

# The status and challenges of clinical informatics development in South Africa

Abayomi Kehinde Owolabi\*<sup>1</sup>, Thokozani Patrick Mhlongo<sup>2</sup> and Neil Evans<sup>3</sup>

Department of Information Studies and Department of Nursing Science  
University of Zululand, South Africa

Yomiowolabi2000@yahoo.com; MhlongoT@unizulu.ac.za; Evansn@unizulu.ac.za

## Abstract

*Clinical informatics has enormous potential to ensure healthcare quality in both developed and developing countries. This paper examines the status and challenges of clinical informatics in the South African health care sector. In a recent survey of major international research databases such as Scopus, it was observed that there is a gap in knowledge on clinical informatics particularly as related to the status and challenges in the country's healthcare facilities. The current status and challenges of clinical informatics in South Africa has not been examined. The present study explores the current status of clinical informatics in the South African healthcare system as well as the challenges facing the development of clinical informatics in South Africa. Through a literature review, the paper provides a conceptual background of clinical informatics, discusses the status and challenges of clinical informatics in South Africa. The last part of the paper discusses the implications of the reviewed literature through a PEST analysis. The paper provides invaluable information on clinical informatics in South Africa that can be used to inform and support further studies in this growing field. The paper is a contribution to discussions and debates on the development of social informatics.*

**Keywords:** clinical informatics, status, challenges, ICT4D, Social informatics, South Africa

\*To whom correspondence must be addressed: K.A. Owolabi, Department of Information Studies (see above).

## Introduction

Clinical informatics is the application of information and communication technology (ICT) in all facets of medicine and a healthcare system (Polasek and Kern 2012). Polasek and Kern further explain that clinical informatics assists the medical doctors in improving their clinical practices. According to the Agency for Health Care Research and Quality (2001), clinical information could be categorised into the following: Electronic Medical Record, Computerised Physician Order Entry, Computerised Decision Support Systems and Diagnosis Imagery Archive.

The objective of clinical informatics in effective healthcare delivery, as observed by Staggers *et al.* (2002), is to improve the health condition of the people through adequate use of ICT resources in the direct diagnosis, treatment and evidence-based medicine for the care of patients. The contributions of clinical informatics to a medical professional include the following: promotion of knowledge sharing, adequate health monitoring, statistics gathering analysis, and the delivery of effective healthcare services (Olatokun and Adebeyejo 2009). Daniel and Oyetunji (2013) identify various purposes in which medical doctors utilise clinical informatics such as the provision of adequate access to professional colleagues through instant transmission/receipt mail message, electronic file systems, and power search utilities to locate information stored in millions of computers around the world, effective communication through the use of the Internet, and diagnosis of patients.

The application of clinical informatics by medical doctors has different goals in developed and developing countries. In developed countries, the main objective of clinical informatics is to reduce healthcare costs, to budget and to provide effective healthcare delivery to people irrespective of their origins and colours (European Commission 2010). On the other hand, in developing countries, the main objective of clinical informatics is to provide improved access to medical care to people due to already limited access to effective healthcare resources (Haluza and Jungwith 2014).

Nuq (2012) indicates that there is a shortage of 4.3 million doctors and other health workers all over the world. He argues further that third world countries are the worst hit, particularly African countries which have 24% of the global burden of diseases with only 3% of the world's medical doctors and less than 1% of the world's health expenditure.

1. Abayomi K. Owolabi, completed his PhD in clinical informatics at the Department of Information Studies at the University of Zululand and is due to graduate in 2017.
2. Thokozani P. Mhlongo, PhD, is Associate Professor and Head of the Department of Nursing Science at the University of Zululand. He was one of the three supervisors of this PhD project.
3. Neil Evans, PhD, is a Senior Lecturer and Interim Head of the Department of Information Studies. He was the lead supervisor of the PhD project.

Wooton, Patil, Scott and Ho (2009) identify various reasons for the need to instil clinical informatics in developing countries, which include expensive costs of traditional healthcare services, shortage of medical doctors in developing countries, lack of qualified personnel in healthcare sectors and ICT innovation. Clinical informatics also provides a window of opportunity to the health sector, particularly in developing countries, through the introduction of ICT resources aimed at reducing epidemics and disease surveillance (Dawaon 2007).

Access to effective clinical informatics is important as it increases healthcare delivery. Unfortunately, medical doctors' inadequate access to and use of clinical informatics prevents them from rendering effective and quality healthcare services to people through preventive, diagnostic, restoration and rehabilitation cares. Ruxwana, Herselman and Conrate (2010) had earlier observed that clinical informatics tools are not being used in most teaching hospitals in Africa because of limited suitable resources. We argue that medical doctors in teaching hospitals in Africa will not be able to render effective, timely, and efficient medical services for their patients due to inadequate access to clinical informatics tools, and lack of the skills in the use of these facilities. Inadequate access to and use of clinical informatics among medical doctors has brought about medical errors and mis-diagnoses. Many people are casualties of medical doctors' inability to access and use informatics tools effectively. Medical errors could have been prevented if medical doctors have access and the ability to use clinical informatics effectively (Idowu *et al.* 2008). Ushie, Salami and Jegede (2013) estimate that as many as 44,000 to 98,000 patients died annually from wrong diagnosis in the United State of America. In Nigeria, 13 to 43% of the instances where stroke has been misdiagnosed due to lack of access and use of clinical informatics tools have been reported (Imam and Olorufemi 2006). Similarly, in South Africa, 40% of medical doctors admitted to having made medical errors due to lack of access and use of clinical informatics in the administration of drugs to the patients (Labuschagne *et al.* 2011).

There is evidence that access to and use of clinical informatics tools in a hospital can improve the quality of healthcare delivery. This can be achieved by adherence to guidelines, enhancing disease surveillance, promoting evidence-based medicine and reducing medical errors.

Several recent studies exist that underscore ICT use among medical doctors (e.g. Cline and Luiz, 2013; Nwagwu and Adio, 2013; Ruxwana *et al.* 2010; Idowu, *et al.* 2008; and Ajuwon, 2006) and noted that there is a paucity of literature in the domain of clinical informatics in Africa. For instance, a search on Scopus database which is the largest database in health sciences (Adelaide University 2014) was employed to examine the number of articles that were published in peer review journals between the years 2005-2015 on clinical informatics in South Africa. The result revealed that between the aforementioned years only twelve articles were published in South Africa.

In this paper we review the development of clinical informatics in South Africa with the intention of providing understanding of the status and challenges for possible intervention.

## 2. Clinical Informatics development in South Africa

Good and high quality healthcare systems are necessary components to improve clinical outcomes and to bring uplift to the health status of a country (Department of Health Annual Report 2013). e-Health Strategies of South Africa (2012) states that an effective health care system is a function of an adequate and reliable health information system that assists in producing relevant and accurate information for decision-making. It has been widely accepted that Information and Communication Technology is a critical resource for achieving this.

### 2.1 Policy and legislation

There are many policies, strategies and legislations that support the development and implementation of ICT in health care delivery in South Africa. Among the policies are the White Paper on Health Care Reform (1997), Public Service Act (2001), Health Sector Strategies Framework (1999-2004), Strategic Priorities for the National Health System 2004-2009, Medical Scheme Act (Acts 131 of 1998), Public Financial Management Act (Act 1 of 1998), Statistics Act (Acts 6 of 1999), National Health Acts (Act 61 of 2003), Medical Schemes (Acts 131 of 1998), and National Health Amendment Act (Act 12 of 2013).

The e-Health Plan outlines the employment of ICT for effective healthcare delivery particularly in the treatment of patients, research, training of medical students, tracking of diseases and monitoring of public health. The document outlines ten strategic priorities for ICT use in healthcare delivery. Among these strategies are capacity building for medical doctors, standards and developing application to support healthcare delivery. Among the specific goals stated in the documents are adequate budgetary allocation and issues of affordability and sustainability of access and use of ICT tools in effective healthcare delivery, registration of all medical doctors with their professional body and professional accreditation of health informatics in the country (e-health Strategies Plan 2012).

## 2.2 Healthcare facilities and equipment

The National Health Act, 2003 (Act 61 of 2003) states that there is a single health system for South Africa. It stipulates the rights and responsibilities of various healthcare facilities and health providers and ensures broader participation in healthcare delivery.

The National Health Care Facilities Baseline Audit (2012) and South Africa Year Book (2015) describe various forms of healthcare facilities in the country. For instance, a clinic is a permanent, well-equipped health facility in which primary health care services are provided. It provides accident, emergency and midwifery services. On the other hand, the audit document defines a district hospital as a level 1 facility that provides outpatient and inpatient services. The services are offered with support from general medical doctors and the facilities can perform operations under general anaesthesia (NHCFA 2012). Cullan (2006) and Scott (2011) note that of 388 hospitals in the country, 64% are district hospitals, 16% are secondary and 4% are provincial and national hospitals.

A regional hospital is a (level 2) facility that caters for and requires the services of specialists and general medical doctors. These hospitals cater for the following seven basic specialities: surgery, medicine, orthopaedics, paediatrics, obstetrics, gynaecology and psychiatry, with the services of radiology and anaesthesia. Another level 2 hospital is the tertiary hospital. Level 3 health facilities comprise the National Central Hospital which is mandated to provide tertiary hospital service and central referral services (Department of Health 2013). They are mandated to provide medical services such as heart and lung transplants, bone marrow transplants, liver transplants and cochlear implants. The facility provides training for medical students, conducts medical research and receives patients referred from regional hospitals. The facility is attached to a medical college as a teaching arm (NBHA 2013).

The essence of the classification of the healthcare facilities in South Africa may be due to the need to redress social and economic injustices, to eliminate poverty, reduce waste, increase efficiency and promote access to quality health. It is also seen as part of improving the healthcare system and ensuring that everybody has equitable access to essential and quality healthcare. The South African government is making efforts to promote adequate health facilities and equipment.

The Department of Health set up a committee to audit the health facilities, particularly to assess infrastructure and human resources. The findings of the committee revealed that essential medical facilities, which include ICT tools, have increased from 40% to 78% as of 2013 (Government of South Africa 2015). This increase in medical facilities may be attributed to the South African's government's commitment to the improvement of ICT access and use in medical infrastructure, through the introduction of the National Health Insurance Scheme that makes funds available for the project. Furthermore, the recent introduction of the National Health Act (Act 12 of 2013) established the Office of Health Standards Compliance which is mandated to inspect ICTs and other medical facilities in both government and private hospitals once every four years.

## 2.3 Human resources

Bandiwala, Fonn, Osegbeagbe and Tollaman (2010) stress that human resources are very vital in the task of repositioning healthcare delivery in South Africa. In order to strengthen the capacity of human resources in the health sector, the Minister of Health launched the Albertina Sisulu Executive Leadership Programme in Health (ASELPH) in 2013 in collaboration with the University of Pretoria, University of Fort Hare, Harvard University, Department of Public Health and South African Department of Health (South Africa Government 2013). Part of training involves the use of ICT tools for effective healthcare delivery (South Africa Government 2013).

However, a report by the Human Sciences Research Council (2009) determines that there were 5103 public sector vacancies for medical doctors in 2006. Erasmus (2008) likewise conducted a study on the shortage of medical doctors in public hospitals in South Africa. The study analysed the Department of Labour's (DOL) database, 112828 vacancies advertised in newspapers from April 2004 to March, 2007 and discovered that 36% of the vacancies were for medical doctors. In the year 2012, there were 165,371 qualified health practitioners in both public and private sectors health facilities that were registered with the Health Professions Council of South Africa. This includes 38,236 doctors and 5,560 dentists. The doctor-to-population ratio is estimated to be 0.77 per 1000, and the vast number of practitioners (73%), the majority of medical doctors worked in the private sector. As at 2012 there was 1 practicing medical doctor per 4219 people (26 SA Medical Stats 2012; South Africa Info 2012). The above illustrates that the medical doctors-to-population ratio is very low (South Africa Info 2012).

In addition the basic medical equipment is not meeting the working standards of medical doctors and the work environment is not conducive (South Africa Infor 2012). These factors may be responsible for the shortage of medical doctors and other allied workers, who may have left for greener pastures. South Africa Infor (2012) enumerates various steps that the government is taking to increase the number of medical doctors in the country. These included signing an agreement with the Cuban, Tunisian and Iranian governments on the training of medical students from South Africa,

employment of Cuban medical doctors, one year compulsory community training, and the state policy to produce 1200 medical doctors from medical schools within South Africa annually.

#### 2.4 Finance of health in South Africa

The National Planning Commission (2014) maintains that the South African health care system needs to be well funded in order to provide adequate health care to the people. The South African government has invested heavily in the health sector. An average of 8.2% of Gross Domestic Product (GDP) is spent annually on the health sector (Econex 2013).

Econex (2013) provides the percentage of budgetary allocations to health from 2007-2012, indicating that it was 7.5% in 2007/2008, 8% in 2008/2009, 8.5% in 2009/10, 8% in 2010/11 and 8% in 2011/2012. The National Planning Commission (2014) notes that the government of South Africa is spending large amounts of money on health in order to achieve the health targets set out by the MGDs which include: increasing life expectancy to 70 years of age by the year 2030, reducing the HIV /AIDS rate in the country, reducing maternal mortality from 500 to 100 for every 100,000 live births, provision of treatment and the need to put preventive mechanisms in place to prevent the spread of diseases, the need to reduce communicable diseases by 28%, and the provision of free access to equal and standardized health care services. The majority of the funds spent on the health care sector in the country come from the national treasury. The budget for the year 2012 was put at R121 billion, which was aimed at improving the hospitals and providing them with adequate ICT tools (NPC 2012).

South Africa Infor (2014) states that in the 2014 budget almost R19.3 billion was allocated to the refurbishing and purchasing of ICT tools and other clinical equipment. Another R1.2 billion was allocated to vital equipment and ICT tools in 856 clinics, 66 hospitals, 17 specialised hospitals and 10 additional hospitals which formed the three metropolitan health complexes (Bateman, 2012).

In order to promote ICT use in hospitals, the government introduced a programme known as Hospital Infrastructures, Procurement of Necessary Equipment and Management Skills which is mandated to equip all public hospital facilities with the latest ICT tools. This was mobilised with the sum of R 1.9 billion as a take up grant (Medical Club of South Africa 2013). In 2011/2012, the national government allocated a sum of R442 million to ICT development in the public health sector and another R442 was allocated in the same year to teaching hospitals to procure relevant ICT tools in their different hospitals. The government also established 29 hi-tech (ICT) hospitals all around South Africa (Medical Club of South Africa 2014).

Furthermore, National Health Insurance (2012) earmarked R125 billion for the provision of ICT tools in the public health sector from 2012 to 2020 and another R255 billion to be spent in the year 2025 for the same purpose. This represents an average annual increase of 4% in real value when compared to the average real increase in the public health expenditure of 6.6% over the last 10 years. Trevor Manuel (2007), the then minister of finance, in his budget speech, observed that the national government had set aside 1 billion Rand for ICT infrastructure development in the public health sector in that fiscal year and earmarked another 1 billion Rand for all the teaching hospitals for automating their equipment.

It is therefore plausible to conclude that the South African government has been spending large amounts of funds on healthcare infrastructure and ICT tools development so that the citizens could have access to better healthcare facilities as is clearly stated in the Constitution.

#### 2.5. ICT access and use in the health care sector

The history of ICT to public health care delivery in South Africa can be traced to the formation of the District Health Information (DHIS) which was launched in 1998 in all the provinces. This was the first systematic computer data gathering tool that was used to link all the primary health centres in the country together for the collection of information on various national health indicators. The programme was facilitated by the Health Information Systems Programme (HISP) and comprised training on ICT, data handling processes, and software tools and design for health care delivery (Info Dev 2006).

The computerised National Health Care Management Information System was introduced in 1994 to cover medical records, registration of health care users, and to control the billing system in selected hospitals in the nine provinces (Littlejohns, Wyatt and Garvican 2003). The South African Department of Health, in collaboration with the Department of Home Affairs, also introduced an ICT project on healthcare named the HANIS Project in which the data elements of every citizen would be stored and infused into a smart card which would contain their medical history, diagnoses, treatment, prescription and medical aid (Infor Dev 2006).

According to the South African Constitution, particularly Clause 27, everyone has the right to enjoy and access good health care services and this includes reproductive health, sufficient food, shelter, water and social security, especially for individuals who are unable to care for themselves. Access to equitable health care is a basic human right. The

Constitution and the Bill of Rights of the Republic of South Africa Section 27 (1) (a) stipulates that: “everyone has the right to have access to health care services” and section 27 (2) states that the government must “take reasonable legislative and other measures to achieve the progressive realisation of the right” (Constitution of the Republic of South Africa 1996). The DoH (2013) lists the strategic priorities that need to be attended to before there could be effective ICT leverage in healthcare delivery to include proper strategy and leadership, involvement of stakeholders, standards and interoperability, good governance and regulations, affordability, benefit gain, capacity and workforce.

Mars and Seebregts (2008) explain the role of the South African government in developing and promoting ICT access and use in healthcare delivery. They observed that the country is an active member of ISO/TC 46 (National Information Standards Technical Committee) which is tasked with harmonising standards in the world of information globally and facilitating access to knowledge and information (The Information, 2015). Furthermore, South Africa has made efforts to promote the interoperability and interchange of data. The country also employed ICD-10 as the national diagnosis standard and HL7 version 2.4 as the national messaging standard, particularly in the public sector (Council for Medical Scheme 2014).

South Africa’s eHealth Strategies (2011) lists various initiatives that the government has adopted to promote the use of and access to ICT in the health sector. Such strategies include a telemedicine project undertaken by the Medical Research Council, Health’s Love Life project and the establishment of the Closed Health Broadcast Channel. The DoH (2013) examines the status of telemedicine in South Africa and has discovered that telemedicine facilities had increased from 28 to 68 sites, with the highest number in the province of KwaZulu-Natal. These and other initiatives suggest that the government has realised the positive impact of ICT in the promotion and improvement of the country’s healthcare system, particularly in remote areas.

The aim of all these initiatives is to create awareness and understanding of the benefits of clinical ICT tools as a mechanism for the promotion of better health care. These initiatives also aim to contribute to economic and social development as well as support the building of a formidable ICT infrastructure in the health care system. The government’s support for the promotion of the ICT use and access in the country is noted by Mars and Seebregts (2008), who claim that “the development of ICT use in health is a very important project in the mind of South Africa and as a result, the National Department of Health has presented many policy documents (which include a white paper, discussion documents and bills) which will promote the adoption of clinical informatics in the country.”

The Department of Health (2013) states that the major purpose of ICT use in healthcare delivery in South Africa is to improve the health status of the people. South Africa’s eHealth Strategies (2012) states that with ICT tools in place, the people will enjoy the following benefits: effective and standard management of healthcare institutions; access to repositories of knowledge; applications and literature; and education for public and access to formal education for health service professional. ICT tools also overcome distance in the diagnosis and treatment of patients.

## 2.6. Opportunities

The opportunities of access to and the use of ICT in healthcare facilities are discussed under the following headings: transformation of the health system, ICT capacity building, and encouraging collaborations.

### 2.6.1 Transformation of the health system

ICT access and use has brought much transformation into the health care sector through the introduction of innovations such as an electronic TB register which is being used in all the provinces, as well as the health care information system (PHCIS), electronic patients’ administration, and billing system which are being used in Gauteng, North West and Mpumalanga (Gray and Varuda 2014).

In addition, the use of ICT in health has brought innovation into the legislative instrument in the country through the introduction of ICT-related laws that will promote the access and use of ICT in the health care system such as State Information Technology Agency Act (88 of 1998) and Policy of Free and open Source software. (Department of Health 2014).

### 2.6.2 ICT capacity building

As indicated earlier, improving the quality of health care has been an important objective of the South African Department of Health for a number of years (Department of Health 2013). There has been a greater focus in South Africa on how ICT could strengthen and promote capacity building and improve the quality of health services in the country.

As a result, the National Department of Health agreed to work with the Department of Education in developing an ICT skills curriculum for medical students (Education Labour Relations Council 2003). Realising the importance of capacity building in ICT among medical doctors, the Universities of Kwa-Zulu Natal and Walter Sisulu introduced a new course called ‘health informatics’ that aim to keep medical doctors abreast of the relevance of ICT in health care delivery and to train medical doctors and allied health workers in the use of computers and other relevant clinical informatics

tools. Coleman (2013) notes that ICT access and use in health care delivery in South African hospitals should promote efficiency, accountability and build confidence in the minds of the medical doctors and the patients.

### 2.6.3 Building collaboration

Healthcare in South Africa is undergoing far-reaching reforms to revitalise and restructure the system and to ensure access to quality healthcare for all. Ruxwana, Herselman and Contradie (2010) state that the integration and incorporation of ICT into the healthcare sector will improve medical doctors' competence. There are a lot of project initiatives, companies and donor agencies that are collaborating in the promotion of ICT in health care delivery in South Africa (Gray and Varda 2014). The Department of Science and Technology (2014) lists some of the agencies that are working with the Department of Health in promoting the ICT to include the South Africa Government National Research Network (SANReN) and National Nanotechnology Strategy Department.

In addition, the government has decided to provide Internet connectivity to all the academic hospitals through the SANReN programme, in which almost 173 research and educational institutions have been connected with high speed networks (Department of Science and Technology 2014). This has resulted in the roll-out of high-speed broadband networks to all the teaching hospitals in the country. The National Health Laboratory service is another agency that is collaborating with the Department of Health in promoting access to and the use of ICT in health care by providing laboratory diagnostic services (Department of Science and Technology 2014).

### 2.6.4 Promoting infrastructural development

The South African government has realised the importance of promoting ICT infrastructure in the country. Ntetha and Mostert (2011) state that the government has been promising effective service delivery in all the sectors, particularly the health sector, by providing a wide range of ICT infrastructure for effective service delivery. To achieve this, the South African government has spent a lot on providing network infrastructure that will promote access and use of ICT for effective healthcare service delivery. The Department of Communication (2014) set a target of 13% broadband penetration for health facilities by the year 2013. This was to be increased to 50% of 10Mbps by the year 2016. By the year 2020, it is expected to have increased to 100% of 10 Mbs or 80% at 10MB.

Burger (2010) restates the need for adequate ICT infrastructure for effective healthcare delivery, particularly in providing evidence-based medicine and reduction in cost. Mutula and Mostert (2010) confirm that South Africa's government has plans towards the promotion of ICT infrastructure in the country, by launching various ICT projects for quality service delivery, with regulatory framework policies.

### 2.6.5 ICT infrastructure development

Adequate investment in the growth of ICT infrastructure contributes to the economic development and transformation of the healthcare sector (National Integrated ICT Policy Green Paper 2014). The deployment of ICT tools in healthcare services is essential to improving the quality of healthcare in the country. According to the National ehealth Strategy South Africa (2012), the key issue that the South African government is facing is how to provide accessible, affordable and reliable ICT tools to the healthcare sectors as part of its economic development.

The South African government is also examining ways to include adequate access to broadband connectivity to various healthcare facilities in the country (National Integrated ICT Policy Green Paper 2014).

### 2.6.6 Policy framework

The Department of Health (2012) notes that the South African government has spent a lot of funds to procure relevant ICT tools for effective healthcare delivery. The available ICTs within the healthcare system have largely not met the requirements and support of the healthcare sector due to lack of regulations and policy frameworks in relation to technology usage (Department of Health 2012). The National Integrated ICT Policy Green Paper (2013) declares that South African policies and legislation on the access to and use of ICTs in healthcare have been slow in implementation. The need for right ICT policies in healthcare delivery is to ensure and maintain the growth brought about by technology and translate it into effective healthcare service.

The National Integrated ICT Policy Green Paper (2013) emphasises the necessity for policy review in healthcare delivery because of the speed of technological advancement and the advent of new media such as the Internet. The policy process needs to recognise that the healthcare system is changing, and the policy interventions need to be evaluated and assessed against the changing objectives of the healthcare system.

## 2.7. Challenges

Some of the challenges facing ICT access and use among medical doctors in South African teaching hospitals are discussed below.

### 2.7.1. Low bandwidth

Bandwidth is one of the challenges facing access and use of ICT in healthcare facilities in South Africa. Sharpey-Schafer and Suleman (2008) claim that uneven bandwidth availability on different segments and often a complete lack of bandwidth is a serious challenge facing many healthcare facilities in South Africa. The National Integrated ICT Policy (2014) confirms the lack of necessary high speed bandwidth networks for effective healthcare delivery in South Africa. Telkom (2015) identifies various challenges facing broadband plans in South Africa to include: geographical situation and demographics, data explosion, changing consumption, low speed performance as well as coverage and affordability.

### 2.7.2. Inadequate funding of ICT in healthcare

The key enabler to access and use of ICTs in healthcare delivery is finance. However, there are limited investments in ICTs for health in most African countries (Agbele, Nyongeza and Adesina 2010). Insufficient financial resources and structural reliance on foreign agencies for the donation of ICT tools is affecting ICT access and use in many hospitals in South Africa (Modiba and Kotz 2011). An audit assessment of ICT has revealed disparities in the treatment of ICT as a strategic enabler for healthcare service delivery in the provinces (Department of Health 2012). The disparity is reflected in the budgetary allocation for health in the year 2009; while Gauteng, Limpopo and KwaZulu-Natal's budget was R188.3m, R178.6m and R105m respectively in nominal terms, North West, Northern Cape and the Free State's budget was R15m, R20.4m and R32m respectively (e-health South Africa 2012).

This implies that there has been poor funding and uncoordinated investment in ICT in healthcare delivery. The major key enabler to the access and use of ICTs for healthcare delivery across the country. Some hospitals may therefore find themselves at a disadvantage.

### 2.7.3. Poor ICT skills

Lack of literacy and computing skills as well as support have been identified as significant factors that prevent many professionals like medical doctors from using the Internet and other forms of ICT (Buabeng-Andoh 2012). Sukums, Mensak, Mpembeni, Kattscmidt, Haefeli, and Blank (2014) claim that computer usage among medical doctors in developing countries such as South Africa is limited because of the lack of adequate skills to operate computers.

South Africa Infor (2014) reveals that the country is well rated in term of the availability of ICT in the health sector. However, Week (2013) notes that despite this high ranking, lack of ICT skills remains a significant barrier to the use of this resource by medical doctors and other professionals. Coleman (2013) agrees that despite the availability of ICT facilities in hospitals, many medical doctors in South Africa are unable to use them. For example, in his study (Coleman 2013) focusing on computer skills among medical doctors in South Africa, he determined that 46% of the medical doctors lacked the skills to operate computers, and 42% admitted that they were averagely skilled in the use of computers, while 12% stated that they had the skills to operate computers.

In order to improve the quality of the clinical information that medical doctors can access, it is essential that they acquire relevant ICT skills to access information from computers. Therefore, in order to improve the quality of the healthcare sector in South Africa, there is an urgent need to train medical doctors to operate computers and access information relating to their medical practice (Loveday, Smith and Monticeli 2006).

## 3. Conclusions

This article is part of a larger PhD study (Owolabi 2017) focusing on access and use of clinical informatics among medical doctors in selected teaching hospitals in Nigeria and South Africa. In the conclusion of the study, it was observed that the clinical informatics environments in the two teaching hospitals are inadequate and there is poor access to clinical informatics resources among medical doctors in the selected teaching hospitals. Major recommendations of the study included the need to establish ICT policies and increase investment in clinical informatics resources at the surveyed teaching hospitals in order to promote effective and value-based healthcare delivery. Also that the hospital management should create awareness on the importance and benefits of clinical informatics particularly for the medical doctors through informal and continuing education and training such as workshops and short courses. Collaboration between the hospital managements with relevant stakeholders such as government, corporate bodies, and departments of health was stressed.

In this paper South African government efforts to develop and improve healthcare facilities through policy and legislations, funding, human resources and infrastructure are recognised. The awareness of the importance of ICT/health informatics in healthcare delivery is commendable. There is therefore a political, economic and technological will on the ground to improve access and use of the ICT in hospitals. The eminent challenges relate to policy revision, implementation, monitoring and evaluation. Inequality of access and use of the resources and infrastructure is also a challenge. For example, the bandwidth for high speed internet access is still an issue. In addition the lack of ICT skills

among medical doctors – as noted with examples in the study – need to be addressed through formal and informal education of the clinical doctors. The social challenge should be addressed as well.

The effective implementation and use of clinical informatics in healthcare service delivery needs to be anchored on policies that are adopted by all levels of government, private health providers, and allied workers. The policy documents should also spell out the role of the government and other stakeholders in the effective implementation of ICTs in the healthcare sector. We suggest the following consideration in the policy:

- The policy documents need to consider the interests of healthcare users, medical doctors, and allied workers in the sector and describe the ways the government could provide interventions with regard to ICT in healthcare delivery.
- The government policies on ICT and healthcare need to be supported with legal documents to ensure that the targets are met and to improve the quality of healthcare delivery.
- The policy needs to be tailored towards the development of clinical informatics.

There must be a regulatory body that will ensure compliance with and the enforcement of the policy documents on ICT in healthcare delivery. This is necessary because poor leadership and ineffective monitoring have been the basis for the unsuccessful implementation of most government policy programmes on healthcare. Consequently, political stability and effective monitoring are very necessary in supporting the effective implementation and use of ICT in healthcare service delivery in South Africa. Lastly, in order for clinical informatics to foster development in South African healthcare systems, there has to be political willingness on the part of the governments to create an enabling environment for ICT adoption and application.

Secondly, in order to effectively implement clinical informatics in South Africa, there is a need to consider the state of economic activities in both the short and the long term. This has become necessary, particularly when comparing the status of clinical informatics in the country to that of other developed nations. Studies by Adomi (2006) and Anie (2011) confirm that there is a close relationship between ICT use and economic development in South African healthcare systems, and that ICT has contributed positively to the development of the healthcare sector in South Africa. The authors also found that the impact of ICT on health contributes to the growth of the economy. Third, effective healthcare service delivery in South Africa require functional and adequate clinical informatics resources. Overall, there is a need for the governments and private organisations to collaborate on ways to improve clinical informatics infrastructure in the healthcare system.

This study has represented only part of the status, issues and challenges of clinical informatics in the country therefore it is our 'story or song'. While we have tried to represent current status as much as possible, there could be recent developments that we are not aware of. The study, however, provides important information for understanding and developing clinical informatics in the country and sets agenda for further research and discourse on this important healthcare knowledge and service. The contributions of this work can be considered from the point of view of literature, practice, and policy.

## Acknowledgement

I wish to acknowledge the financial support I received from the University of Zululand towards my PhD and the support I received from my Supervisors: Dr. Neil Evans, Prof. Dennis Ocholla and Prof. Thokozani Mhlongo that enabled the publication of this paper among others to come.

## References

- Adelaide University 2014. Scopus guide. Viewed 5 July 2015, from [http://libguides.adelaide.edu.au/research\\_support/publishing](http://libguides.adelaide.edu.au/research_support/publishing).
- Adoni, E.E. 2006 Mobile phone usage patterns of library and information science at Delata State University, Abraka, Nigerian. *Electronic Journal of Academic and Special Libarianship* 7(1): 12-21. Viewed 8 August 2015, from <http://southernlibrarianship.icaap.org/index.html>.
- Agbele, K., Nyongeza, H. and Adesina, A. .2010. ICT and information security perspctive in e-health system. *Journal of Mobile Technology* 4(1): 17-22. Viewed 21 January 2015, from <https://repository.uwc.ac.za/handle/10566/1060>.
- Agency for Health Care Research and Quality. 2001. Clinical informatics to promote patient safety. Viewed 3 December 2015 from <http://grants.nih.gov/grants/guide/rfa-files/RFA-HS-01-006>.
- Ajuwon, G. A. 2006. Use of the Internet for health information by physicians for patient care in a teaching hospital in Ibadan, Nigeria. *Biomedical Digital Libraries* 3(12): 1-9, Viewed 8 August 2015 from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1764751/pdf/1742-5581-3-12.pdf>.
- Ajuwon, G. and Rhine, L. 2008. The level of internet access and ICT training for health information professionals in Sub-Saharan Africa. *Health Information and Libraries Journal* 3(12): 175-185, Viewed 7 August 2015 from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1764751/pdf/1742-5581-3-12.pdf>.
- Anie, S.O. 2011. The economic and social benefits of ICT policies in Nigeria. *Library Philosophy and Practice* Pap Viewed 4 August, 2015er 457. <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1475&context=libphilprac>.

- Bandiwala, S.I., Fonn, S. Osegbeagbe, O. and Tollaman, S. 2010. Workforce resources for health in developing countries. *Public Health Review* 32(1) : 296-318. Viewed 5 September 2015 from [http://www.cpha.ca/uploads/progs/\\_/sopha/public\\_health\\_review\\_workforce.pdf](http://www.cpha.ca/uploads/progs/_/sopha/public_health_review_workforce.pdf).
- Bateman, C. 2012. Will our public healthcare sector fail the NHI? *South Africa Medical Journal*. 102(11), 817-818, Viewed 6 August, 2016 <http://www.samj.org.za/index.php/samj/article/view/6358/4747>.
- Buabeng-Andon, A. 2012. Factors influencing teachers adoption ICT into teaching; a review of the literature. *International Journal of Education and Developing using ICT* 8(1): 135-155.
- Burger, D. 2010. South Africa Year Books 2009/10.
- Cline, G. B. and Luiz, J.M. 2013. Information technology systems in public sector health facilities in developing countries: the case South Africa. *BMC Informatics and Decision Making* 13(13): 1-5. Viewed 7 December from <http://www.sajim.co.za/index.php/SAJIM/article/view/541>.
- Coleman, A. 2013. Using a virtual ICT training framework to support doctors in rural hospitals in South Africa. *Ethro Med* 7(3): 137-141. Viewed 7 October 2016 from <https://www.researchgate.net/publication/286966143>.
- Coleman, A. 2013. Using a virtual ICT training framework to support doctors in rural hospitals in South Africa. *Ethro Med* 7(3): 137-141. Viewed 9 July 2015, from <https://www.researchgate.net/publication/286966143>.
- Council for Medical Schemes 2014. Annual Report 2014/15, 15 years of the pulse. South Africa ,Viewed 22 May, 2015
- Cullians, K. 2006. Health services in South Africa: a basic introduction. health –e News Service. *Health Management* 1(1): 1-2. Viewed 21 June 2015 from <https://www.health-e.org.za/2006/01/29/health-services-in-south-africa-a-basic-introduction/>.
- Daniel, G.O. and Oyetunji, M.O. 2013. Nursing informatics: a key to improving nursing practice in Nigeria. *International Journal of Nursing and Midwifery* 5(5): 90-98 .
- Dawaon, J.A. 2007. Comparative study on system requirements and success factors of telemedicine solution in resource poor setting. Masters thesis, Norway: Faculty of Mathematics and Natural Science, Department of Informatics University of Tromso.
- Department of Communication, National Intergrated ICT Policy Green Paper 2014 . South Africa. Viewed 12 May 2016, from [http://www.gov.za/sites/www.gov.za/files/37261\\_gon44.pdf](http://www.gov.za/sites/www.gov.za/files/37261_gon44.pdf).
- Department of Health, 2013. South Africa Strategies Plan 2014/15 2018/19. Department of Health. South Africa. Viewed 9 March 2015, from [https://www.brandsouthafrica.com/wpcontent/uploads/brandsa/2015/01/Department\\_of\\_Health\\_Strategic\\_Plan\\_2014\\_to\\_2019.pdf](https://www.brandsouthafrica.com/wpcontent/uploads/brandsa/2015/01/Department_of_Health_Strategic_Plan_2014_to_2019.pdf).
- Department of Health, 2013. Annual report Department of Health, South Africa. Viewed 13 June 2016, from <http://www.gov.za/documents/department-health-annual-report-20132014>.
- Department of Health, 2013. South Africa Strategies Plan 2014/15 2018/19. Department of Health. South Africa Viewed 7 July 2015, from [https://www.brandsouthafrica.com/wpcontent/uploads/brandsa/2015/01/Department\\_of\\_Health\\_Strategic\\_Plan\\_2014\\_to\\_2019.pdf](https://www.brandsouthafrica.com/wpcontent/uploads/brandsa/2015/01/Department_of_Health_Strategic_Plan_2014_to_2019.pdf).
- Department of Health, 2014. Province of Kwa Zulu-Natal; King Edward VII Viewed 5 June 2015, from [www.kznhealth.gov.za/kingedwardhospital.htm](http://www.kznhealth.gov.za/kingedwardhospital.htm).
- Department of Science and Technology, 2014. Annual report financial years vote 34. Department of Science and Technology, South Africa.
- Department of Health, 2012. Management and governance of public sector hospitals under the national health insurance. Department of Health, South Africa.
- Econex, 2013. The South Africa private healthcare sector: role and sontribution of the economy. South Africa private pactionner forum. South African Private Practitoners forum. Viewed 30 June 2015, from <http://www.mm3admin.co.za/documents/docmanager/f447b607-3c8f-4eb7-8da4-11bca747079f/00060290.pdf>.
- Education Labour Relations Council, 2003. South African policy handbook for educators, Universer prints group: Pretoria.
- E-health strategy plan South Africa 2012 . Department of Health, South Africa. Viewed 9 September, 2016 from <https://www.health-e.org.za/2014/09/11/report-ehealth-strategy-south-africa-2012/>.
- E-health strategy plan South Africa 2013 . Department of Health, South Africa. Viewed 9 September, 2016 from <https://www.health-e.org.za/report-ehealth-strategy-south-africa-2012/>.
- E-health strategy plan South Africa, 2011 . Department of Health, South Africa. Viewed 14 May 2016, from <https://www.health-e.org.za/2011/09/11/report-ehealth-strategy-south-africa-2012/>
- E-health strategy plan South Africa, 2013 . Department of Health, South Africa. Viewed from 14 May 2016, from <https://www.health-e.org.za>.
- Eneji, M. A. Dickson, V. J. and Onabe, B. J. 2013. Healthcare expenditure health status and national productivity in national productivity in Nigeria 1999-2013. *Journal of Economics and International Finance*. 5 (7) : 1-15 Viewed 14 May 2016, from [http://www.academicjournals.org/article/article1383042323\\_Eneji%20et%20al.pdf](http://www.academicjournals.org/article/article1383042323_Eneji%20et%20al.pdf).
- Erasmus, J. C. 2008. Vacancy analysis report. report on HSRC survey commissioned by the Department of Labour, South Africa.
- European Commision, 2010. Survey takes pulse of e-health in europe and prescribes wider ICT use among doctors. press realise data base Viewed 7 July 2016, from [http://release\\_IP-08-641\\_en.htm?locale=en](http://release_IP-08-641_en.htm?locale=en) from [https://www.medicalschemes.com/files/Annual%20Reports/AR2014\\_2015.pdf](https://www.medicalschemes.com/files/Annual%20Reports/AR2014_2015.pdf)
- Gray , A. and Verda, Y. 2014. Health Policy and legislation . In padarathe, A. English . South Africa Health Review 2013/14.

- Haluza, D. and Junqwirh, D. 2014. ICT and the future of healthcare aspects of human promotion. *International Journal of Medical Informatics*, 84(1): 48-57. Viewed 12 July 2015, from <https://www.ncbi.nlm.nih.gov/pubmed/25293532>
- Health Sector Strategic Framework 1999. 1999-2004. South African Government Department of Health Viewed 22 May, 2016, from <http://www.gov.za/documents/health-sector-strategic-framework-1999-2004>
- Human Science Research Council 2009. Annual Report 2009-2010, South Africa Government.
- Idowu, D.C., Cornford, D. and Batin, L. 2008. Health Informatics development in Nigeria. *Journal of Health Informatics in Developing Countries* 2(1):15-33. Viewed 11 October 2015, from <http://www.jhidc.org/index.php/jhidc/article/view/11>
- Imam, I. and Olorunfemi, G. 2006. Clinical diagnosis of stroke: need for Audit. *Annals of Africa Medicine* 3(4): 167-169. Viewed 10 October 2015, from <http://www.ajol.info/index.php/aam/article/view/8331>.
- Info Dev 2006. Improving health, connecting people: the role of ICTs in the health sectors of developing countries; A framework paper. World Bank 1(1). Viewed 12 May 2015, from <http://documents.worldbank.org/curated/en/234041468163474585/>.
- Labuschange, M. Robbertze, W. Robbertze, W. Rozmiarek., J. Strydom, W. and Diederikcs .B.J.S 2011. Errors in drug administration by anaesthetists' in public hospitals in Free State Province, South Africa *Medical Journal* 101(5): 12- 23.
- Littlejohns, P., Wyatt J., C., and Garvican, L., 2003. Evaluating computerised health information systems: hard lessons still to be learnt. *BMJ* .326 (12), 860-863. Viewed 5 January, 2015, from <http://www.bmj.com/content/326/7394/860>
- Loveday, M., Smith, J. and Monticeli, F. 2006. Health Information Audit Report South Africa. *Health System Trust*. Viewed 5 July 2016, from <http://www.hst.org.za/publications/health-information-audit-report-south-africa>
- Mars, M.S. and Seebregts, S. 2008. Country case study for ehealth. South Africa Rockefeller Foundation.
- Medical Club of South Africa. 2014. Health care in South Africa. South Africa.Info. Viewed from 4 March 2015, from [www.brandsouthafrica.com/investments-immigration/economynews/sa-economy-key-sectors](http://www.brandsouthafrica.com/investments-immigration/economynews/sa-economy-key-sectors).
- Medical Club of South Africa, 2013. South Africa Department of Health.
- Medical Club South Africa, 2012. Health care in South Africa. South Africa.Info. Viewed 7 July 2016, from [www.brandsouthafrica.com/investments-immigration/economynews/sa-economy-key-sectors](http://www.brandsouthafrica.com/investments-immigration/economynews/sa-economy-key-sectors).
- Medical Schemes Act No 131 of 1998, South Africa Medical Schemes Acts No 131 of 1998. Medical Schemes Act No 131 of 1998. Viewed 4 March 2016, from [http://www1.chr.up.ac.za/undp/domestic/docs/legislation\\_52.pdf](http://www1.chr.up.ac.za/undp/domestic/docs/legislation_52.pdf).
- Modiba, F.S. and Kotz, D. 2011. The challenges of accessing ICT technologies as indicating woman entrepreneur in Pretoria South Africa. *International Journal of Interdisciplinary Social Science* 6(4):1-12 Viewed 7 March 2016, from <http://ijournalpublisher.com/product/pub.88/prod.1446>.
- Mutula, S.M. and Mostert, J. 2010. Challenges and opportunities of e-government in South Africa. *The Electronic Library* 28(1), 38-53. Viewed 10 March 2016 <http://www.emeraldinsight.com/doi/abs/10.1108/02640471011023360>.
- National e-health strategy in South Africa. 2012. Department of Public Health South Africa 1(2) :1-36, 6 January 2016, from <http://www.google.co.za/url?sa=j&esrc>.
- National Health Act. 2003. Act 61 of 2003. Department of Health, South Africa.
- National Health Amendment Act (Act No 12 of 2013), 2013 Department of Health, South Africa.
- National Health Insurance, 2012. Department of Health, South Africa.
- National Healthcare Facilities Baseline Audit, 2012. Summary report. Department of Health, Republic of South Africa.
- National Integrated ICT policy Green Paper, 2013. Department of Communication, South Africa.
- National Integrated ICT policy Green Paper, 2013. Department of Communication, South Department of Communication.
- National Integrated ICT Policy Green Paper. South Africa. Viewed 7 July 2015, from [http://www.gov.za/sites/www.gov.za/files/37261\\_gon44.pdf](http://www.gov.za/sites/www.gov.za/files/37261_gon44.pdf).
- National Integrated ICT policy Green Paper, 2014. Department of Communication, South Department of Communication.
- National Integrated ICT Policy Green. South Africa. Viewed 29 June 2015, from [http://www.gov.za/sites/www.gov.za/files/37261\\_gon44.pdf](http://www.gov.za/sites/www.gov.za/files/37261_gon44.pdf).
- National Integrated ICT Policy, 2013. Department of Communication, South Africa.
- National Planning Commission, 2012. Department of Presidency Republic of South Africa.
- National Planning Commission, 2014. Department of Presidency, Republic of South Africa.
- Netha, M.A. and Mostert, B. J. 2011. Availability and utilisation of ICT for service delivery; a South Africa case study. *South Africa Journal of Library and Information Science* 77(2): 10-17. Viewed 9 October 2016, from <http://sajlis.journals.ac.za/pub/article/view/55>.
- Nuq, P.A. 2012. Towards a better understanding of the intention to use ehealth services by medical professionals; the case of developing countries. Ph D thesis submitted to the School of Management, University of Newcastle.
- Nwagwu, W. and Adio, A. 2013. Contexts of utilisation of ICT by medical practitioners in private hospitals in Osun State, Nigeria. *World Journal of Science, Technology and Sustainable Development*. 10(3): 229-246, Viewed 4 March 2016 from <http://www.emeraldinsight.com/doi/abs/10.1108/WJSTSD-01-2013-0004>.
- Olatokun, M. and Adeboyejo, C. 2009. Information and communication technology use by reproductive health workers in Nigeria: state of the art, issues, and challenges. *An Interdisciplinary Journal on Humans in ICT Environments* 5(2): 181-207. Viewed 13 July 2015, from <http://www.humantechnology.jyu.fi/archives/abstracts/olatokun-adeboyejo09.html>. Accessed on 8th September, 2014.

- Owolabi, K.A. 2017. Access and use of clinical informatics among medical doctors in selected teaching hospitals in Nigeria and South Africa, PhD thesis submitted to the Department of Information Science, University of Zululand, Kwalengdewa.
- Polasek, O. and Kern, I. 2012. Medical informatics scientific output in 35 European Countries, *Informatics for Health and Social Care* 37(1), 12-22, Viewed 7 July, 2015 from: <http://www.ncbi.nlm.nih.gov/pubmed/21999433>.
- Public Finance Management Act No 1 of 1999. South Africa Public Finance Management Act (No 1 of 1999) as amended by Act 29 of 1999.
- Public Service Regulation, 2001. South Africa Public Service Regulation rule Federal Republic of South Africa.
- Ruawana, N., Herselman, M. and Conradie, D.P. 2010. ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa. *Health Information Management Journal* 39(1): 17-26. Viewed 7 March, 2016 from [www.himaa.org.au/.../Ruxwana%20et%20al%20-%20kinderboeksiness Administration at the University of the North-West University](http://www.himaa.org.au/.../Ruxwana%20et%20al%20-%20kinderboeksiness%20Administration%20at%20the%20University%20of%20the%20North-West%20University).
- Sharpey-Schafer, K. and Hussein, S. (2008). Evaluating health Informatics for developing countries using stimulation. IIMC International Information Management Corporation. Viewed 11 July 2016, from [http://pubs.cs.uct.ac.za/archive/00000455/01/ISTAfrica\\_Paper\\_ref\\_75\\_doc\\_2112.pdf](http://pubs.cs.uct.ac.za/archive/00000455/01/ISTAfrica_Paper_ref_75_doc_2112.pdf).
- 26 South Africa Medical stats, 2012. Health 24 .Viewed 7 June, 2016 from <http://www.health24.com/Medical-schemes/News/26-SA-medical-stats-20130210>.
- South Africa Constitution, 1996. Republic of South Africa.
- South Africa Info, 2012 . Healthcare in South Africa. Department of Health South Africa.
- South Africa Info, 2014. South Africa more fast fact. Viewed 6 August 2015, from <http://www.south.infor/>.
- South African Government. 2015. Health report. Government of South Africa. Viewed 7 January, 2016 <http://www.gov.za/about-sa/health>.
- South African Government, 2013. Launch of Albertina Sisulu Executive Leadership Programme in health . Viewed 7 July 2015, from <http://www.gov.za/launch-albertina-sisulu-executive-leadership-programme-health-aselph>.
- Staageler, N. and Thompson, B. 2002. The evolution of definition for nursing informatics: A critical analysis and revised definition. *Journal of America Medical Informatics Association* 9(3): 255-261. Viewed 14 Jul, 2015, from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC344585/>.
- State Information Technology Agency Act (88 of 1988) . Federal Republic of South Africa Government Gazette Viewed from [http://www.sita.co.za/gov\\_bodies/sitaact98.htm](http://www.sita.co.za/gov_bodies/sitaact98.htm)
- Statistics Act 6 of 1999. South Africa Government
- Strategic Priorities for the National Health System 2004-2009. 2004 Department of Health , South Africa.
- Sukums, F. Mensah, N. Mpembeni, R. Kaltschmidt, K. Haefeli, L. and Blank, J. 2014. Health workers' knowledge of and attitudes towards computer application . *Globe Health Action* .7(10): 1 – 12, Viewed from 13 June 2016, from [www.globalhealthaction.net](http://www.globalhealthaction.net).
- Telkom, 2015. Intergated report for the year 2015. Telkom, South Africa.
- The Information 2015. ISO/TC Information and Documentation, Standard catalogue . Viewed 12 January 2016, from [http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_tc\\_browse.htm?commid=48750](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=48750).
- Trevor, A.M. 2007. Budget speech 2007 . Minister of Finance, South Africa.
- Ushie, B. A. Salami, K. K. and Jegede, A. S. 2013. Knowledge and perceived reactions to medical errors in a tertiary health facility in Nigeria. *African . Health Science* . 13(3): 820 -826. Viewed 4 June 2015 from; <https://www.ncbi.nlm.nih.gov/NCBI/Literature/PubMedCentral/PMC>
- Ushie, B., A., Salami, K., K., and Jegede, A., S., 2013. Knowledge and perceived reactions to medical errors in a tertiary health facility in Nigeria. *African . Health Science* . 13(3), 820 -826 Retrieved from Viewed 6 August, 2016 <https://www.ncbi.nlm.nih.gov/NCBI/Literature/PubMedCentral/PMC>
- Week, R. 2013. The convergence of systematic threads shapping a future South Africa health dispensation: a technology management perspective. ACTA Commercial Independent. *Research Journal in the Management Science* 13(1): 23 – 33
- White paper for the transformation of the transformation of the health system in South Africa 1997 .Notice 667 of 1997. Viewed 10 June 2016, from [/www.gov.za/files/17910-gen667-](http://www.gov.za/files/17910-gen667-)
- Wooton, R. Patil, N.G.Scott, R.E. and Ho, K.2009. Telehealth in developing world. Interm Developing Research Centre.