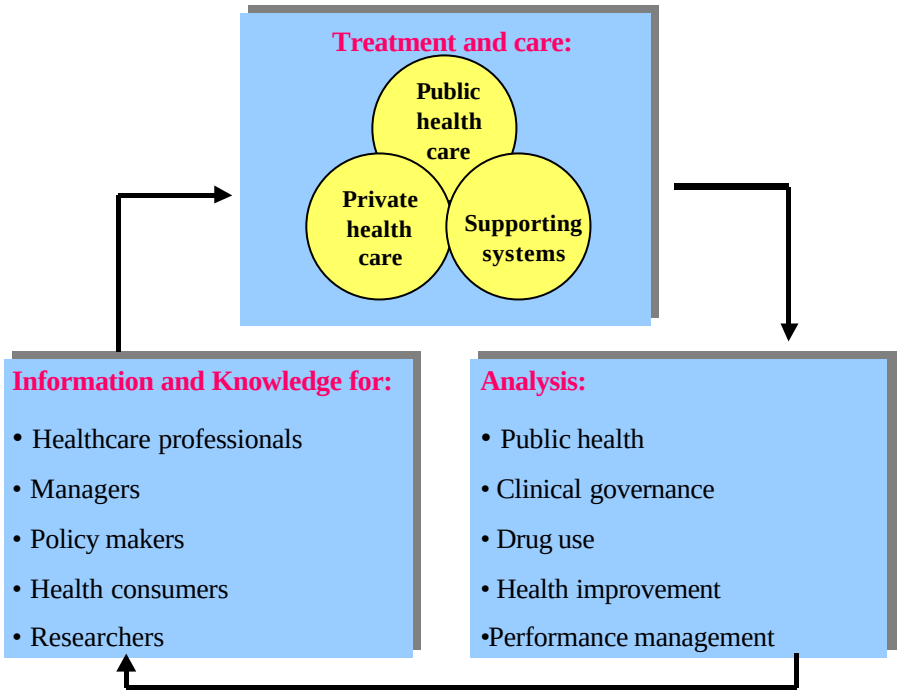
- Sufficient IT infrastructure and telecommunication links are in place to conduct business optimally,
- Common standards are used (including the implementation of data dictionaries),
- Security is addressed,
- e-Health systems are in place (knowledge networks, portals, call centres, telemedicine),

- e-Business is used (claim eligibility checking, electronic claims processing and billing,
- New technology is introduced and linked to sophisticated databases and warehouses (use of smart cards),
- Systems are in place to adhere to new legislation and to protect sensitive data (patient confidentiality),
- Computerised district health information systems are used,
- Computerised laboratory information systems are in place,
- Burden of disease systems are in place (supporting the information flow on the burden of disease e.g. on infectious diseases, such as HIV/AIDS, TB and malaria),
- The organisation is catering for data and knowledge flows in the greater health sector.

In general none of the abovementioned elements of health ICT is implemented or operating at a high level of utilisation. The narrative comments received closely correlate with the low scores recorded.

With reference to the integrated model of information flows as depicted in the diagram in section 2.1 of the full report, and reproduced below, it can be stated that many of the organisations in their own right do contribute to the data and information flow of the larger health sector. Some systems are quite advanced—with integration of components—such as in the case of the information systems implemented at some academic hospitals. There is also an emergence of e-Health gateways/portals serving various audiences in the greater health sector and in some instances specifically providing for communities of practice to stimulate innovation and enable improved decision making. However, there are several 'broken lines' in the model in terms of (electronic) information flows. This is due to several factors, such as a lack of computerisation at some levels (e.g. in many parts of the Eastern Cape Province), the fact that ICTs have been implemented in vertical environments as 'stand-alone' solutions that have not been designed to feed information beyond the operational environment, lack of Internet access, and a lack of holistic planning or financial constraints to implement more integrated systems.

These flows obviously differ between those organisations operating in the public sub-sector and those operating in the private sub-sector, and one finds that the two sub-sectors, in most cases, are actually operating in somewhat independent environments. Flows in the private sub-sector are mostly driven by a business model to expedite the processing of financial transactions—refer the information flows from healthcare service providers via switching networks to administrators and funders. The intermediaries in such a chain have started to build their own warehouses, mostly to protect data but also to analyse data with a view to selling information to third parties, although they are not (necessarily) the owners of the data. In general the information flows in the private sub-sector are fairly advanced, but there is the (common) phenomenon of parallel flows—not interlinking to allow a holistic view.



Systems implemented at small organisations/entities may be as advanced in terms of functionality as those of larger organisations. The systems being implemented at health district level are well designed and are providing a good basis for an interfaced hierarchical health information system, such as being envisaged by the National Health Information System for South Africa (NHISSA). Minimum data sets for districts, and for public and private hospitals, are currently being collated at district, provincial and national level, on a monthly basis. The review of the national disease notification system is currently out to tender, and should result in greatly improved availability of information. However, flows within the public sub-sector are far from optimal, which would make it very difficult for instance at this stage to build a common comprehensive data warehouse which can be interrogated for management information purposes and insight into the burden of disease.

The researchers view the level of codification of knowledge and the availability of such codified knowledge as important for a country such as South Africa where transfer of knowledge to build capacity should be an important goal. The study therefore included a broad Knowledge Management assessment of the organisations surveyed. It concludes that the private healthcare sub-sector is the most sophisticated as regards knowledge management. The level of "unarticulated codified" knowledge, however, is the highest in the public healthcare sub-sector. The higher this value, the more inefficient the organisation concerned will be in terms of knowledge transfer. It therefore indicates an insular approach to information and knowledge dissemination in this sub-sector. The level of "unarticulated uncodified" tacit knowledge is also the highest for the public healthcare sub-sector. These findings correlate with the general situation of uncoordinated ICT systems in the public healthcare sub-sector.

It is the researchers' view that the flow of knowledge in the South African health sector is not optimal, particularly in the public sector. Insufficient telecommunication and Internet connectivity is an important aspect highlighted by this survey. It is clear that bandwidth is a major factor to be taken into account for

future ICT planning initiatives. Many respondents highlighted this as a major inhibiting factor.

So, as to what the Health sector and the ICT Industry can do to enhance ICT benefits:

- The health sector should gear itself for an expected increase in demand for e-health systems and telemedicine should also be flagged as an area for exoansion.
- The lack of appropriate bandwidth stands out as a particular issue. By catering for the availability of bandwidth at more affordable rates and improved integration of systems, the health sector would benefit on the medium term from cost reduction.
- The SA Health*Info* information portal, developed under the auspices of the MRC, facilitates and enables interaction and iterative information flow among players in the health system (researchers, health services, industry, health policy-makers and communities). It was noted that as part of a government gateway the national Department of Health is planning a health gateway. The latter should closely interact with the SA Health*Info* portal to avoid duplication.
- Provincial government departments should allow full Internet access to relevant health care workers, in order to access required trusted and evidence-based health information. Wireless networks and downloading of data via satellite should be considered. The apparent lack of coherence in the public healthcare sub-sector would need strong leadership intervention.
- The health sector should consider the establishment of a national health data warehouse, incorporating appropriate healthcare data from the private and public healthcare sub-sectors. In this regard it may be worthwhile to study the progress of the US Anceta initiative.

As to what Government can do:

Government should first of all ensure that legislation provides a suitable control environment, but not an inhibiting environment for the essential flow of health data.

- Government could also assist the health sector in facilitating the funding for training of ICT staff in the workplace.
- Where the IT industry is willing to come on board in strategic partnerships for necessary ICT development projects in the public healthcare sub-sector, government should consider incentives in the form of tax rebates.
- Government should also support initiatives to generate focussed proactive maintenance and enhancement of quality of life throughout an individual's lifetime through the creation of an integrated lifetime health record.
- Government has a responsibility in terms of empowerment of the general public with education on health and wellness by disseminating health information personalised to the individual's need.

The researchers believe that the IT industry has a unique opportunity to come to the forefront and accept the challenge to build systems which will be appropriate for South Africa—also with a view to rolling these out to other African countries within the spirit of NEPAD.

1 Overview and baseline information

This investigation provides insight into ICT diffusion within the South African private and public health care services sub-sectors, including systems in a supportive role. The focus is on the infrastructure and systems in place in terms of underpinning data, information and knowledge flows for relevant decision making. Data and comments have been obtained from 52 persons who we consider to be in a position to be able to give an informed opinion on: the situation within their own organisation; the value chain effecting their organisation; the health sector at large in South Africa and how it compares with other economic sectors; and, the health sector in South Africa in comparison with the global (developed-world context) situation - 50 completed questionnaires have been included in the analysis. The information obtained from respondents has been supplemented by the researchers' knowledge of the South African healthcare system.

The reader should take into account that this investigation reflects but a snapshot of what transpires in the health sector as regards ICT diffusion and applications in use. However, we are confident that it largely reflects the current situation and certain trends and expectations did come to the forefront which policy makers, health managers, health researchers and ICT suppliers should find useful as a baseline for planning future interventions, preferably linked to further detailed investigation.

A survey, making use of a structured interview and a questionnaire, was preceded by a study to obtain a baseline understanding of the situation as regards ICT diffusion and systems aimed at health information flow in the developed world, the developing world – with the focus on Africa – and in South Africa. The findings of this study for the developed world and the developing world are attached as **Appendix A**. Background information on South Africa is briefly reflected below.

1.1 Baseline information

Over 300 million people are now wired in around the globe and around one billion will be online by 2005. Rapidly falling costs of communications and computing and the extraordinary penetration and accessibility of World Wide Web is turning the world into a global village. However, on the other hand, more than 850 million people in developing countries are excluded from a wide range of information and knowledge[2], whilst telecommunication cost in the developing world remains at a premium. The developing world suffers from a tremendous burden of disease, in particular sub-Saharan Africa, and closer, southern Africa. Disease knows no boundaries and the South African health system therefore also has a responsibility to build systems that cater for cross-country information flow. The Internet presents a valuable opportunity to disseminate quality information to the right people across national boundaries, facilitating access to powerful collaborative tools.

[2] Vikas Nath. *Heralding ICT enabled Knowledge Societies - way forward for the developing countries*, 2000; www document, URL http://members.tripod.com/knownetwork/articles/heralding.htm

The health sector in general has demonstrated a growing demand for ICT, and is considered an important sector in terms of its potentially huge impact on productivity.

1.2 The South African situation – background information

In South Africa various health ICT initiatives are in place – ranging from highly sophisticated systems to fairly rudimentary ones. In many instances there is a lack of logical integration or interfacing of relevant systems. The level of ICT diffusion also varies considerably between the public and private sector healthcare services, also with variations within these sectors. Several factors impact on the technology diffusion, including telecommunication restriction or unavailability, financial considerations, policy issues, availability of trained ICT staff, a resistance to re-engineering, unco-ordinated system development, etc.

It was reported by ISI in January 2001 that 55 countries navigating the Information Superhighway account for 98% of all IT in 150 countries.[3] According to this report South Africa ranked 38th out of these countries, with a score of 2,029 (highest score 6,496 by Sweden). This status obviously impacts the health sector as well. Internationally it is expected that health as a sector will have a growing demand for relevant ICT. In South Africa it is expected that this trend will also be applicable. However, taking the country's ranking reported here into account, one can assume that this will be at a much lower level. More detailed understanding of the level of ICT diffusion in the health sector, in particular health information flow, would assist in understanding requirements for improved utilisation of ICTs.

Examples of ICT support for health care in SA cover a very wide range, from basic computerised systems to support patient records for research projects to highly sophisticated computerised diagnostic equipment. For this project, the emphasis has been placed on the role of ICTs in ensuring information flows to support decision making, at facility or practice level, and at district, provincial and national levels, and between these levels, in both the public and private healthcare sectors.

In the public sector, health information system development is expected to take place within the framework of the development of the NHISSA (the national health information system for South Africa), which has been conceived as a comprehensive computerised health information system, which supports all aspects of the SA healthcare system in both public and private sectors. In practice, information systems in public and private healthcare sectors are very largely separate, with infectious disease notification as a notable exception.

The major emphasis in the development of the NHISSA to date has been in the implementation of computerised hospital information systems (CHISs) of varying degrees of sophistication. Historically, some of the public sector academic hospitals have used CHISs since the 1970s, with billing and other systems being implemented in other public and private sector hospitals since then. Since 1994, when the development of NHISSA commenced, the number of public sector hospitals using CHISs has increased dramatically, with tenders for new CHISs

[3] ISI. *ISI Countries and current ranking*, 2001; www document, URL www.worldpaper.com/2001/jan01/ISI/2001%20Information%20Society%20Ranking.html

already having been awarded in the Northern Province, Gauteng, Free State, Northern Cape and Western Cape. There are plans for similar tenders in the other provinces.

The development of district health information systems in South Africa until at least the mid-1990's was essentially research-based, as part of research into the implementation of a district-based SA healthcare system. The successful implementation of the DHIS (district health information software) in parts of the Western Cape has resulted in the DHIS becoming the national standard, and being rolled out to most districts in the country. This development attempts to address all components of the successful implementation of health information systems, including user input in design, human resource development, and the quality of data being input to the system, and is therefore a very important model for health information system development in SA and other developing countries. HISP was initially funded by NORAD and supported by academic institutions in the Western Cape. It is also being implemented in several other countries, including Moçambique and Cuba.[4]

In the private sector, there have been significant developments in the implementation of e-business, most notably in the area of billing for services. Highly sophisticated networks have been (and are being) developed to support these functions, to the extent that it is claimed that 90% of claims to funders (medical aid schemes) for pharmaceuticals in the private sector are transmitted electronically, normally in real time.

Telemedicine is an important area of growth in both private and public sectors. The Department of Health has established a telemedicine project, which is entering its second phase. The MRC has established a Telemedicine Lead Programme to undertake research in support of this programme to establish telemedicine nodes in several provinces. The MRC Telemedicine Programme developed a Telemedicine Evaluation Methodology that was used to evaluate the 28 sites of the first phase of the Department of Health National Telemedicine System.

Further examples of health ICT projects in South Africa are:

- PAAB and PADS (in-house developed basic hospital information systems; currently in use in public sector hospitals in several provinces; PAAB was originally developed in Gauteng as a standalone system, but has been modified for use across LANs; PADS was developed in the Free State as an internet-enabled, networked system.)
- The National Department of Health has recently (May 2002) circulated a draft data flow policy, which seeks to streamline and formalise data flows, particularly within the public healthcare sector. This is an important step towards an effective health information flow policy framework, which has not been formally developed in the past.[5]
- Inkosi Albert Luthuli Hospital, KZN (aim to have a paperless hospital; computerised information systems will be implemented to support all components of hospital operation)

[4] Heywood A and Wilson R. Health Sector Reform and the Role of Decentralised Information Management and Innovative Design at District Level in South Africa. RHINO workshop, Washington DC, March 2001.

[5] NHISSA committee – data flow policy. Department of Health, Republic of South Africa. Unpublished.

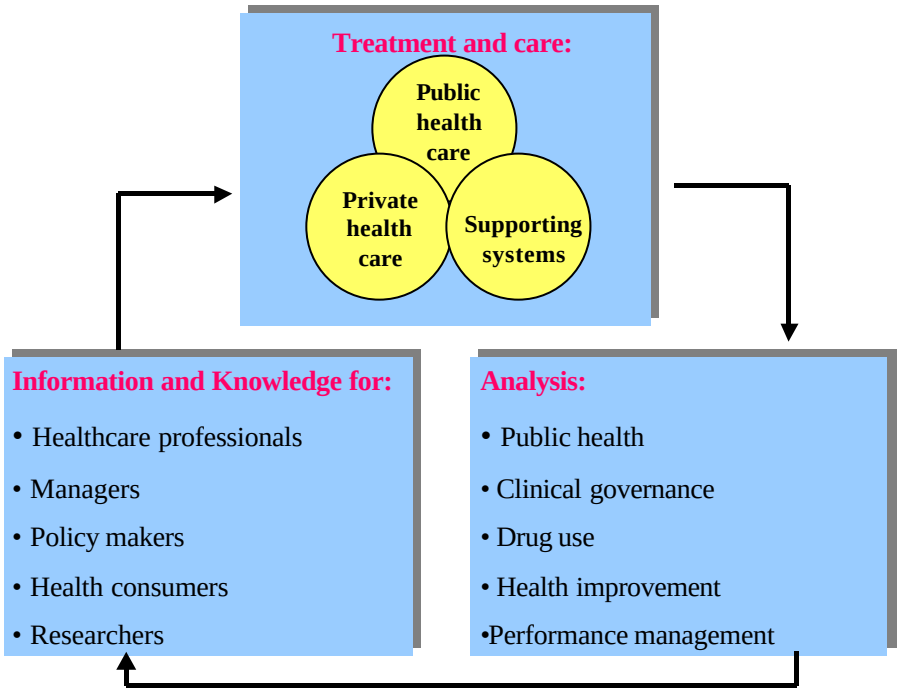
- SAHealth*Info* (knowledge network to provide access to quality-controlled health information for South and Southern Africa; developed by the MRC with funding from the DACST Innovation Fund (1999 – 2001); being maintained and extended by the MRC; now forms the base for several other projects, including a planned HIV/AIDS portal for Southern Africa.

2 Methodology

2.1 Nature of Questionnaire (Sector Specific Components)

This study formed part of a larger project which analysed ICT diffusion in 8 sectors in South Africa.

A common set of questions was used in the generic part of the questionnaire to allow lateral comparisons between the eight sectors. However, within the generic section the interviewees in the health sector were prompted to identify their organisations' roles in terms of information flow within the context of the following diagram:



This diagram should be viewed within the context of a complex variety of role players, and is not intended to reflect all possible interactions among them.

A set of questions, which are specific to the health sector, was included in the questionnaire. These questions also served to correlate views expressed within the generic section of the questionnaire and requested a rating from 0 (not applicable/ don't know) to 5 (fully utilised) of the level of diffusion of health-specific ICT in the particular organisation (and its interaction with stakeholders). The following aspects were included:

- Sufficient IT infrastructure and telecommunication links are in place to conduct business optimally
- Common standards are used (including the implementation of data dictionaries)
- Security is addressed

- e-Health systems are in place (knowledge networks, portals, call centres, telemedicine)
- e-Business is used (claim eligibility checking, electronic claims processing and billing, etc.)
- New technology is introduced, linked to sophisticated databases and warehouses (use of smart cards, etc.)
- Systems are in place to adhere to new legislation and to protect sensitive data (patient confidentiality)
- Computerised district health information systems are used (or linked to)
- Computerised laboratory information systems are in place
- Burden of disease systems (supporting the information flow on the burden of disease e.g. on infectious diseases, such as HIV/AIDS, TB and malaria) are in place or contributed to
- Whether the organisation is catering for data and knowledge flows in the greater health sector.

Respondents were also asked to give narrative comment as regards the major flows of data, information and knowledge to and from their organisations and whether these flows are effective, in that they provide the required information to support decision making within the organisation. Further narrative comment was requested on how the use of ICT can improve this information flow immediately and within the next two years.

The point of departure for these health-specific questions has been the strategic issues raised for the health sector in the 1999 South African Information and Communication Technology and Health Foresight studies. Since knowledge management is also an aspect highlighted in these studies, we have included a set of questions to make a high-level assessment of the level of knowledge codification as an indication of the overall sophistication of knowledge management within the organisation surveyed. Based on the work of Grimaldi and Torrisi[6] this part of the survey assessed the following levels of codification and the related organisation of knowledge - using a five-point scale ranging from 1 (non-existent) to 5 (common):

- Fully codified, articulated: recordable, storable and transferable at negligible costs (e.g. blueprints, manuals, journals and text books)
- Unarticulated codified: displaced hard copy source, stand-alone source, closed jargon by specialists (epistemic community or community of practice), formal authority
- Unarticulated uncodified: no hard copy or stand-alone source exists, reference to procedural authority, charismatic leaders
- Unarticulable: technical constraints over articulation and codification (e.g. how to do a certain procedure).

An example of the health sector component of the questionnaire is attached as **Appendix B**.

[6] Grimaldi R. and Salvatore T. Codified-tacit and general-specific knowledge in the division of labour among firms A study of the software industry; *Research Policy* 2001, 30 (9), 1425-1442

2.2 Questionnaire Administration

Questionnaires were elucidated at interviews and were completed by interviewees in writing (manually) or electronically. In some instances the interviewers assisted the interviewees with the completion, due to logistical reasons (e.g. one respondent has very poor eyesight). The completed questionnaires were forwarded by the interviewers via courier service to Miller Esselaar and Associates (MEA). This allowed the collective capturing of responses on MS Excel spreadsheets and data to be analysed and to be expressed in the form of bar chart graphs. This also allowed MEA to make lateral comparisons across the eight sectors surveyed.

In all cases the interviewees were given the assurance that their responses would be treated as confidential, and would not be made available in any format that could identify the particular respondent.

2.3 Selection of Interviewees

Interviewees were selected to reflect as wide a range as possible of the components of the SA healthcare system, including both public and private sectors, at all levels of care, i.e. primary, secondary and tertiary. For the private healthcare sector, funders represent an important set of stakeholders, and were therefore included.

In addition to interviewees working in or for healthcare organisations, interviewees were selected from organisations which supply healthcare-specific ICTs and related services to the healthcare sector in South Africa.

Academic and research organisations were included, since they are important providers of information for the healthcare sector, and require a return flow of information to inform their activities. The requirements for ICTs in these subsectors of the healthcare system are not necessarily the same as for service delivery and planning. The increasing recognition of e-health, including the importance of the provision of trusted information to consumers, healthcare practitioners and health policy makers has resulted in an increasing number and scope of initiatives to provide such information. Several South African projects are represented in the group of interviewees.

Due to constraints of time and resources, it was not possible to interview a completely representative sample of stakeholders in the South African healthcare system. Two important sets of stakeholders who could not be included are health consumers and NGOs providing health and health-related services.

In general, specific interviewees were chosen for their experience and/or knowledge of the application of ICTs in healthcare. For some subsectors, interviewees were asked to recommend further potential interviewees.

A more detailed description of the interviewees is given in **Appendix C**.

2.4 Interview Process

The Interviewees' involvement was secured by prior e-mail correspondence or telephonic discussions.

In all cases the interview commenced with an explanation of the rationale and expected value of the outcome of the investigation (as stated in the Inception Report). Actual visits were possible for 90% of interviews, while telephonic-conference style interviews were held for the rest due to logistical constraints. Items in the questionnaire were elucidated where needed. Apart from the narrative feedback as per the completed questionnaires, the interviewers have also made separate notes of verbal comments by interviewees, some of which are reflected in the relevant sections of this report.

In some cases, interviewees were asked to complete the questionnaire from a broader perspective than a single organisation, thus reflecting their extensive experience, e.g. "the 4 provinces in which the interviewee had been active in implementing a district health information system", or "the interviewee's experiences of being involved in the development, implementation and support of computerised hospital information systems in South Africa".

For future reference it should be noted that the interview process was very time-intensive, taking 60 to 90 minutes per interview.

3 Results

3.1 Nature of Sector: boundaries and sub-sector map; large company/small company picture; international relationships

The survey focused on organisations within the private healthcare sub-sector, the public healthcare sub-sector and relevant support structures within these two sub-sectors. The organisations surveyed can be grouped as follows:

Public sector:

- National Department of Health[7]
- Provincial departments of health (four provinces)
- Specialist hospital services
- District health services, including local authority health services
- Telehealth initiatives, including telemedicine and e-Health portals
- Medicines Information Centre
- Research networks and related systems
- Health system developers and related ICT services
- Pharmaceutical products supply

Private sector:

- Private hospital group
- Private hospital
- Board of Healthcare Funders
- Health funders and administrators
- General practitioners (GP) research network
- GP network, associated with Independent Practitioner Associations
- Pharmaceutical association
- Health system developers and related ICT services, including a switching network
- Health information management consultant (national study).

[7] Completed questionnaires were not returned by these interviewees.

From the abovementioned groupings it should be evident that a wide spectrum of organisations have been targeted. Some of these operate also at an international level, but the South African healthcare system functions largely independently. Several ICT suppliers reported being linked to or part of international organisations, and some private healthcare funders and administrators function across several countries in southern Africa.

3.2 Characteristics of ICT Use

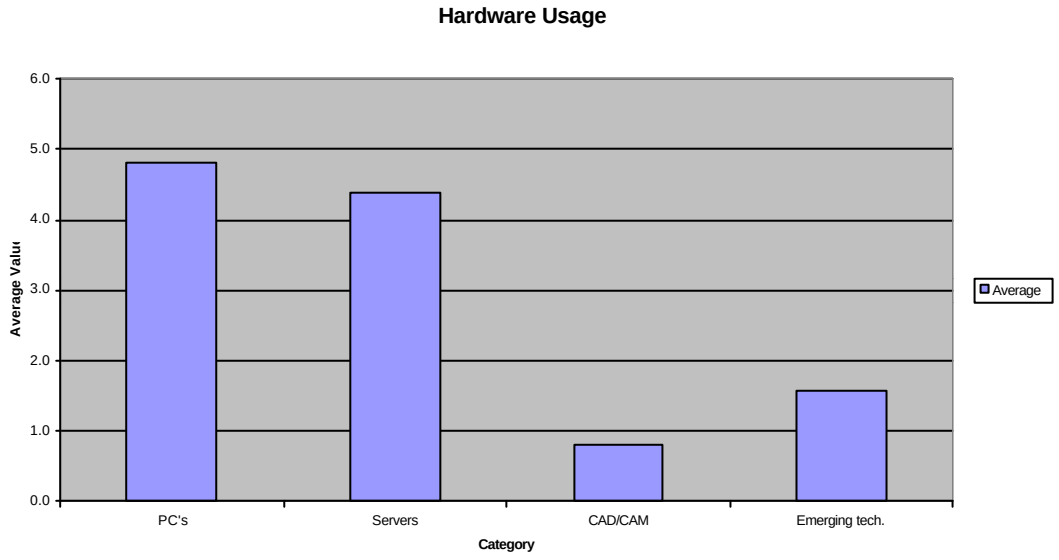
This section provides feedback on the findings in terms of the extent of actual ICT usage throughout the organisations surveyed.

3.2.1 Basic Technologies

3.2.1.1 ICT hardware

This section examined the use of: PCs; servers/mainframes; CAD/CAM technologies; and, emerging technologies (e.g. sensing devices, geo-spatial technologies and robotics).

The graph below reflects the pattern that has emerged:

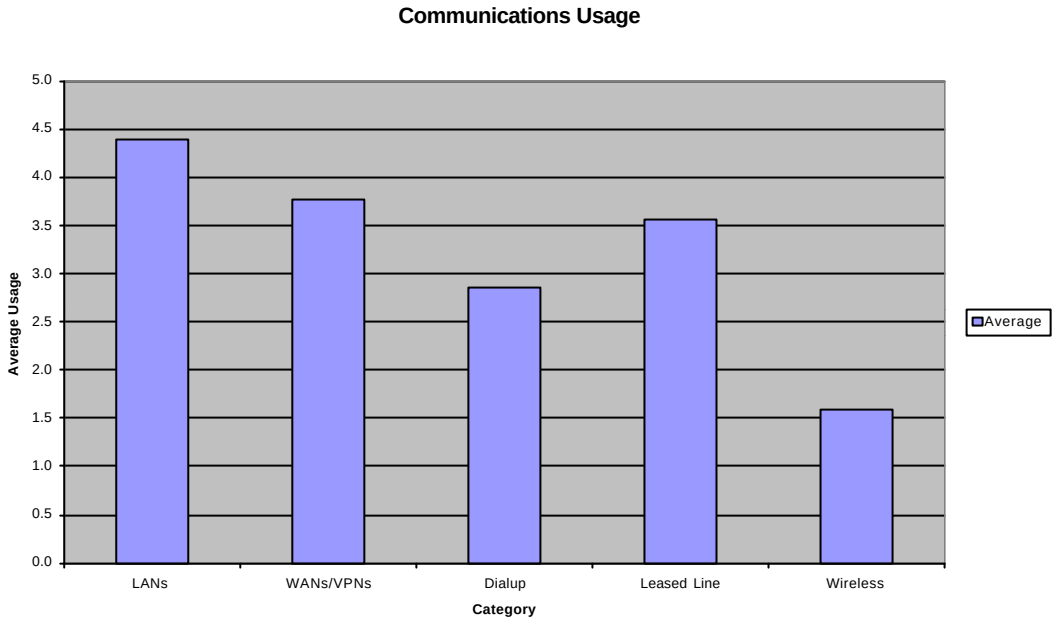


The health sector in general is more geared for the ordinary use of PCs as workstations - networked and linked to file servers in all the private sector institutions surveyed, with emerging local area networks in public sector institutions. The use of 'emerging technologies' on average is relatively low, however, this is not the case in environments where specialised health services are provided and where for instance meta-analysis of health information is done.

3.2.1.2 Communications infrastructure

This section examined the use of: Local Area Networks (LANs); Wide Area Networks (WANs)/ Virtual Private Networks (VPNs); Dialup Internet Connectivity; Leased Line Internet Connectivity; and, Wireless Networks for Data Transmission.

The graph below reflects the pattern that has emerged:



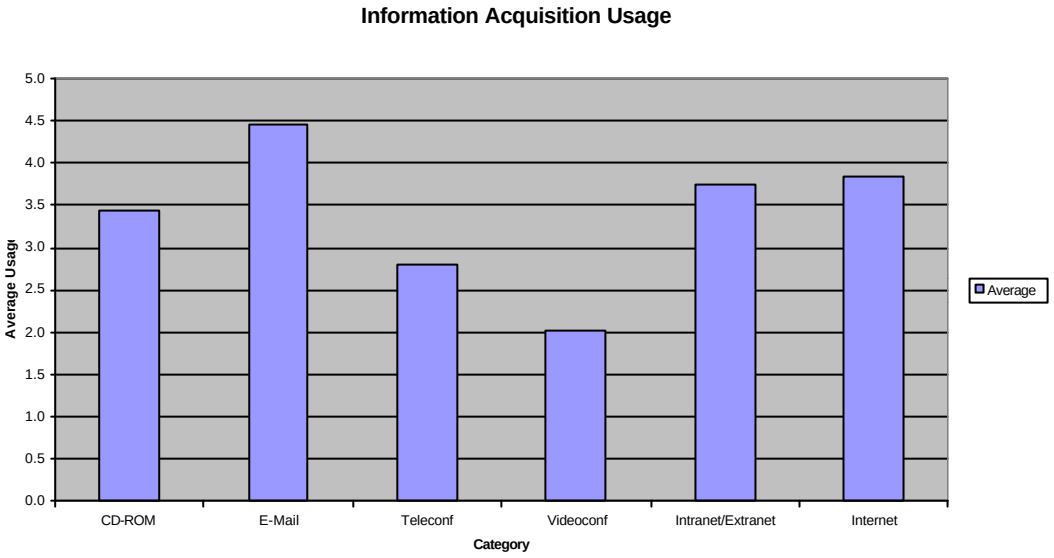
From the above graph one can deduce that there is fairly common use of LANs and WANs, however, the 'dipstick' nature of the survey does not necessarily provide a statistically relevant picture. There are many geographically dispersed clinics and private practices that are not linked to any network. Where physical telecommunication infrastructure is the root cause of such insular cases, the potential of wireless solutions should not be ignored.

3.2 2 Applications

3.2.2.1 Information acquisition and communications

This section examined the use of: CD-ROM sources; E-mail; Teleconferencing; Videoconferencing; Intranets and Extranets (Company information dissemination, document transfer, e-mail, web access); and, the Internet (e.g., advertising, information searches).

The graph below reflects the pattern that has emerged:



Clearly e-mail is widely used. A good example of the use of an Intranet is in the case of Medi-Clinic which reported (in September 2001) that: "The Intranet has grown tremendously over the last few years, with a monthly average of 900 visitors and a daily average of 700 hits. There has been a great increase in participation by departments as the Intranet is a powerful vehicle for publishing information and improving communication in the group. Currently 11 departments have their own websites and seven more will follow soon. All our hospitals have access to the Intranet and an overall 138 000 (6 270 per day) web pages are viewed per month."

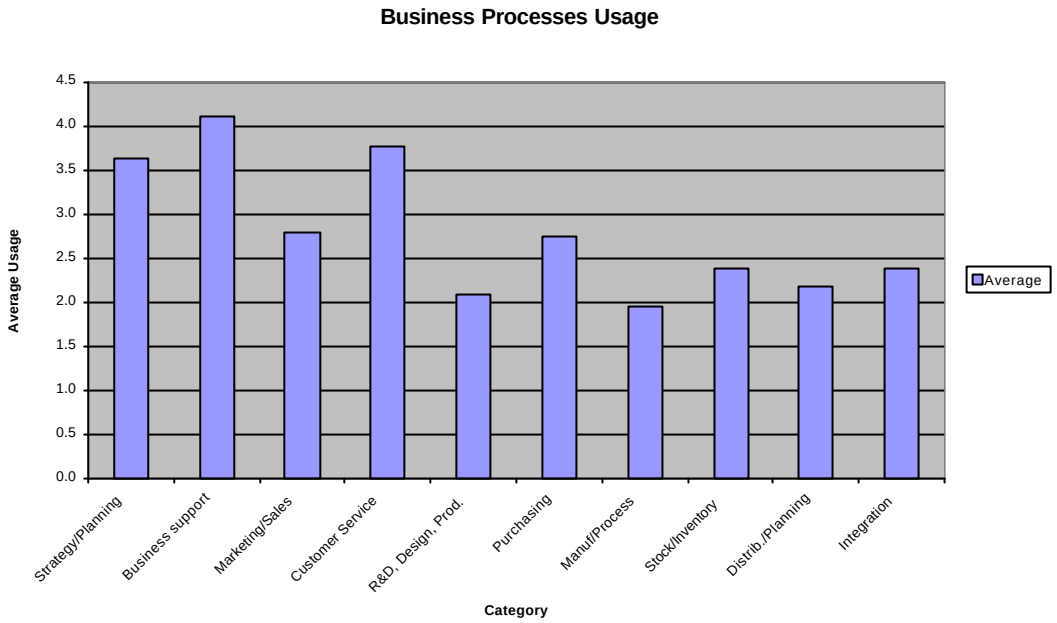
The use of video-conference communication is obviously impacted by the cost of ISDN lines. Due to high bandwidth costs, video over the Internet or Intranets is not really a logical option at this stage.

3.2.2.2 Streamlining business processes

This section examined the use of ICTs for: Strategy and Planning Activities (e.g., organisational and strategic planning, knowledge management); Business Support Activities (e.g., finance/accounting, data storage and retrieval, personnel management and payroll activities, training); Marketing and sales (e.g.: electronic promotional materials); Customer Service (e.g.: database records of customers, telephone call centres, customer relationship management); Research, development, design and production (e.g.: CAD/CAM); Purchasing/procurement (e.g.: Electronic data interchange); Manufacture/process control; Stock and

Inventory Control/ Warehouse Management; Distribution Planning and Control; and, Business Process/Systems Integration (e.g., ERP).

The graph below reflects the pattern that has emerged (aspects measured are in the same order as listed above):

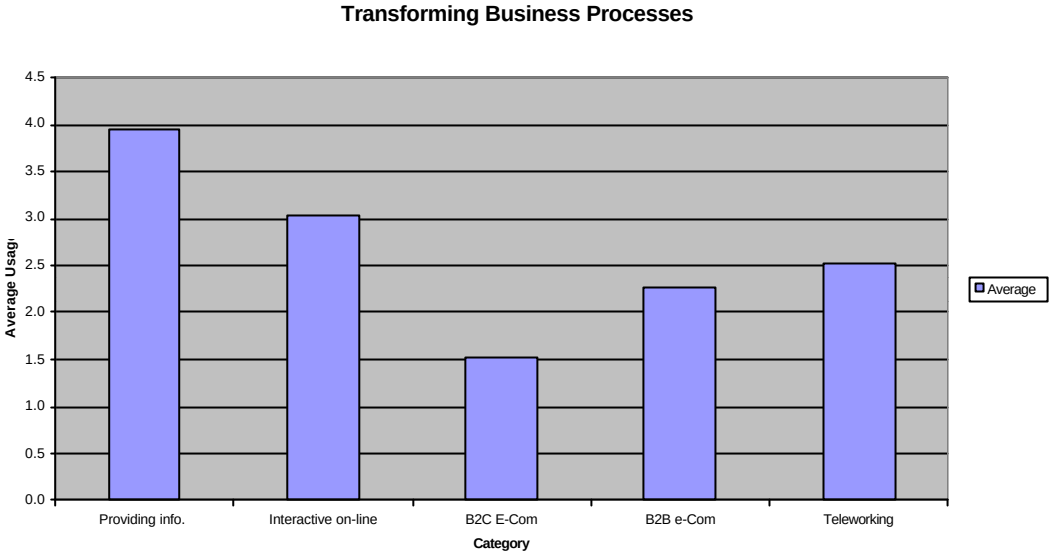


ICT is most commonly used for the category Business Support Activities (e.g., finance/accounting, data storage and retrieval, personnel management and payroll activities, training), followed by Customer Service (e.g.: database records of customers, telephone call centres, customer relationship management) and Strategy and Planning Activities (e.g., organisational and strategic planning, knowledge management). The lowest use is for the category Manufacture/process control. It is expected that the use of ICT for streamlining business processes will rise over the next two years.

3.2.2.3 Transforming business processes

This section examined the use of ICTs for: Providing Information (e.g. on CD-ROMs, via websites); Interactive on-line services (e.g. quoting prices, answering queries, taking orders by e-mail); Completion of commercial transactions on-line (business to consumer e-commerce); Completion of commercial transactions on-line (business to business e-commerce); and, Teleworking (employers and employees do a significant amount of their work using remote access facilities).

The graph below reflects the pattern that has emerged:

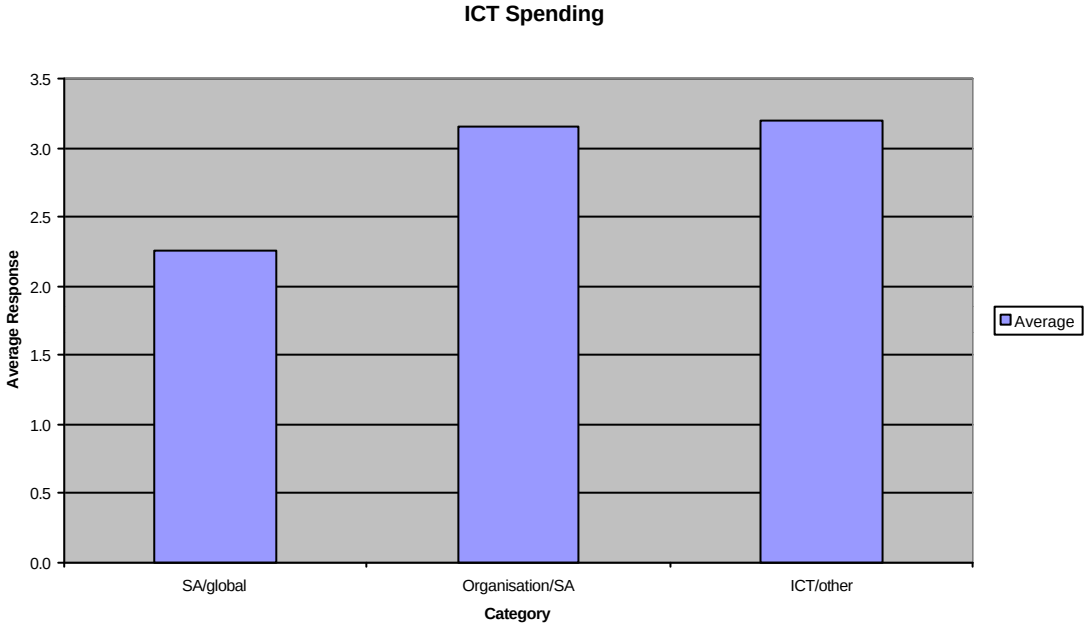


E-business services are fairly new to the South African health care sector, but constitute a potential growth area. For example, in December 2001 Medi-Clinic reported that it was the first hospital group in South Africa to implement an eBusiness health care portal, Medi-Clinic Online.

In the newsletter *Medi-Clinic Milieu*, December 2001, p.9, it was reported that: "Medi-Clinic strives to form a communication link between all its stakeholders to improve business relations, with Medi-Clinic Online as the platform. Medi-Clinic Online consists of two websites - a public and a member site. The public site has health related news feeds, a health calendar, an extensive doctor search facility, hospital information and links to other health related websites (including doctors' websites). It is through the member site that Medi-Clinic Online has clearly started to focus on eBusiness systems. This part of Medi-Clinic Online is only accessible to medical practitioners and provides doctors with more services than the public site. Depending on their membership type, doctors are provided with a connection to the Internet Service, e-mail facilities, hosting of a personal website and funder narrations (an application that provides doctors with the rules and regulations of a selected medical aid). The next building block to be added onto Medi-Clinic Online is the Patient Administration Project. In line with the eBusiness strategy, this project aims to improve business efficiency in patient administration. The initial focus will be on the patient/doctor/hospital interaction and will include processes such as pre-admission and admission of patients and theatre and bed bookings. Medi-Clinic Online is also the facility where information can be shared electronically between Medi-Clinic and other service providers such as suppliers, funders, pathologists and radiologists. A pilot project has been started with the Pathcare Group (Lancet, DSP) who operate pathology laboratories at our hospitals. The Pathcare Group's system connects to the Medi-Clinic Online services application electronically to collect relevant patient demographic information from the hospitals."

3.2.3 ICT Spending Patterns

Depending on the industry and the stage of development of particular firms within the industry, global data shows that there is a wide range of expenditure on ICT (hardware, software, telecomm facilities, ICT human resource, training, support, etc.) ranging from less than 1% of turnover to more than 20%. Interviewees were requested to rate on a scale from 1-5 (1 = Much less than the norm; 5 = Much more than the norm) the expenditure on ICT in three categories. These categories are: the health sector's ("your sector's") ICT expenditure in South Africa relative to the norm in the health sector globally; the organisation's ICT expenditure relative to the norm of the health sector's ICT expenditure in South Africa; and, the growth of the expenditure on ICT relative to other areas in the organisation surveyed. The results are indicated in the graph below.



These results indicate that, in the opinion of the interviewees:

- The health sector in South Africa, on average, spends less than the norm of the global health expenditure on ICT.
- The organisations surveyed spend slightly more than the norm of the South African health sector's expenditure on ICT.
- The ICT budgets of the organisations surveyed are growing slightly more than the norm, in comparison with other budget areas.

This is consistent with the nature of the organisations represented in the sample, which could generally be regarded as being more extensive users of ICT than the norm in this sector.

The cost of implementing computerised health information systems in relation to the potential return on investment remains an important issue for debate, taking into account that there are obviously budget limitations which prevent the optimal implementation of ICTs to support all aspects of healthcare services.

It is expected that the role players will increasingly realise the benefits of computerisation. In the private healthcare sub-sector the medical profession has been slow to embrace the use of ICT for day-to-day operation of a doctor's practice. However, this is changing and there is clear evidence from discussions during the survey that batch and real-time electronic interaction via switching networks between healthcare service providers and funders provides real benefits of improved cash-flow and reduced administration costs for the service providers. In all instances ICT applications can reduce time-consuming paperwork. This trend is evident in the fact that Digital Healthcare Solutions, for example, reported that 2400 pharmacies and 6200 medical practitioners now base their businesses on online processing capabilities offered by that company.

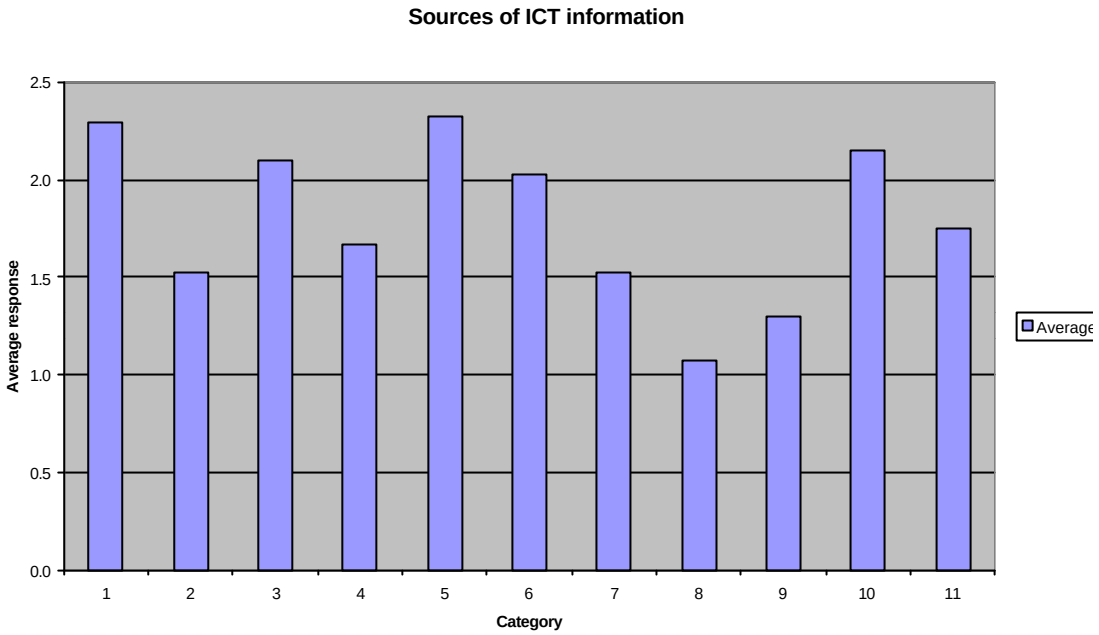
3.2.4 Sources of ICT Information and Training

The diffusion of ICT innovations and the adoption within firms is closely related to awareness of such innovations and their potential, as well as employee training. The questionnaire requested the interviewees to indicate their organisations' main sources of information related to ICTs and their use in the health sector, and the sources of ICT training for their professional and user staff. The scale used was: 1 = sources least used or not used at all; 2 = sources sometimes used; and, 3 = sources most used.

The selection of sources was coded as indicated in the following table:

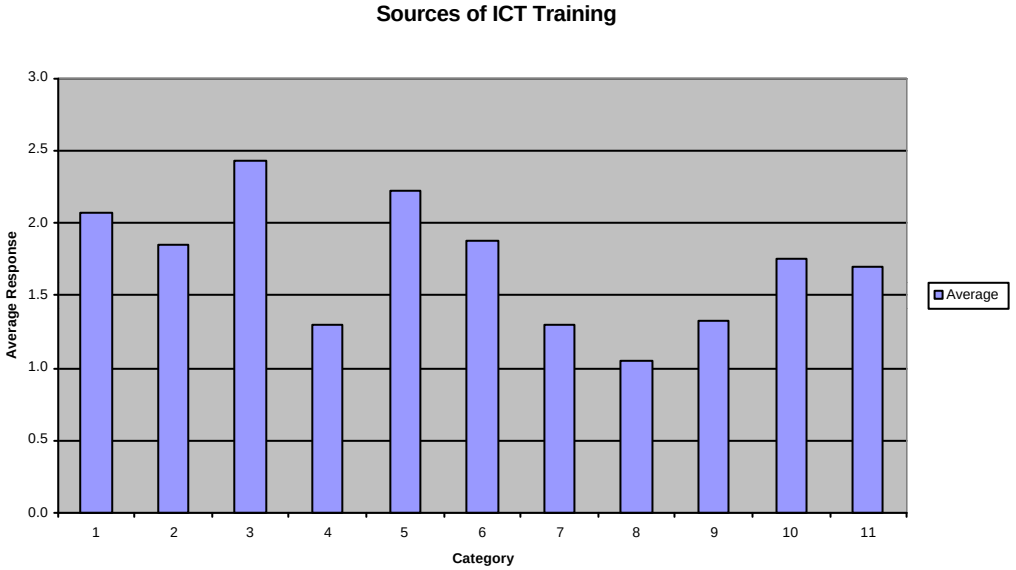
1	ICT suppliers e.g. vendors of software/hardware
2	Specialised private sector trainers
3	In-house training programmes
4	Newspapers, magazines, journals
5	Experts within the company (incl. parent company)
6	Consultants/service providers
7	Trade and business associations
8	Chambers of Commerce
9	Government training initiatives
10	Internet
11	Universities / Technikons
12	Other (specify)

The graph below indicates the use of the abovementioned sources to acquire/access ICT-related information.



On average, sources "sometimes used" (i.e. score 2 and above) to acquire/access ICT-related information are: ICT suppliers, e.g. vendors of software/hardware; In-house training programmes; Experts within the company/organisation (incl. parent company); Consultants/service providers; and, the Internet.

The following graph indicates the use of the abovementioned sources for ICT-related training.



Comments relating to training were more positive than expected, and although gaps were identified, the use of computer-based training seemed fairly widespread. Although there are obviously deficiencies and issues, the overall impression was that this was not a major item on the agenda.

On average, sources most used for ICT-related training are: 'ICT suppliers e.g. vendors of software/hardware'; 'In-house training programmes'; and, 'experts within the company (incl. parent company)'.

The researchers are a bit concerned that training needs may have been underestimated by some interviewees and consider this as an area that still needs particular attention. On the question whether the interviewees are aware of any government initiatives supporting the use of ICTs in your industry, the following (general) response is worth noting: "Yes, an extensive roll out of health information systems being implemented by provincial departments of health, although limited funding is restricting this and in some instances results in outdated technology solutions (e.g. DOS-based systems). A limited roll out of telemedicine workstations." Training logically follows the rollout of such initiatives.

3.2.5 ICT Adoption: Drivers and Barriers

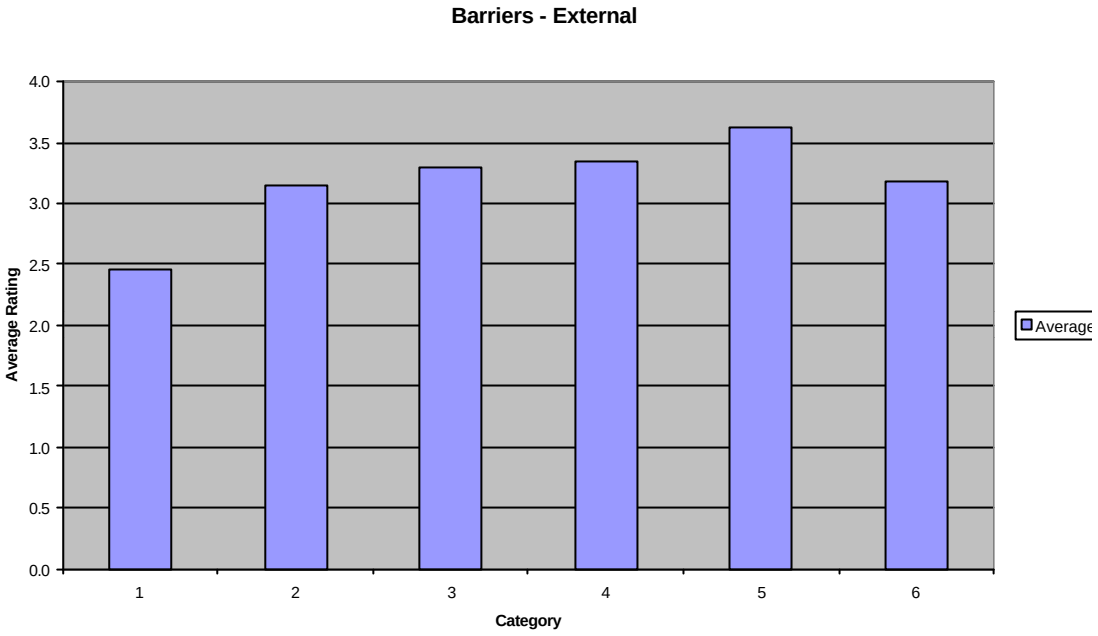
There are many internal and external factors that influence a particular organisation's decision to invest in ICTs. One or more aspects of the external and internal environment can be a driver for accelerated investment while similar factors may be a real barrier to adoption. An understanding of the main drivers and barriers in a particular sector and across sectors can provide pointers to beneficial actions at the firm level, sector level and national level. Interviewees were therefore requested to rate their organisations' adoption of ICT on a five-point scale (1 = strong negative influence or barrier; 5 = strong positive influence or driver), in terms of several variables. These variables were clustered under three categories as indicated below:

External economic conditions:

- 1 = General economic conditions in my sector
- 2 = My sector's culture and attitude towards ICT
- 3 = Expected increased competition in the short term (next two years)
- 4 = Expected increased competition in the medium term (next 5 - 10 years)
- 5 = Increased global business opportunities
- 6 = Increased influence from multinational firms.

In general the responses to this part of the questionnaire indicated that 'increased global business opportunities' is viewed as the strongest driver, with 'general economic conditions in the South African health sector' as a negative influence. For the public healthcare sub-sector, 'increased global business opportunities' was interpreted as referring to increased opportunities for accessing technology solutions.

The graph below reflects the average responses for this category.

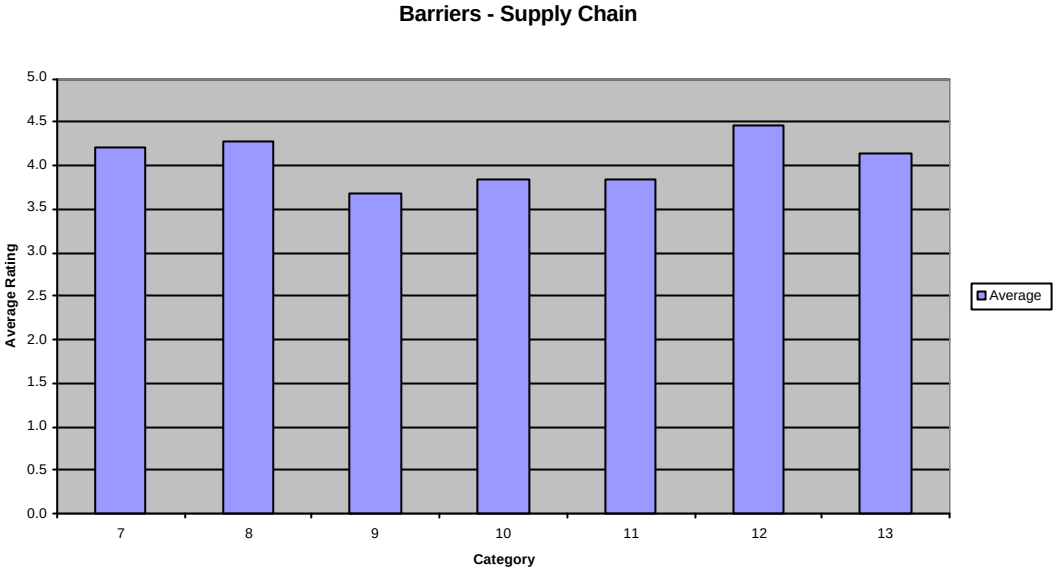


Supply chain factors:

- 7 = Need for increased organisational efficiency
- 8 = Need to respond to customer requirements
- 9 = Need to respond to supplier requirements
- 10 = Need to respond to government requirements
- 11 = Need to respond to national or international regulatory/environmental standards
- 12 = Need to improve communications
- 13 = Need to reduce paperwork

In this category there were no negative barriers reported. The following were considered as having a positive influence: need for increased organisational efficiency; need to respond to customer requirements; need to improve communications; and, need to reduce paperwork.

The results are reflected in the graph below:

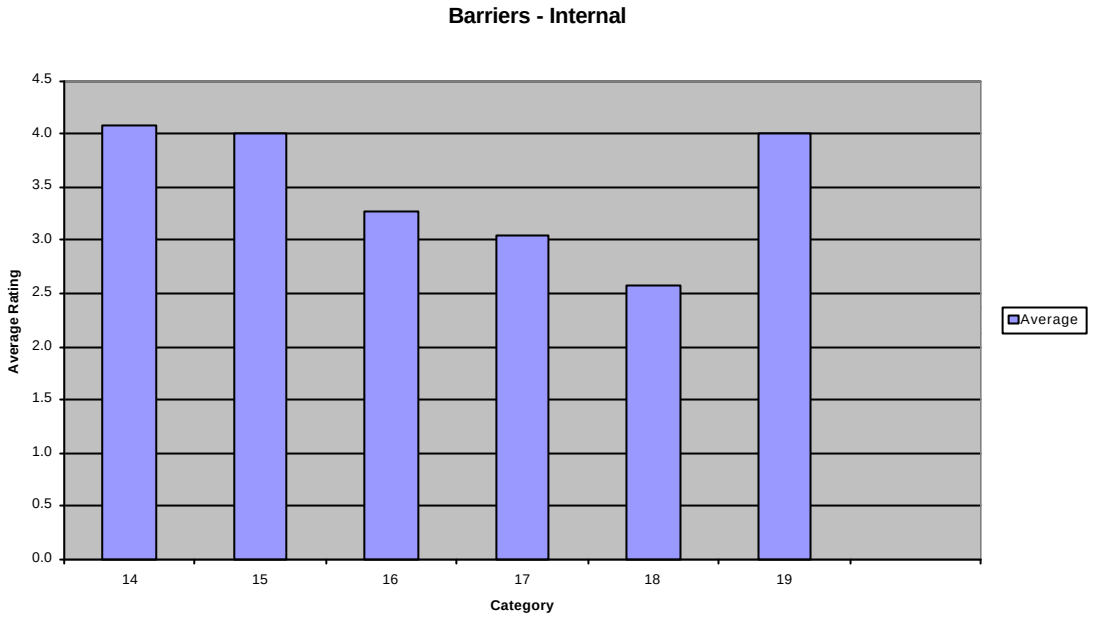


Internal factors:

- 14 = Attitudes of Senior Management towards ICT
- 15 = General attitude of personnel towards ICT
- 16 = Level of ICT skills in the workplace
- 17 = Availability of ICT professional skills
- 18 = Perceived cost of ICTs
- 19 = Need for increased computing to do business (R&D and other functions).

Results indicate that apart from 'perceived cost of ICTs' there were no negative barriers, while the following were considered as having a positive influence: 'attitudes of Senior Management towards ICT';' general attitude of personnel towards ICT'; and, the 'need for increased computing to do business (R&D and other functions).

The results are reflected in the graph below:



Questions relating to security/privacy showed good awareness, a high level of concern and most organisations appeared to be doing something about it.

The following reflects the typical response on the questions "How concerned is your organisation about the security of organisational data and information?" and "What mechanisms are in place to protect this corporate asset?":

- "Very concerned."
- "In general, the risk of cyber attacks is most likely increasing every day." "The normal use of firewalls and password control could also be improved by vending data and applications to end-users on the Internet via portal technology."

3.2.6 Diffusion of ICT

Everett Roger's well-established model describes the diffusion (i.e., penetration, extent of adoption) of innovations like ICT. Interviewees were requested to characterise, in very general terms: their organisations' rate of adoption; the adoption by the South African health sector in terms of the South African economy; and the South African health sector's adoption in terms of the global economy. The following five-point scale was used:

1 = Among the first few percent to adopt ICT (an Innovator)

2 = Among the next 10-15 % percent to adopt ICT (an Early Adopter)

3 = Among the next 30-40% percent to adopt ICT (the Early Majority)

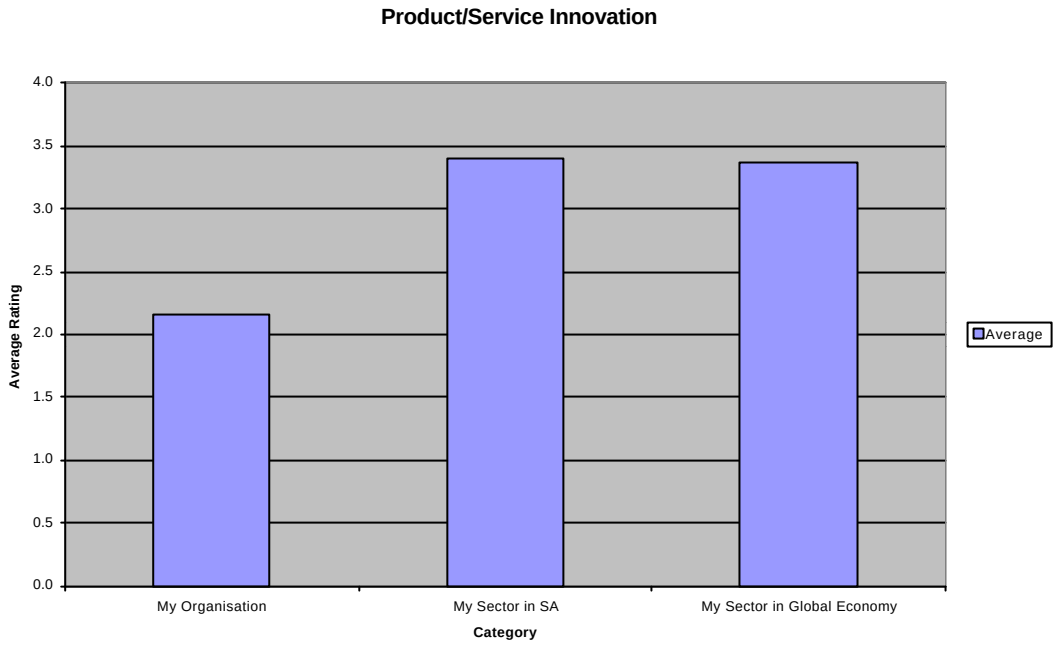
4 = Among the next 30-40% percent to adopt an ICT (the Late Majority)

5 = Among the last few percent to adopt an ICT innovation (a Laggard).

The rate of adoption was measured in terms of five categories as indicated below.

Product/service innovation (using ICT to develop new products/services or exploit new market niches):

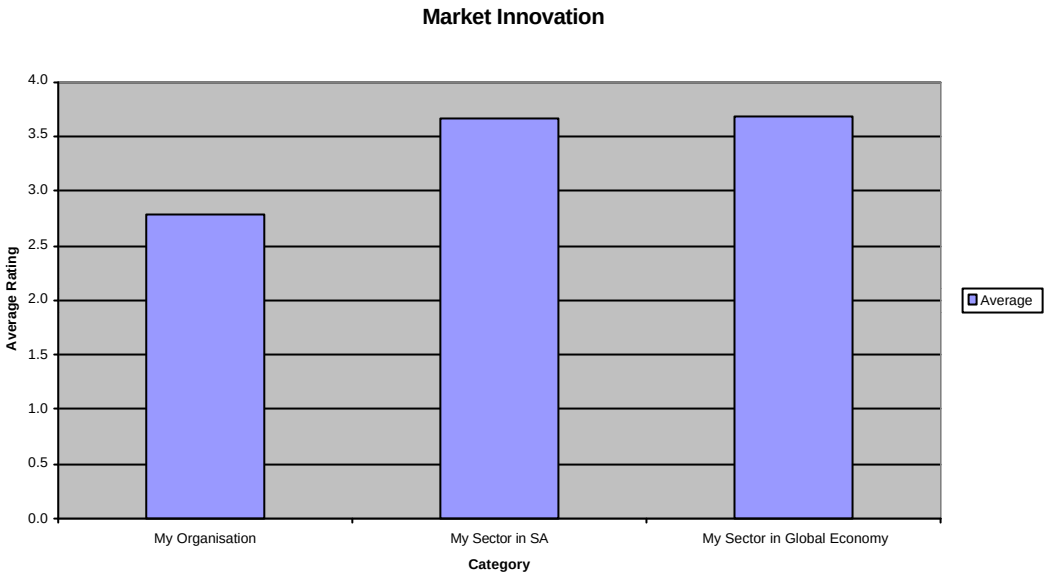
The results of the survey are reflected in the following graph:



This shows that in terms of 'product/service innovation' the organisations surveyed, on average, can be considered to be 'early adopters' of ICT. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the global economy.

Market Innovation (applying ICT and especially the Internet to create new channels for marketing and distributing products and services):

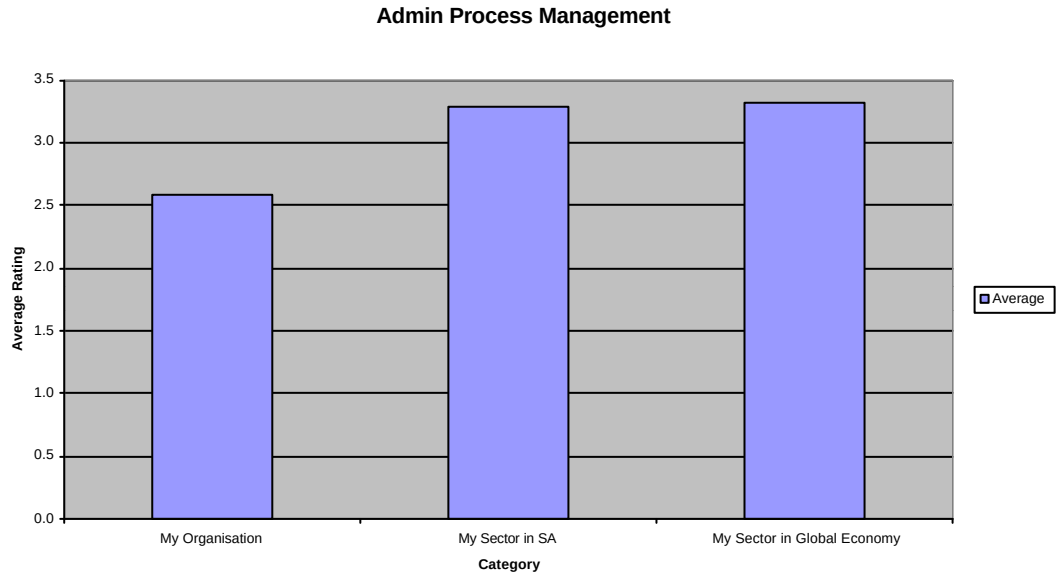
The results of the survey are reflected in the following graph:



This shows that in terms of 'market Innovation' the organisations surveyed, on average, can be considered to be 'early adopters'. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the global economy.

Administrative Process Management (Using Intranets and the Internet to improve communications, especially via e-mail and Web access):

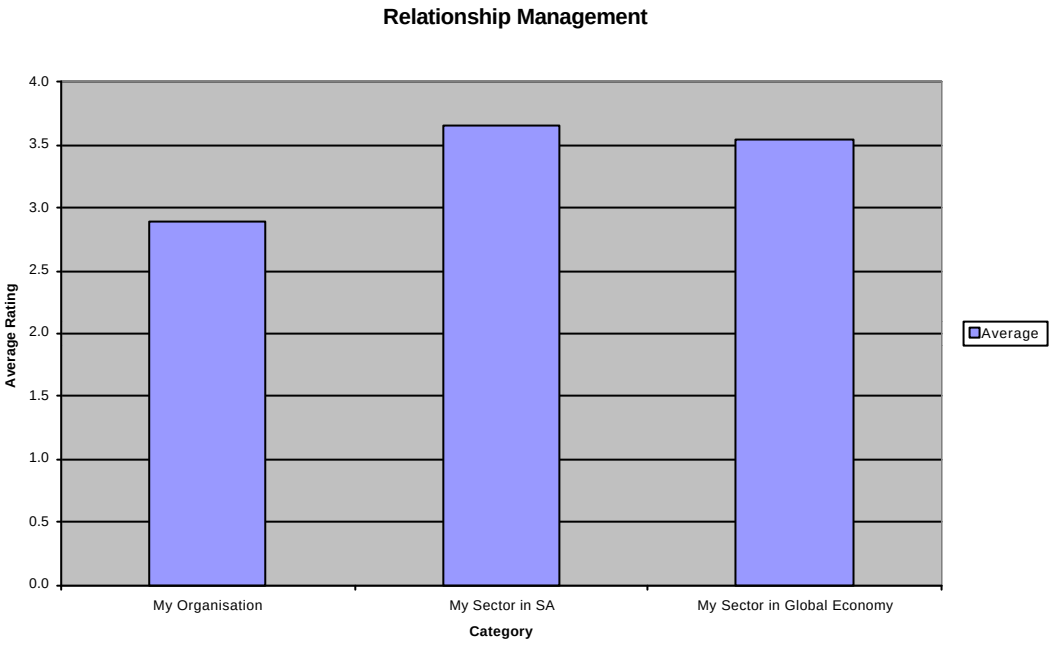
The results of the survey are reflected in the following graph:



This shows that in terms of 'administrative process management' the organisations surveyed, on average, can be considered to be 'early adopters'. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the global economy.

Relationship Management (using Extranets, the Internet and Virtual Private Networks (VPNs) to create closer links with other stakeholders (customers, suppliers, interested parties), especially for EDI-based ordering and invoicing and "just-in-time" production):

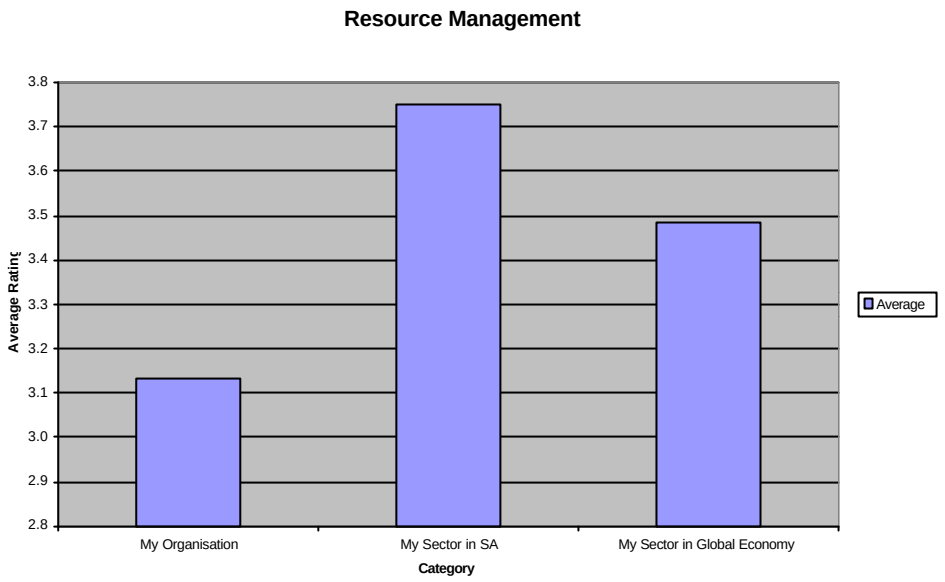
The results of the survey are reflected in the following graph:



This shows that in terms of 'relationship management' the organisations surveyed, on average, can be considered to be 'early adopters'. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the global economy.

Resource Management (Using the Internet to provide or obtain expertise at a distance, like remote consultation, health diagnostics, distance learning and education):

The results of the survey are reflected in the graph below:



This shows that in terms of 'resource management' the organisations surveyed, on average, can be considered to be the 'early majority'. The health sector in South Africa compared with other sectors is viewed as falling in the category 'early majority', and the same holds true for the South African health sector in terms of the global economy.

Thus, in terms of diffusion of ICT, the South African health sector appears to be an 'early majority' in terms of Everett Roger's model of the diffusion (i.e., penetration, extent of adoption) of using ICT in comparison with the global health sector. This does not mean that all available ICT solutions are adopted and indeed the challenge would be to ensure that only appropriate technology solutions enter the South African health sector marketplace. Compared with the developed world, the South African health sector can still benefit from new advances, in the area of telemedicine for example. Compared to the developing world, the South African healthcare sector in general is far advanced.

Answers to questions at the end of the survey questionnaire's ICT Usage Section showed a pattern of identifying the following as issues that need attention and which will necessarily lead to a demand for new ICT solutions/products:

- Telecommunication infrastructure (with lack of Internet connectivity and where available the cost of bandwidth as the main issues)
- Attention to Business Processes (including the need for remote 'teleworking' and the use of call centres)
- Limited computer skills and equipment
- E-Commerce (business-to-business and EDI)
- Integrated information between provinces/public/private.

The lack of appropriate bandwidth stands out as a particular issue. Further, the apparent lack of coherence in the public healthcare sub-sector would need some

strong leadership intervention. By catering for the availability of bandwidth at more affordable rates and improved integration of systems, the health sector would benefit on the medium term from cost reduction.

A variety of schemes were suggested to stimulate ICT use and a number of responses reiterated previously identified weaknesses (bandwidth, integration of information and training) but other observations related to the lack of leadership in the Public Health System particularly at Government level, and the need for more Telemedicine projects. On the question "What types of projects / incentives / schemes should be initiated immediately to stimulate the use of ICTs in your industry and the sector as a whole and who should lead/participate?", the following response is worth noting:

"Apart from bandwidth/transmission issues, there is a need for better integration of health information flows and the establishment of an 'independent' centralised health data warehouse, which can feed data for research purposes, specialised analyses and building commercially-viable information products. An organisation such as the MRC could drive this process by bringing major role players in the public and private sector health care industry together to workshop such an option. There is also a great need to use common standards."

3.2.7 Health-specific questions

The health-specific questions of the questionnaire delivered the following results (scale 1-5; 1 = no use at all, 5 = fully utilised):

- Sufficient IT infrastructure and telecommunication links are in place to conduct business optimally: average = 3,6
- Common standards are used (including the implementation of data dictionaries): average = 3,375
- Security is addressed: average = 3.65
- e-Health systems are in place (knowledge networks, portals, call centres, telemedicine): average = 3,0
- e-Business is used (claim eligibility checking, electronic claims processing and billing, etc.): average = 2,3
- New technology is introduced, linked to sophisticated databases and warehouses (use of smart cards, etc.): average = 2,45
- Systems are in place to adhere to new legislation and to protect sensitive data (patient confidentiality): average = 2,825
- Computerised district health information systems are used (or linked to): average = 2,05
- Computerised laboratory information systems are in place: average = 1,625
- Burden of disease systems (supporting the information flow on the burden of disease e.g. on infectious diseases, such as HIV/AIDS, TB and malaria) are in place or contributed to: average = 2,375
- Whether the organisation is catering for data and knowledge flows in the greater health sector: average = 2,9.

It is clear that none of the abovementioned elements of health ICT is implemented or operating at a high level of utilisation. The narrative comments received closely correlate with the low scores.

Health Information Flows:

With reference to the integrated model of information flows as depicted in the diagram in section 2.1 of the report, it can be stated that many of the organisations in their own right do contribute to the data and information flow of the larger health sector. Some systems are actually quite advanced, with integration of components, such as in the case of the information systems implemented at some academic hospitals. There is also an emergence of e-Health gateways/portals, serving various audiences in the greater health sector, and in some instances specifically providing for communities of practice to stimulate innovation and enable improved decision-making. However, there are several 'broken lines' in the model in terms of (electronic) information flows. This is due to several factors, such as a lack of computerisation at some levels (e.g. in many parts of the Eastern Cape Province), the fact that ICTs have been implemented in vertical environments as 'stand-alone' solutions that have not been designed to feed information beyond the operational environment, lack of Internet access, and a lack of holistic planning or financial constraints to implement more integrated systems. These flows

obviously differ between those organisations operating in the public sub-sector and those operating in the private sub-sector, and one finds that the two sub-sectors, in most cases, are actually operating in somewhat independent environments. Flows in the private sub-sector are mostly driven by a business model to expedite the processing of financial transactions – refer the information flows from healthcare service providers via switching networks to administrators and funders. The intermediaries in such a chain have started to build their own warehouses, mostly to protect data but also to analyse data with a view to selling information to third parties, although they are not (necessarily) the owners of the data. In general the information flows in the private sub-sector are fairly advanced, but there is the (common) phenomenon of parallel flows – not interlinking to allow a holistic view.

Systems implemented at small organisations/entities may be as advanced in terms of functionality as those of larger organisations. The systems being implemented at health district level are well designed and are providing a good basis for an interfaced hierarchical health information system, such as being envisaged by the NHISSA. Minimum data sets for districts, and for public and private hospitals, are currently being collated at district, provincial and national level, on a monthly basis. The review of the national disease notification system is currently out to tender, and should result in greatly improved availability of information. However, flows within the public sub-sector are far from optimal, which would make it very difficult for instance at this stage to build a common comprehensive data warehouse which can be interrogated for management information purposes and insight into the burden of disease.

The academic/research environment brings an important supportive contribution to the health sector. The problem is that only in a very few instances there is a transversal two-way flow between the healthcare environment and the academic/research environment – while reciprocal flows would obviously be of great advantage to both these environments.

There are obviously other factors impacting on the information flows, in particular the fact that common data and transmission standards still need to be agreed upon for significant components of both public and private sectors.

Knowledge Management:

As indicated under section 2.1 of the report a specific knowledge management assessment was also done. Far from being a detailed knowledge management assessment, it does provide an indication of the level of sophistication in this regard in the health sector. This part of the survey assessed the levels of codification linked to the related organisation of knowledge - using a five-point scale ranging from 1 (non-existent) to 5 (common). The researchers view the level of codification of knowledge and the availability of such codified knowledge as important for a country such as South Africa where transfer of knowledge to build capacity should be an important goal. The following overall average scores were obtained:

- Fully codified, articulated (recordable, storable and transferable at negligible costs, e.g. blueprints, manuals, journals and text books): average score = 3,84
- Unarticulated codified (displaced hard copy source, stand-alone source, closed jargon by specialists (epistemic community or community of practice), formal authority): average score = 2,58

- Unarticulated uncodified (no hard copy or stand-alone source exists, reference to procedural authority, charismatic leaders): average score = 2,46
- Unarticulable (technical constraints over articulation and codification, e.g. how to do a certain procedure): average score = 2,47.

For this part of the analysis the total number of responses were further subdivided into three groups: public healthcare sub-sector; research and e-Health facilities, particularly gateways/portals in a supportive and value-adding role; and, the private healthcare sub-sector. The different (average) profiles obtained are indicated in the following table.

Level of Knowledge Codification

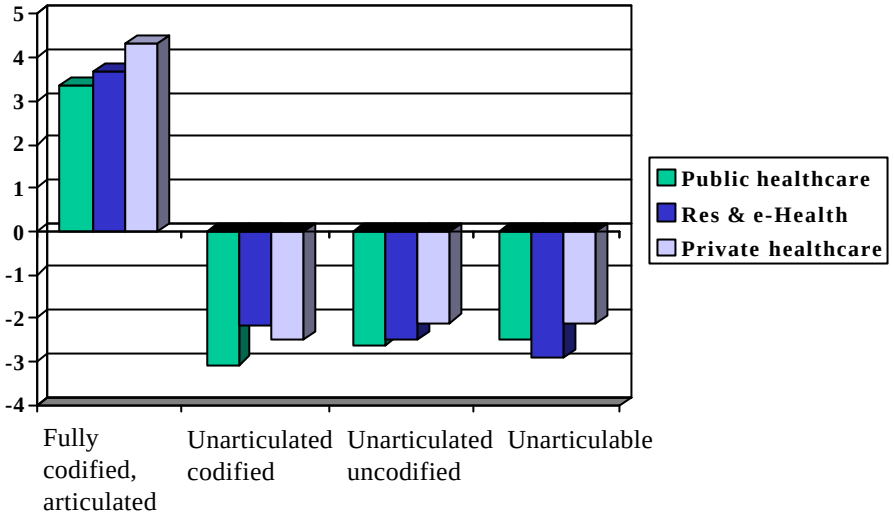
Category	Fully codified, articulated	Unarticulated codified	Unarticulated uncodified	Unarticulable
Public healthcare sub-sector	3,36	3,07	2,64	2,50
Research and e-Health gateways	3,69	2,15	2,46	2,92
Private healthcare sub-sector	4,33	2,5	2,16	2,11
Average for all interviewees	3,84	2,58	2,40	2,47

In terms of this instrument used the private healthcare sub-sector is the most sophisticated as regards knowledge management.

The level of "unarticulated codified" knowledge is the highest in the public healthcare sub-sector. The higher this value, the more inefficient the organisation concerned will be in terms of knowledge transfer. It therefore indicates an insular approach to information and knowledge dissemination in this sub-sector. The level of "unarticulated uncodified" tacit knowledge is also the highest for the public healthcare sub-sector. These findings correlate with the general situation of uncoordinated ICT systems in the public healthcare sub-sector.

The knowledge management assessment scores are also reflected in the graph below. In order to demonstrate the inhibitors to knowledge transfer, the values of the following categories are reflected as negative values: 'Unarticulated codified'; 'Unarticulated uncodified'; and, 'Unarticulable'.

Levels of codification linked to the related organisation of knowledge, 2002

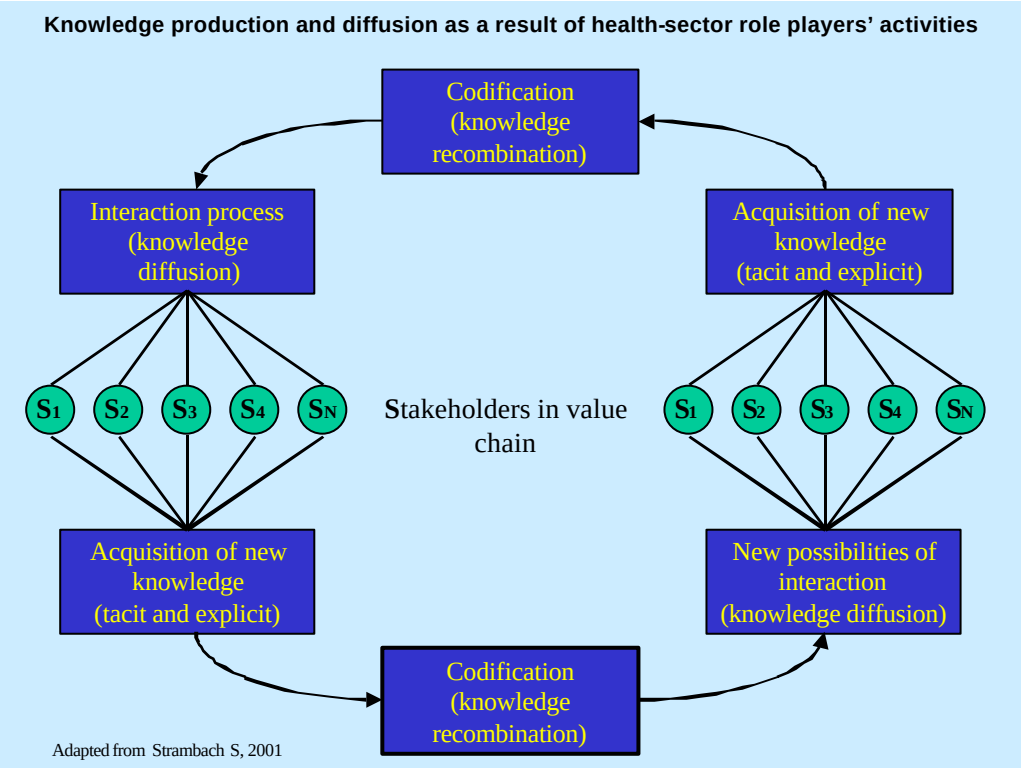


4. Conclusions and Recommendations

4.1 What can the Sector do to better exploit ICT?

4.1.1 Systems for knowledge acquisition and dissemination

ICT in the health sector and supporting mechanisms for the acquisition of new knowledge should be geared for the interaction processes and codification (knowledge recombination) that should happen in such a system. Systems to support stakeholder interaction are essential and should be planned within the context of the model depicted below[8]:



It is the researchers' view that the flow of knowledge in the South African health sector is not optimal, particularly in the public sector. This is illustrated in the following example. In an effort to investigate the role of information in the process of decision-making, researchers from the MRC Burden of Disease Unit conducted in depth interviews with programme and district managers in the Department of Health in one of the provinces in 2001. The study has shown that managers are well aware of their information needs but that the information system generally does not meet their needs. The quality of health management information is

[8] Refer: Strambach S. 2001. *Innovation processes and the role of knowledge-intensive business services*. In: Koschatzky K, Kulicke M, Zenker A (Eds.), Innovation Networks – Concepts and Challenges in the European Perspective. Physica, Heidelberg, pp.53-68.

described as inaccurate, incomplete and inadequate in informing all the decisions. In particular, the inadequacy of routine, data and the inappropriate level of aggregation appear to be constraints.[9]

The South African healthcare sector should take cognisance of the various international initiatives aimed at providing health information to frontline healthcare workers (refer to Appendix A).

A practical system implemented to support information flow in the health system is the SA Health*Info* (www.sahealthinfo.org) knowledge network, which previously received funding from the DACST Innovation Fund. This system under the auspices of the MRC facilitates and enables interaction and iterative information flow among players in the health system (researchers, health services, industry, health policy-makers and communities). Such action is essential to drive innovation processes and improved decision making for finding solutions for the southern African region's health problems.

An underlying principle is that the knowledge network provides a trusted single entry-point resource for quality-controlled and evidence-based information. It now has the following Modules (information clearinghouses for focused areas): Alcohol and drug abuse; Bioinformatics; Chronic diseases of lifestyle; Ethics in health research; Evidence-based medicine; HIV/AIDS; Malaria; Medical Inventions; Mental Health; Nutrition; Traditional Medicine; Tuberculosis; Violence and injury surveillance. More Modules will follow. This Internet portal also serves as a gateway to other trusted health resources.

The SA Health*Info* information portal is viewed as a good example of concentrating and facilitating information flows. It delivers comprehensive and unified access to a heterogeneous collection of information sources, through a secure access layer. Specific functionality addressed includes:

- Personalisation and notification – allowing users to select and receive information relevant to their interests and roles.
- Searching – the ability to search for information buried across multiple formats and sources.
- Unified access – organising and disseminating information assets, whether structured (databases, spreadsheets) or unstructured (e.g. documents, web pages).
- Strict security models – ensuring various levels of security to ensure information is accessible yet protected.
- Content submission and sharing – allowing collaborators to share valuable information in a simple, effective manner.
- Intelligent classification – allowing the subject matter to be organized according to certain standards and taxonomies.
- Common terminology – the portal provides a medium to establish a common metadata repository, ensuring consistency in understanding of information.

The health sector should build on this initiative. It was noted that as part of a government gateway the national Department of Health is planning a health gateway. The latter should closely interact with the SA Health*Info* portal to avoid duplication.

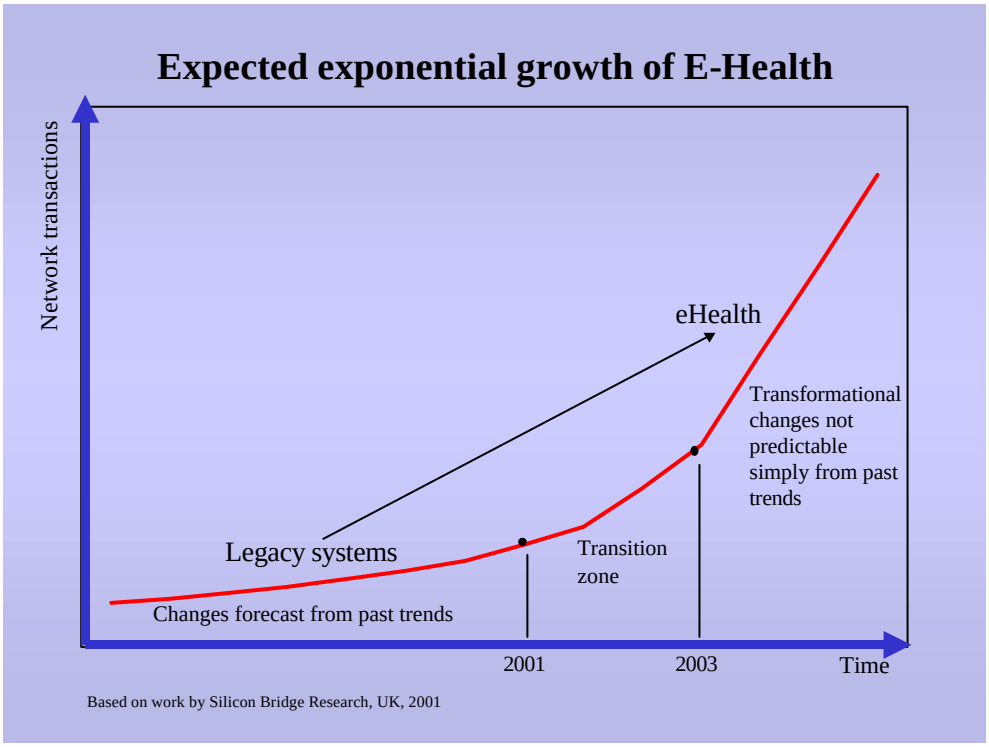
[9] Mbananga N and Sekokotla D. 2002. *The utilisation of health management information in Mpumalanga province.* Health Systems Trust, Durban, February 2002.

Elizabeth Gummerson of the Center for International Development at Harvard University - based on her study "Assessing the Global Audience for Health Care Web Sites" – reported that in developing countries the percentage of local users of health information systems aimed at eHealth on the Internet constitutes only 10% of total usage. This figure correlates with the findings of the SA Health*Info* knowledge network (**www.sahealthinfo.org**), which has logged 9,7% usage by sub-Saharan Africa for the period January to April 2002, and that of the Health Systems Trust, which logged 8% usage by sub-Saharan Africa for December 2001 (although the latter figure only includes the static portion of the web site and not the dynamic database output pages). These analyses are influenced by the use of robots linked to search engines, which skew the usage in favour of the developed-world users. However, there is clearly a need for some additional intervention by these sites to get information to the main target audience. It is our view that this phenomenon is linked to the level of ICT diffusion – and infrastructure needs such as improved bandwidth.

4.1.2 Telecommunication and Internet connectivity

The health sector should gear itself for an expected increase in demand for e-health systems.

Modern healthcare is a highly sophisticated and information intensive activity involving many interlinked and interdependent transactions. With the move towards E-Health, healthcare transactions are set to grow exponentially leading to fundamental changes in healthcare delivery processes. It is expected that the demand for E-health systems will grow at an exponential rate, with the next two years probably a transition period – refer to the following diagram 'Expected exponential growth of e-health'.



Insufficient telecommunication and Internet connectivity is an important aspect highlighted by this survey. It is clear that bandwidth is a major factor to be taken into account for future ICT planning initiatives. Many respondents highlighted this inhibiting factor. The following issues should perhaps be flagged:

- Bandwidth costs are a major problem. To illustrate the effect of bandwidth cost: one interviewee mentioned that it is currently cheaper to buy a return airline ticket from Cape Town to London to go and obtain a tape with the Human genome data, than to download those data from the UK via the available Internet link. This is a serious constraint in an era where modern health science would increasingly be dependent on fast Internet access for work in the field of genomics and bioinformatics.
- The technology as regards supplying bandwidth also comes into play. The cost-effective technology option of carrying Internet protocol (IP) on fibre optic lines is available. Increased competition with the advent of a second network operator in South Africa will probably make this available. In the US a 1,5 Megabits per second data line costs much the same as a telephone line, with its 56 Kilobits per second transmission rate. Hopefully this technology option will be available in South Africa with the advent of a second telecommunication service supplier.
- Ethernet technology has increased its speed over the past few years from 10 Megabits per second to 1 Gigabit per second, and is set to move into wide area networks (WANs) with its 10 Gigabits per second version.
- Wireless WANs – with substantial bandwidth – have been an option, but are apparently now more readily available in terms of approval by the telecommunication authorities.

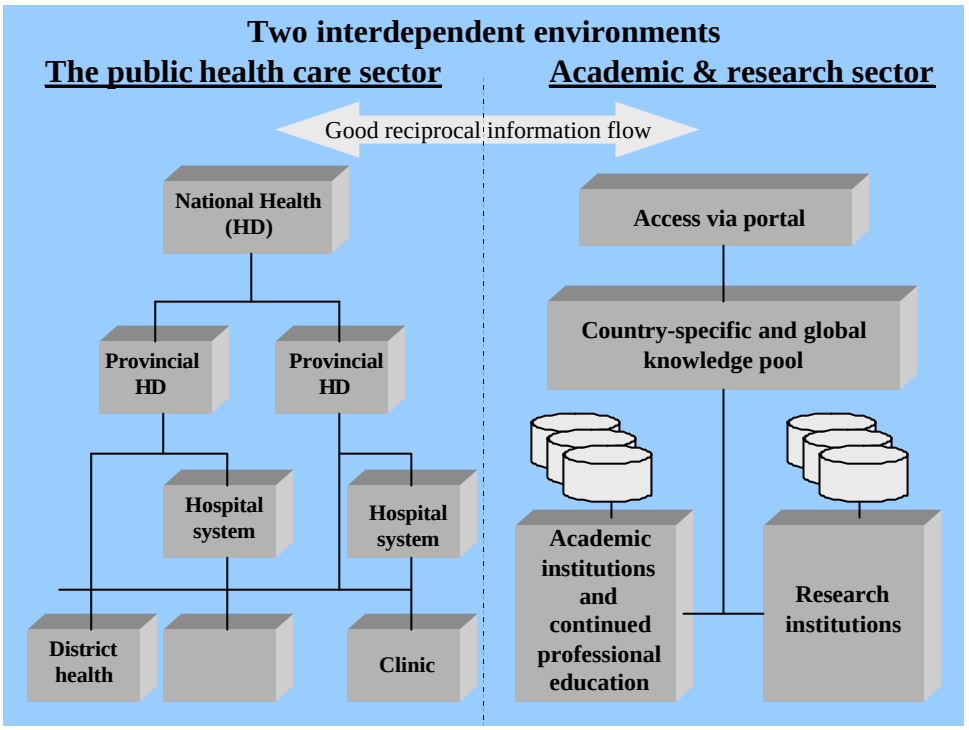
Specific initiatives should be put in place to improve affordable Internet connectivity and to plan for the implementation of the latest available technology solutions as these become available. In the meantime there are options available to optimise network traffic.

Most users with access to workstations in the public health sector are only able to operate within an intranet environment or are restricted to the Govnet extranet environment. This makes it difficult to allow access to these health care professionals workers to information sources on the Internet, such as SA Health*Info*. The challenge is that Provincial government departments should allow full Internet access to relevant health care workers, in order to access required trusted and evidence-based health information. Provincial health departments should also network the IT infrastructure invested in at district-health level. A simple illustration of the value of such a decision would be the online availability of scientific journal articles - with an expanding source of freely available articles – and the possibility for online distance education.

Wireless networks and downloading of data via satellite should be considered. USASA International (an American-based non-profit consortium) and the South African MRC have developed a concept to establish a telemedicine/tele-education broadband wireless infrastructure in the Maputo Corridor in Mpumalanga Province. This system should build on the National Telemedicine System and link with the National Health Information System for South Africa (NHISSA). The initiative can act as an economic development catalyst for advanced telecommunications in the region for medical, educational and commercial purposes.

4.1.3 Integrating systems with academic/research environment

From the interviews for this survey, it became clear that, in general, several independent vertical operational environments ('silos') of data gathering and processing exist – without sufficient interfacing. The most prominent of these relate to the public sector, the private sector and the academic and research sector. It is important to ensure that the health care sector does not develop information systems in isolation or ignoring the necessary interfacing with the valuable information resources in the educational and research sector – and vice versa, e.g. as depicted in the following diagram.



4.1.4 Building a national health data warehouse

The health sector should consider the establishment of a national health data warehouse, incorporating appropriate healthcare data from the private and public healthcare sub-sectors, and appropriate research data. Such a system should be able to deliver information for improved decision-support, for research purposes and also to feed potential commercial ventures that analyse and repackage data to build new information products for the market. In this regard it may be worthwhile to study the progress of the US Anceta initiative.

Several of the interviewees reported on the development of data warehouses within their environments (e.g. a private healthcare funder). While sophisticated analysis of the available data is being conducted in some environments, the scope of the datasets is a limitation.

The American Medical Group Association (AMGA) is an association that represents medical groups, including some of the largest integrated health care delivery systems in the US. AMGA's mission is to shape the health care environment by advancing high quality, cost-effective, patient-centred, and physician-directed health care. The members of AMGA deliver health care to more than 50 million patients in 40 states, including 15 million capitated lives. The average AMGA member group has 186 physicians and 12 satellite locations.

On 2 April 2002 the (AMGA) announced that it has formally renamed the organisation dedicated to the development of a (US) national data warehouse of health care information, to Anceta (refer www.biomednews.com and www.amga.org). AMGA has provided comparative data to medical groups for the past decade.

Anceta takes a major step towards the creation of an integrated data warehouse. It will enable members to examine how their organisations compare with others of similar size and structure. It will also will help health care industry partners to optimise treatments, improve clinical data study design and study patient enrolment, and establish 'gold standards' for treatment.

Anceta will bring many additional benefits to participating medical groups, including:

- Access to comparative clinical and operational performance data.
- The ability to select peer groups for comparison.
- High levels of confidentiality and security.
- Access to the database and analytic tools through secure Internet communications.
- Participation in the selection and/or design of risk adjustment methods.

This initiative will give medical groups an enhanced capability to conduct physician productivity evaluations and assess clinical guideline compliance, as well as conduct practice pattern studies. The warehouse will allow groups to track laboratory and pharmacy data to billing code and capture higher payment eligibility -- and to reduce the incidence of missed billing for services. In addition, the data warehouse will provide clinical performance and clinical outcomes data. That will leverage market positions and payer negotiation, as well as expand medical groups' ability to attract clinical research funding.

4.1.5 Other related issues

The following further issues arising from the interviews, and based on current ICT activities related to health in South Africa, may be flagged as important for consideration by the healthcare sector:

- The need for information to be recorded in way that it is future proofed (e.g standard data dictionaries with formal version control).
- To ensure that future-proof software is used.
- The need for systems to be interoperable at the knowledge level.
- The need to have a uniform system for an electronic patient record.

- Access to information at healthcare institutions should allow for a variety of uses. Apart from the needs of the institution itself it should cater for providing appropriated aggregated and anonymised health data to the greater health system.
- The availability of the required infrastructure, especially for networked systems, which reach into areas remote from urban centres. This infrastructure includes the requirement for competent people to support both the application and the infrastructure.
- Staff education and training is an essential component of successful ICT implementation and maintenance. At present, there is an identified need for training for hundreds of newly-appointed district health information officers throughout the country, in addition to training requirements associated with the implementation, maintenance and use of computerised hospital information systems and other computerised health information systems.
- Increasing dependence on computerised information flow between components of the SA healthcare system, in both public and private sectors, demands the implementation of common standards, both for the content of messages (requiring the development and implementation of data dictionaries at all levels of organisation, for example) and for the format of messages. While there are significant initiatives under way to develop and implement standards in both the public and private sectors, much remains to be done to ensure effective and efficient communication of health information. Several interviewees specifically noted the requirement for common standards.
- Due to the sensitive nature of health information, it is essential to ensure that patient confidentiality is maintained appropriately at all times. Current and planned legislation to govern access to information places great emphasis on this requirement. Examples of current and planned legislation include the draft National Health Bill (published November 2001), the Access to Information Act (Act 2, 2001) and the Electronic Communications and Transactions Bill (published March 2002). However, the need for individual patient confidentiality also has to be balanced against the need for access to information on groups of people, to support management and planning, and research.

4.2 What can the ICT Industry do for this sector?

The researchers are of the opinion that the ICT industry has a unique opportunity to come to the forefront and accept the challenge to build systems which will be appropriate for South Africa - also with a view to roll these out to other African countries within the spirit of NEPAD.

Particularly the area of e-health and telemedicine should be flagged, but also the integration/interfacing of systems to facilitate data flows and improve the availability of information for decision support. However, the ICT industry should consider its possible involvement in all of the following aspects of health ICT:

- Technical infrastructure, including 'last mile' connections, based on the most appropriate technology
- Standards for computer communication and record content
- Knowledge presentation

- Information management
- Decision support
- Electronic patient records
- Hospital information systems
- Clinical recordkeeping, based on standardised coded data
- Telematics in healthcare
- Signal processing
- Imaging
- Robotics and virtual reality
- Bioinformatics
- Education and training
- Evaluation of systems
- Security and confidentiality
- Ethical, legal and social issues (e.g. impacted on by legislation)
- Consumer health informatics applications (including remote patient monitoring)
- Primary and ambulatory care applications
- Nursing information systems
- Collaborative working (e.g. via portals)

The notion of strategic partnerships between the ICT industry and healthcare providers should be promoted.

4.3 What can government do?

Government should first of all ensure that legislation provides a suitable control environment, but not an inhibiting environment for the essential flow of health data.

Government could also assist the health sector in facilitating the funding for training of ICT staff in the workplace. In this regard a sensible flow of SETA funding to organisations to provide in-house training should be promoted. Where the ICT industry is willing to come on board in strategic partnerships for necessary ICT development projects in the public healthcare sub-sector, government should consider incentives in the form of tax rebates.

The development of integrated lifetime electronic health records has the potential for contributing to improved quality of life for the population. Government should support initiatives towards such development.

Government has a responsibility in terms of empowerment of the general public with education on health and wellness by disseminating health information personalised to the individual's need. In this regard government should ensure that potential initiatives by the public healthcare sector take into account the existing initiatives in the private, academic/research and NGO sectors – to avoid 'reinventing the wheel'.

5. Appendices

a. Baseline information: developed world and developing world – Appendix A

b. Health sector-specific components of questionnaire – Appendix B

c. Description of Interviewees – Appendix C

Appendix A

Baseline information: developed and developing countries

A.1 Developed countries

It is clear that health care has been identified both within the European Union and globally (G-8) as one of the sectors in society with potential for great benefits to be gained through the application of information and communications technologies (ICT) in the Information Society.[10]

A 1996 report in this regard highlighted the following:

- 'Society for all' is a globally accepted UN target for the development of societies, particularly taking into account the needs of the disabled and marginalized people by empowerment.
- Health promotion, prevention and self-care are important challenges for ICT development and future markets for innovative products and services. Citizens as service users should be included in their development.
- Telematic healthcare services and applications for home care support the independent living and social integration of elderly and disabled people, if their needs are taken into account in the development and implementation of the systems and services. The inclusion of those needs in the universal service obligation for telecommunications operators is essential.
- The implementation of information and communication technologies in health care is expected to increase equity by making health care services more accessible to all citizens. ICT can also help improve the quality of health care services and give citizens better facilities for participation.
- Telemedicine and multimedia are the technologies which arouse the keenest interest among both policy makers and IT industries. They are also prominently portrayed in the media. Both telemedicine and multimedia will most probably gain an essential role in European health care in the future. Also other products of the information age, such as smart cards and expert or decision support systems, are definitely finding their applications, some of which may be unforeseeable. At present, conventional ICTs still have unexploited potential in health care. For instance, a considerable proportion of European hospitals and health-care centres lack adequate local information systems for administration, and for patient and clinical data. When properly designed and developed to

[10] Ani Kajander, and Mauno Konttinen (ed.). *Information and Communication Technologies in Health Care*. Stakes. Helsinki, 1996. 59 s. ISBN 95 l-33-0246-6; (summary); www document, URL http://www.stakes.fi/pdf/kajander-abs.htm

support and facilitate new ways to provide care, the ICTs for hospitals will have a.major impact on the quality, efficiency, and effectiveness of health care.

- Administrative structures and organization of care delivery systems are predicted to undergo thorough changes *pari passu* with the application of modern ICT in health care. Work and professions in health care change, too. The training and education of medical professionals and other healthcare personnel to utilize all the possibilities of their ICT-based work-environment is a challenge to all industrialized countries. Healthcare professionals should participate in the development and implementation of ICT.
- Confidentiality, data protection and security are crucial issues in health care. The confidentiality of identifiable patient or client data has to be guaranteed in all ICT applications and data transfer. On the other hand, overprotection of data should not prevent epidemiological or other research from obtaining access to individualized health data on the population concerned.
- The health care sector comprises a considerable and growing market for the ICT industries. On one hand, there are primary care centres, GPs and hospitals, on the other, a growing number of consumers both willing and able to buy ICT applications for self-care and home care. Due to the considerable public share in the financing of health care, there is also strong public interest in the ICT developments and investments.
- The cost-containment constraints of publicly funded health care mean that the increase of ICT costs must be compensated and even surpassed by savings. It may therefore even be wise to restrict the commercial flow of expensive ICTs in health care, unless their cost-effectiveness is clearly verified. However, ICT should not be seen only as a means to reduce costs but as an option to increase innovativeness and to create new forms of work organization in health care service provision (refer footnote 2).

E-health is very topical in 2002. It can be defined as being *the leveraging of the information and communication technology (ICT) to connect provider and patients and governments; to educate and inform health care professionals, managers and consumers; to stimulate innovation in care delivery and health system management; and, to improve our health care system.* ICT has the potential to significantly and irrevocably change the delivery of health care services and patient care, and the management of the health care system around the world. Not only are the technologies and applications changing at ever increasing speeds, so are the dynamics of the business surrounding the implementation and application of e-health technologies and applications. The electronic patient record is an important component of e-health. A conference "e-Health 2002: A New Era of Health Delivery" was held 20-23 April 2002 in Vancouver, Canada (refer http://www.e-health2002.com/).

Telemedicine is also very topical in 2002. Telemedicine provides new ways to share knowledge virtually without limitations in space and time. By its nature it promotes equity, since using telemedicine on a broad scale helps to allow everyone equal access to medical care on a higher level. The rapid increase of information in medicine is reflected by the fact that no single person can provide profound medical knowledge in all areas of health care any more. Telemedicine can help to correct the uneven distribution of knowledge among health care professionals: the inexperienced caregiver may become more competent, and the underserved patient receives better care. The potential of telemedicine to contribute to excellent care is obvious. It is only a matter of time until every citizen, every potential patient will claim the benefits to secure quality of care and quality of life. A conference on this

topical issue is scheduled for 22-25 September 2002, in Regensburg, Germany (refer http://www.ict2002.org/).

A.2 Developing Countries – focus on Africa

ICT has not been harnessed systematically to improve the health of populations in developing countries.[11] The current digital divide between developed and developing countries must be viewed as a serious underlying factor. Africa had an estimated 3 million Internet users in November 2000, compared to the world total of 407 million (i.e. 0,7% of the total world users and only 0,4% of the total African population).[12]

Previous research by CIDCM staff and affiliates has shown that in general rich countries have adopted new ICTs more rapidly than poor countries, and open societies more rapidly than closed ones. At the same time, countries that share approximately the same structural characteristics have had different experiences with Internet diffusion. Differences in policy-making, leadership, and institutional organization are regarded as largely explaining the different diffusion experiences across countries. Previous work suggests that extensive social networking among businessmen, government actors, NGOs, academics and others is a necessary condition for ICT diffusion and determines its pervasiveness and the speed with which it spreads.[13]

The Economic Commission for Africa (ECA) published a Common Position for Africa's Digital Inclusion in 2001.[14] This document highlighted that ICT can play a substantial role in mitigating some of Africa's problems in the health sector. It can do this by improving access to health services in rural areas, underpinning public education campaigns to promote healthy behaviour, transferring diagnostic information to specialised centres, strengthening the basis for decision making, promoting information exchange among researchers and students, and enhancing the effectiveness of health institutions. Specific ECA recommendations include:

- Establishing a network of health professionals;
- Developing multimedia health information systems, databases and websites;
- Using ICTs to facilitate delivery of health care services;
- Creating and strengthening telemedicine projects to leverage local resources;
- Instituting specialised training for health professionals especially in continuing medical education;
- Specially emphasising the use of ICTs in the fight against HIV/AIDS in Africa; and

[11] Tessa Tan-Torres Edejer. Disseminating health information in developing countries: the role of the internet; BMJ 2000, No 7264, 797-800

[12] Ashfaq Ishaq. *On the Global Digital Divide*; Finance and Development, (a quarterly magazine of the IMF), 2001, 38 (3)

[13] Center for International Development and Conflict Management. *Negotiating the Digital Divide: A Framework of Analysis*; www document, URL http://www.bsos.umd.edu/cidcm/events/execsummary.htm

[14] Economic Commission for Africa. *Common Position for Africa's Digital Inclusion: Recommendations of the Meeting on Africa's Contribution to the G8 DOT Force and the UN ECOSOC Panel on Digital Divide, 10-12 May 2001, Addis Ababa, Ethiopia*.

- Supporting the establishment of African centres of medical excellence and promoting co-operation and exchange of expertise.

There are currently various international initiatives aimed at delivering health information to developing countries. These are in essence all planned with very benevolent aims to improve the situation at the primary health care level. There is proof of the commitment of the organisers and funding bodies behind such initiatives. However, these initiatives are in many instances unco-ordinated and may at best constitute attempts at addressing the needs of developing countries as perceived by the developed world. It is viewed as essential that African health policy makers should take cognisance of these initiatives and view them as an excellent resource to improve health information flow to various categories of end users – from frontline health workers to community organisations and individuals seeking health information. Decision makers within these structures should investigate ways of appropriate collaboration. Such collaboration will hopefully result in: more focus in terms of responding to country- and region-specific health needs; economies of scale in terms of ICT infrastructure roll out; and, local end-user involvement to the extent that true reciprocal flow of relevant information can happen.

The following list provides an indication of international initiatives, which are expected to impact on health ICT diffusion in Africa:

- Interactive Health Network – Director Dr Harry McConnell – is geared towards the frontline health worker. The goal of the Interactive Health Network is to establish a broad-based interactive community for healthcare workers. This interactive community would increase the exchange between developing and developed countries, between NGOs working in international health and between local practitioners and volunteers from outside agencies. This will serve the primary purpose of increasing health promotion and medical education in order to facilitate accurate diagnosis and treatment. The Interactive Health Network will provide content and assistance in co-ordination with global health information initiatives. (hmcconnell@compuserve.com).
- The Health InterNetwork for Developing Nations – a very ambitious project. The InterNetwork will serve as a two-way communication system between health professionals within developing countries and also around the world. Its goal is to install 100 Internet-accessible computers in each of the 130 poorest countries selected for this venture. Cost: in the region of 150 to 200 million dollars.
- SHARED – a system funded by the EU to promote interaction among health researchers in developing countries. Researchers are invited to post information on their research projects and indicate their areas of interest. The data are in many instances outdated. The project is co-ordinated by Dr Barend Mons. (http://www.shared.de/sharedhome.html).
- SatelLife - well-known for its healthnet listserv in African countries (still mostly based on old FidoNet technology).
- Afro-Nets listserv – co-ordinated by Dr Dieter Neuvians of GTZ (previously in Harare) – a very useful service.
- The International Network for the Availability of Scientific Publications (INASP), launched in April 1996, is a co-operative network of partners aiming to improve world-wide access to information – refer http://www.inasp.org.uk/. INASP-Health promotes 'access to reliable information for health professionals' as a key development issue, as potentially the most cost-effective approach to

sustainable improvement in healthcare in developing and transitional countries. It links with the WHO-HIF Cooperation Programme and is managed by Dr Neil Packenham Walsh (e-mail: inasp@gn.apc.org).

- WHO initiatives such as: WHOLINK library and information networks; the WHO Blue Trunk Library project in some 20 African countries, providing a collection of manuals and texts to district health centres, organised in a blue trunk which acts as a mini library – regarded as a valuable complementary (manual) system (bertrandi@who.ch); the African Index Medicus (shakakatar@whoafr.org) produced under the auspices of WHO AFRO and the Association for Health Information and Libraries in Africa (AHILA)
- http://www.who.int/hlt/countrysup/aim/English/aime.htm).
- World Bank – e.g. HNPFLASH newsletter service.
- UNAIDS announced that it has been spending $15 million (in 2000) to install Internet backbones in 20 African countries. In April 2000, a network was launched to counter the spread of HIV/AIDS. Supported by the UNAIDS, this network, the first of its kind in French, was described as an important step to "broaden the exchange of information and experiences, strengthen advocacy efforts, promote prevention measures (and) reinforce access to care and treatment" in one of the areas hardest hit by the HIV/AIDS pandemic.
- As part of the Multi-lateral Initiative on Malaria (MIM) - with the US National Library of Medicine (NLM) - investing in Internet connectivity to and document delivery services via the University of Zimbabwe and the South African Medical Research Council. (http://mim.nih.gov/ and http://www.mimcom.net).
- Dissemination centres initiated about three years ago by the Commonwealth Regional Health Community Secretariat for East, Central and Southern Africa - e.g. the Uganda dissemination centre on nutrition and reproductive health (fkalyowa@usa.net).
- The system for HIV/AIDS information management and dissemination in Senegal in collaboration with UNAIDS - making information available on the Internet and in printed materials (bobibrahim@yahoo.com/aciannex@enda.sn and http://www.acibaobab.org).
- The International Development Research Centre (IDRC), The United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the International Telecommunications Union (ITU) have all been instrumental in undertaking a new form of collaboration and partnership in pursuing Multipurpose Community Telecentres pilot projects. They are fusing their respective organisational cultures in an effort, not only to build successful models for rural African telecentres, but also for international co-operation for social and economic development.
- (http://www.idrc.ca/acacia/outputs/lemonade/lemon.html).
- In May 2000, the US-based WorldSpace Foundation and SatelLife launched a health information system to supply a "steady stream of material to assist medical professionals in Africa in the diagnosis, prevention and treatment of diseases that are ravaging that continent. Called the Public Health Channel, and created with a range of "high-quality information resources", this service seeks to combat such diseases as tuberculosis, in addition to HIV/AIDS, through a steady 'dose' of relevant medical assistance.

- The Health Information for Development (HID) Project is working towards a network of health information resource centres, with at this stage the focus on connectivity and ICT capacity development to enable access to health information. The Health Information for Development project is the first phase of a projected $45 m Information Waystations and Staging Posts project, which aims to upgrade selected resource centres into Information Waystations and create a network. In a further phase, some Information Waystations will become Staging Posts to adapt and republish health information. Director: Dr Chris Zielinski (e-mail: dvt@compuserve.com; URL: http://www.iwsp.org).The HELINA listserv and web site for health informatics in Africa, (http://www.uku.fi/english/organizations/helina-l/The renowned Cochrane Library, designed to supply high quality evidence to inform people providing and receiving care, and those responsible for research, teaching, funding and administration at all levels,
- (http://www.update-software.com/cochrane/cochrane-frame.html).

To be effective in an African context, these global health information initiatives would need Internet availability and sufficient bandwidth. This is a challenge to governments and organisations wishing to invest in telecommunication infrastructure.

The digital divide of developing countries (and Africa in particular) in comparison with the developed world is a reality. According to the World Bank the number of Internet hosts per capita increased 29 per cent in sub-Saharan Africa in 1997–99, compared to 87 per cent in OECD countries. However, there are promising signs. Even in war-torn Somalia entrepreneurs have set up four independent telephone companies, both fixed landline and cellular, and recently banded them together to offer Internet service to users. The use of appropriate technologies will make a difference. Mobile telephones, satellite connectivity and alternative electricity supply will 'extend' the Internet. Telbureau has recently created a portable box that opens into a fully equipped desk with a computer, connection to the Internet and a solar power system. In November 2001 a United Nations agency and the ITU signed a deal to set up three remote Internet centres in refugee camps in Tanzania, yanking them into the 21st century. The centres will help about 130 000 refugees from a vicious ethnic war in Burundi to contact relatives as well as get long-distance education and *health advice* over the Internet. Similar projects had been set up in Mali, Senegal, Zimbabwe, Cameroon and Ethiopia, according to Brahima Sanou, head of the ITU's regional Africa office.[15]

Arguably the most comprehensive site on connectivity in Africa is that of Mike Jensen. The information published on this site may assist policy makers in reviewing the investments in ICT in Africa – refer http://demiurge.wn.apc.org:80/africa/ (e-mail mikej@sn.apc.org). There are multiple examples of the development and implementation of computerised hospital information systems (CHIS) in Africa, some dating from the early years of CHIS development. These include the implementation of the USA VA hospital information system in a hospital in Egypt, the development and implementation of CHIS in hospitals in Ile Ife in Nigeria, and recently-announced plans to develop a CHIS for use in Tanzanian hospitals. In each of these cases, there has been significant input from computer scientists at local universities.

[15] Reuters . Satellite connections help yank rural Africa into electronic global village; November 16, 2001

Developing countries have also had to develop information systems to support the district-based health services, which form the backbone of public health services in many countries. Work in Ghana has been reported in multiple forms, and has also formed a significant input to the development of district health information systems (DHIS) in South Africa.

District health information systems (DHISs) are typically aimed at supporting facility- and district-level management, and do not include individual patient records. In developed countries, information systems to support public health services, which seem very similar in scope to the well-established DHISs in developing countries, have recently gained some support. The RHINO (routine health information) network, which aims "to promote high quality and practical approaches to the collection and use of routine health information in developing countries" was established in March 2001.[16] One of the outputs from the workshop which marked the establishment of RHINO (and at which South Africa was represented) was a statement advocating investment in routine health information in developing countries.[17] This very practical initiative could greatly facilitate the development of robust, appropriate systems which provide accurate information to support health system planning, monitoring and evaluation.

From the above it should be clear that there are various health initiatives constituting drivers of ICT diffusion. The demand for ICT interventions will be impacted by the availability of appropriate technology solutions, the necessary supporting policy/political environment and other relevant ICT issues. Country-specific initiatives in the health sector obviously differ and these can also be linked to the general level of ICT diffusion in those countries. Normally the level and quality of ICT performance is also closely linked to the structure and performance of the national economy. One would expect richer countries to have better developed ICT sectors, and poorer countries to have less well-developed ICT sectors. However, some interesting variations have been reported. A number of African countries at roughly the same level of economic development (as seen in GDP per capita) have very different levels of telecommunication or Internet penetration, or broadcast liberalization.[18]

[16] Routine Health Information Network (RHINO) http://www.cpc.unc.edu/measure/rhino/rhino.html, 7 May 2002.
[17] The Potomac Statement on Investment in Routine Health Information in Developing Countries, RHINO, March 2001, http://www.cpc.unc.edu/measure/rhino/statement.pdf
[18] Ernest Wilson, and Kelvin Wong. *African Information Revolution: a balance sheet* (draft); 2000; www document, URL http://www.bsos.umd.edu/cidcm/events/AIR.htm

Appendix B

Health sector-specific components of questionnaire

SECTION 7: Sector-specific questions, Health

7.1 An indication of the level of diffusion of health-specific ICT in your organisation

Please indicate the extent of ICT diffusion in each case from 0 to 5, as follows:

Not applicable/ don't know	No use at all				Fully utilised
0	1	2	3	4	5

Type	Examples	Extent of diffusion
Sufficient IT infrastructure and telecommunication links to conduct business optimally		**0 1 2 3 4 5**
Common standards are used (including the implementation of data dictionaries)		**0 1 2 3 4 5**
Security is addressed		**0 1 2 3 4 5**
e-Health systems are in place(knowledge networks, portals, call centres, telemedicine)		**0 1 2 3 4 5**
e-Business is used(claim eligibility checking, electronic claims processing and billing, etc)		**0 1 2 3 4 5**
New technology is introduced, linked to sophisticated databases and warehouses(use of smart cards, etc.)		**0 1 2 3 4 5**
Systems in place to adhere to new legislation and to protect sensitive data (patient confidentiality)		**0 1 2 3 4 5**
Computerised district health information systems are used (or linked to)		**0 1 2 3 4 5**

Computerised laboratory information systems are in place		**0 1 2 3 4 5**
Burden of disease systems (supporting the information flow on the burden of disease e.g. on infectious diseases, such as HIV/AIDS, TB and malaria)		**0 1 2 3 4 5**
Catering for data and knowledge flows in the greater health sector		**0 1 2 3 4 5**

Describe the major flows of data, information and knowledge to and from your organisation. Are these flows effective, in that they provide the required information to support decisionmaking within your organisation?

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How could the use of ICT's improve this information flow

- **Immediately?**
- **Within the next 2 years?**

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7.2 Knowledge Management

The interviewers' assessment of the level of knowledge codification as an indication of the overall sophistication of knowledge management within the organisation surveyed.

Extent: 1=non-existent, 2=embryonic, 3=budding, 4=established, 5=common

Level of knowledge codification	Organisation of knowledge	Elucidation	Extent of practice in the organisation
Fully codified, articulated	**Recordable, storable and transferable at negligible costs (e.g. blueprints, manuals, journals and text books)**		**1 2 3 4 5**
Unarticulated codified	**Displaced hard copy source, stand-alone source, closed jargon by specialists (epistemic community or community of practice), formal authority**		**1 2 3 4 5**
Unarticulated uncodified	**No hard copy or stand-alone source exists, reference to procedural authority, charismatic leaders**		**1 2 3 4 5**
Unarticulable	**Technical constraints over articulation and codification (e.g. how to do a certain procedure)**		**1 2 3 4 5**

Appendix C

Description of Interviewees

ROLE IN ORGANISATION	SUBSECTOR	REASON FOR SELECTION
Epidemiologist; District management	District health services, including clinics and local government health services	Responsibilities include ensuring the effective use of information for a large local authority; previously project manager for HISP district health information system
District health informatics staff (information officers)	District health services, including clinics and local government health services	Extensive experience with the development and implementation of computerised HIS for a large local authority
Health informatics staff: Training and implementation support	District health information system developers & suppliers	Extensive experience of the development, implementation and use of district health information in 4 provinces; comprehensive understanding of national requirements and constraints
Head: Information Services	District health services: Maternal and Child Health	Experience of information system support for district health services, and information support for maternal and child health services
General Manager: Health Support	Provincial Department of Health (policy makers and service providers)	Senior provincial manager; extensive experience with and interest in health information systems
Deputy Director: Information Management	Provincial Department of Health (policy makers and service providers)	Extensive experience with and interest in health information systems
Deputy Director: Information Management	Provincial Department of Health (policy makers and service providers)	Extensive experience with and interest in health information systems; part of senior management team of Department of Health
Deputy Director: Information Management	Provincial Department of Health	Responsible for the effective use of health information in the province
Deputy Director: Information Management	Provincial Department of Health	Responsible for the effective use of health information in the province to support health programmes
Provincial health informatics staff: Chief statistical advisor	Provincial Department of Health	Responsible for the effective use of health information in the province
Provincial health informatics staff: Senior Data Technologist	Provincial Department of Health	Extensive experience with the development and implementation of computerised HIS for the province

Pharmaceutical services	Provincial Department of Health	Extensive experience with information support for the effective distribution of pharmaceuticals for provincial health facilities
System developer	Provincial Department of Health	Responsible for the outsourced development and implementation of information systems to support provincial pharmaceutical services
Chief Pharmacist	Provincial Department of Health	Line responsibility for pharmaceutical services and supporting information systems
Head of clinical department	Academic health complex: Provincial Department of Health	Extensive experience with and interest in information systems to support clinical practice, especially for paediatrics
Medical Superintendent	Tertiary hospital services: Provincial Department of Health	Hospital manager responsible for the effective use of hospital information systems; extensive experience
Head: Medical Informatics	Tertiary hospital services: Provincial Department of Health	Very extensive experience of managing and providing information support for administrative and clinical management of tertiary hospitals
Director	National Department of Health (focus: policy and informatics)	Responsible for health information management at national level for the public healthcare sector
Deputy Director	National Department of Health (focus: policy and informatics)	Responsible for health information management at national level for the public healthcare sector
Chairperson	Private healthcare service providers – general practitioners (at association level)	Aa network of general practices which act as sentinel sites for monitoring infectious disease incidence
CEO	Private healthcare service providers – general practitioners (at association level)	Network of GPs,
Chairperson	Private pharmaceutical practitioners (at association level)	Responsible for the development and management of a standard product and pricing file for the pharmaceutical sector in SA
Clinician	Private healthcare providers – hospital	
Clinical Manager	Private hospital	
Manager: Statistics & Informatics	Private health care funders and administrators	Actuarial analysis support to national (and regional) association of healthcare funders
Chief Operating Officer	Private health care funders and administrators	Information systems support to national association of healthcare funders, including development of new services
Manager: Operations Development	Private health care funders and administrators	Extensive experience in development and implementation of information systems to support a large healthcare funder

Manager: Risk and Information	Private health care funders and administrators	Responsible for the effective use of clinical information to support the clinical aspects of the use
Clinical risk analyst	Private health care funders and administrators	
	Private health care funders and administrators	
Manager: Public/Private Partnership	ICT suppliers: switching networks and VANs	Comprehensive understanding of the components of private health care in SA, and integrating information support requirements
GM Marketing and Communications	ICT suppliers: Switching networks and VANs	
MD	ICT suppliers: Switching networks and VANs	
GM Health Informatics	ICT suppliers: Switching networks and VANs	
CEO	ICT suppliers: Facility HIS	Very extensive experience of the development and implementation of HIS in public and private sectors, and to support clinical research
Sales Manager	ICT suppliers: Facility HIS	Very extensive experience of the development and implementation of hospital information systems in public and private sectors
Strategic marketing analyst	ICT suppliers: Facility HIS	Very extensive experience of the development and implementation of hospital information systems in public and private sectors, as both user and supplier
MD	ICT suppliers: Practice management system developers & suppliers	
CEO	Health information management consultants	Extensive, current understanding of SA health information flows, especially in the private sector, from a recent MRC project.
Manager, IT services	Health research organisation	Responsible for ensuring effective information delivery platforms for a heavily information-dependent organisation
Deputy director: health information service	Health research organisation and health information provider	
Institute director	Health research: Bioinformatics	
Programme Director	Health research: HIV/AIDS	
Programme Manager	Health research: TB	
Programme Leader	Health research: Telemedicine	
Director	Unique systems for acquisition, recombination and diffusion of health knowledge	
Clinical management and practice	Unique systems for acquisition, recombination and diffusion of health knowledge	
Project manager	Unique systems for acquisition, recombination and diffusion of health knowledge	

Manager, Knowledge Management	Unique systems for acquisition, recombination and diffusion of health knowledge	
CEO	Unique systems for acquisition, recombination and diffusion of health knowledge	
Project manager	Unique systems for acquisition, recombination and diffusion of health knowledge	
Manager (Administration and Finance)	Unique systems for acquisition, recombination and diffusion of health knowledge	