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Research Article

Robotic Competitions: Motivation for Engineering Programmes

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ABSTRACT

e-Health is referred to in literature as the usage of information and communication technologies (ICT's) in the health domain, to administer treatment of patients, research, health education and the monitoring of public health. South Africa is in the process of re-engineering its public healthcare to improve healthcare for all South African citizens. E-health forms part of the re-engineering process. The purpose of this paper is therefore to explore benefits and challenges of e-health as experienced in other countries. A list of both e-health benefits and e- health challenges are provided and could provide guidance in the implementation of e-health in South Africa. To realise the purpose of the paper, an inductive content analysis methodology was followed. The main results were that although the challenges outweighs the benefits in the provided lists, there is still hope that through proper ICT solutions the benefits of e-health can grow more rapidly. This can lead to improved e-health service delivery and citizens in countries can all benefitfrom this.

KEYWORDS

E-health; Health Information Systems; ElectronicHealth Records; E-health Benefits; E-health challenges.

1 INTRODUCTION

The World Health Organisation defines e- health as the usage of information and communication technologies (ICT's) in thehealth domain, to administer treatment ofpatients, research, health education and the monitoring of public health [1].

South Africa is in the process to re-engineer its public healthcare sector to improve it to thebenefit of all South African citizens [2]. The Department of Health in South Africa releaseda National E-health Strategy in 2012. This strategy aims to implement e-health in South Africa in concordance with electronic healthrecords, routine health management information, vital registration, healthknowledge management, mobile health, telemedicine, virtual healthcare and health research [3].

Health facilities in South Africa currentlymainly use paper-based health records. The National e-health strategy aims to have a fully comprehensive integrated ICT solution forhealth by 2017 [3]. Although the South Africanhealthcare sector could benefit from the use of e-health, there are also challenges with regards to e-health [3], [32].

The purpose of this paper is to explore benefits and challenges of e-health as experienced in other countries. A list of both e-health benefits and e-health challenges are delivered and could provide guidance in the implementation of e- health in South Africa. The lists of benefits and challenges are ordered according to their effect on e-health. The ordering criterion is explained in section 2. A total of 22 e-health benefits and 31 e-health challenges are tabulated in section5.

This exploration is outlined in the rest of the paper by the methodology which is applied, the definition of e-health (including brief descriptions of health information systems and electronic health records), the

purpose of e- health, e-health benefits and e-health challengesin the findings section and a conclusion.

2 RESEARCH METHODOLOGY

The research methodology followed in this paper is inductive content analysis. Content analysis is a method of analyzing written communications [4], in this case literature. Inductive content analysis consists of preparation, organizing and reporting of data. The research philosophy applicable to this paper is interpretivism.

Search Strategy
We conducted a systematic review of literature regarding what e-health is, electronic health records, health information systems and benefits and challenges regarding e-health, health information systems and electronic health records. We made use of tools such as Google Scholar and other relevant Information Technology databases.

Inclusion and Exclusion Criteria
We searched for articles containing any of theabove mentioned themes and topics. Literaturein languages other than English was excluded. The keywords and phrases searched for arelisted below:
Electronic Health Records (EHR)
Health Information Systems (HIS)
Electronic Health (e-health)
Personal Health Records
National Health System (NHS)
Papers with one or more of these keywords or phrases were considered if the words or phrases occurred either in the title, abstract or body of
the paper. The table below indicates the level ofconsideration:

Table 1: Paper inclusion criteria

Criteria	**Consideration level**
Title	High
Abstract	Moderate
Body	Low

The search for papers (journal papers, conference papers and documents) ranged from August 2013 to August 2014.
57 Documents emerged from the search, with55 documents containing words/phrases in the title (“high”) and 2 containing words/phrases inthe abstract (“moderate”). Documents with a“low” level of consideration were excluded from the search.

Data Collection
To evaluate the literature, we coded all the relevant articles to include relevant information into the literature review.
The 57 papers were searched for definitions of e-health, electronic health records and health information systems as well as the uses of e- health to provide a background to the search for e-health benefits and challenges. The 57 papers were coded to identify e-health benefits andchallenges.

The keywords regarded as "benefits" are:
Benefits
Advantages
Opportunities
Pro's
Gains
Uses
Improvements
Effectiveness
Success

The keywords regarded as "challenges" are:
Challenges
Difficulties
Con's
Barriers
Complications
Obstacles
Struggles
Disadvantages
Issues
Failures

27 of these papers contained either benefits,challenges or both of e-health.
Thereafter, e-health benefits and challenges were tabulated (see section 7). The tabulation ofthe benefits and challenges are compiled and prioritized by using the following criteria:

Table 2: Benefits and challenges inclusion criteria

Criteria (number of papers)	**Effect**
3 or more	High
2	Moderate
1	Low

These tables are thus an overview of e-health benefits and challenges in existence and can be applied to inform the South African Departmentof Health to improve their proposed e-health systems.
The definition of e-health is a significant part ofthe exploration of e-health benefits and challenges. The definition of e-health, along with descriptions of Health Information Systems and Electronic Health Records are discussed in section 3.

3 DEFINITION OF E-HEALTH

ealth can be defined as a conversion to electronic health records and benefiting frominternet use and health agreements [5] in order to develop sufficient communication betweenhealthcare professionals [6].
The term e-Health (electronic health) may include various applications of healthcare; internet resources, electronic patient information, data analysis tools, communicationbetween health professionals as well as communication to patients, electronic health devices and administrative data [7].

Nuq and Aubert [8] define e-Health as the use of information in electronic format and communication technologies in the health domain. The term e-Health is thus a broad term that refers to everything that applies to the combination of computing or electronic devicesand healthcare or medicine [9], [10].
More specifically, in the hospital, home andprimary care settings, e-Health could include[11]:

Electronic patient administration tools and technologies, laboratory information systems, electronic communication systems, etc. are allexamples of e-Health in the hospital setting.
Telephone consults, diabetes and asthmamonitoring systems are examples of e- Health in the home setting.
Patient records, electronic prescribing,medical records and patientmanagement are examples of e-Health in the primary care setting.

With the term e-health defined, it is important to explore Health Information Systems. Section provides a background to HealthInformation Systems

Health Information Systems

Various countries around the world are doing research to successfully implement a national health information system. These countriesinclude Canada, Malaysia, Australia, USA,England, South Africa and Finland amongst many others. All of these countries have thesame prospects for such system [12]:

- Including patients in the use of their personal health information records
- The definition of the essential information in these health records
- Standardizing the system in terms of codes, languages and vocabularies to ease interoperability to provide open EHR systems.
- The implementation of data security, in terms of the system's infrastructure as well as security policies. A guideline for the content of a successfuhealth information system includes [13]:

Table 3: Health Information System Content [13]

Clinical documentation	Test and imaging results	Computerized provider-order entry	Decision support
Demographic characteristics of patients	Laboratory reports	Laboratory tests	Clinical guidelines
Physicians' notes	Radiologic reports	Radiologic tests	Clinical reminders
Nursing assessments	Radiologic images	Medications	Drug-allergy alerts
Problem lists	Diagnostic-test results	Consultation requests	Drug-drug interaction alerts
Medication lists	Diagnostic-test images	Nursing orders	Drug-laboratory interaction alerts
Discharge summaries	Consultant reports		Drug-dose support
Advanced directives			

Electronic Health Records form part of Health Information Systems and is discussed in Section 3.2.

Electronic Health Records

Electronic health records have been researched, tried, implemented and de-implemented since the 1990's.

Studies now show that a fully interoperable, working e-Health system could still be 10 years away in the United States of America [14]. The process of fully implementing electronic health records is ongoing.
This section defines electronic health records and discusses the uses of electronic health records in healthcare facilities.
EHR (electronic health records) can be formally defined as a database or warehouse with digital patient data, which is stored in a secure manner and can be exchanged and is available to various authorized users [12]. Another definition of electronic health records can be given as: an individual's health care data of his entire lifetime, with the aim of continuity of care, supporting teaching and research and the sharing of this information with confidentiality and security ensured [15].
The definition of EHR has not changed in the past decade [14] - as seen in the above definitions, an electronic health record is a patient's health information as a whole, stored in electronic format.
Patient records used to serve mainly to record treatment the patient has received and to ease communication to the patient. Patient/health records are now used to serve as evidence in law cases, general research and mainly to get an overview of the patient's entire health profile and history [16]:

- Patient's condition
- Care given
- Measurements taken
- Medication administered
- Human body systems
- Common patient problems

Along with the formal definitions of EHR, the content of a typical electronic health record serves as a part of the definition and could be very specific. EHR has become a wide-known term, but other terms may benefit the definition of what electronic health records mean.
There are 5 types of personal health records[17]:

1. *Offline personal health records* – these records may be stored electronically, but not on a web-based system. Individuals may ask for a copy of their personal health records.
2. *Web-based Organisational health records* – these records are accessible for the purpose of data-mining and research.
3. *Functional Personal health records* – these records may be web-based. The purpose of these records is to guide emergency health services, independently of geographical areas.
4. *Provider-based personal health records* – such as; medical history, and administration information such as appointment scheduling.
5. *Partial personal health records* – these health records are available online, but without any patient identification. This refers to available anonymised patient data.

Clinicians make use of electronic health records to guarantee continuity and stability of care. They mainly make use of these EHR to [16]:

- Understand the patients complete condition or health status;
- Make clinical choices;
- Communicate with other health workers.

Continuity of care means that patient care should be continuous in all the phases of healthcare. These phases are (in chronological order) as follows [15]:

- Preventative care
- Diagnosis of the patient's current condition
- Treatment of the current condition
- Rehabilitation

Iakovidis [15] also states that along withcontinuity of care in all phases of care, continuity should also be applied in all healthcare facilities, such as primary carefacilities, clinics, hospitals, pharmacies, at home, rehabilitation facilities amongst many others.
A framework for uses of electronic health records is given by the Information Strategy forthe Modern NHS [18]. This framework is givenbelow:

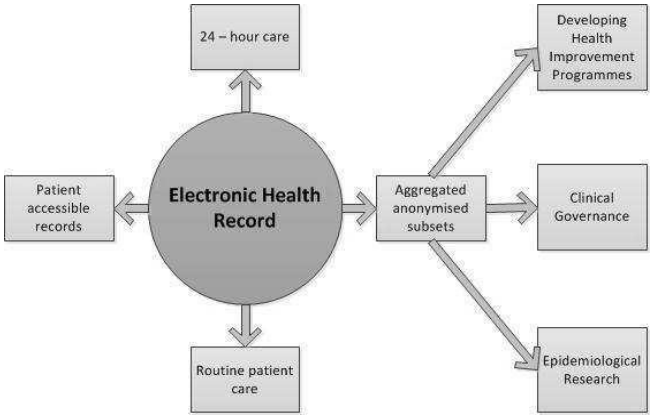

Figure 1: Uses of Electronic Health Records [18]

The Information Strategy for the Modern NHS [18] explains the uses in the framework asfollows:

- the development of health records, accessible by the patient, by making useof smart cards and other technologies;
- supporting direct and primary patient care, by making use of integrated healthcare;
- providing 24-hour care for patients by making patient health information accessible for all authorized healthcare professionals, and summarizingimportant health data;
- needs assessments, service planning and epidemiological research in support of clinical governance.

The term e-health has become a term globally used. With the definition of e-health providedin section 3, it is significant to discuss the purpose of e-health before exploring the benefits and challenges thereof. The purpose of e-health is discussed in section 4.

4 PURPOSE OF E-HEALTH

Although the "e" in e-Health generally refers to"electronic", Eysenbach [11] provides 10 e's in e-Health. The "e's" in e-Health serves as a definition of the purpose of this field:
Efficiency is one of the primary objectives of e-Health. Healthcare should become more efficient throughthe

use of electronic health, and therefore the cost regarding health should reduce.
Enhancing quality; this refers to enhancing the quality of care. By improving communication and interoperability in healthcare systems and patient information, the quality of care should improve.
Evidence based; the effectiveness of e- Health should never be assumed. Theeffectiveness of e-Health should bescientifically proven, before engaging inan e-Health intervention.
Empowerment of both the consumers and patients. By making patient records accessible and enhancing the availability of medical information patient-centered medicine is enhanced. This empowers patients to make decisions with insight.
Encouragement refers to encouragementof an improved relationship between a patient and the health worker. This is established by the easy sharing of information and transparency of patient data and medical information.
Education of health professionals should be improved by making use of internet sources. The health education of patients and consumers should also be enhanced, or knowledge should be broadened through information providedon the internet. This could be seen as preventative health information.
Enabling communication and astandardized information exchange between different healthcare facilities is a key outcome of e-Health.
Extending e-Health beyond the original borders of health. This refers to physical as well as metaphorical boundaries. With the use of communications technologies, it becomes possible to extend healthcare in terms of location.
Ethics; in the midst of possibilities regarding information exchange, communication technologies and health information systems, it remains important to adhere to privacy and equity laws and ethical considerations.
Equity refers to the equal access and use of e-Health. The digital divide, especially in developing countries, remains a challenge in the successful implementation of e-Health.

Regardless of whether a system is electronic or paper-based, the data will not be useful if it is of substandard data quality [1]. The World Health Organization [1] provides a guideline of what health data should be capable of:
determining the continuing and futurecare of a patient at all levels of health care;
medico-legal purposes for the patient,the doctor and the health care service;
maintaining accurate and reliable information about diseases treated and surgical procedures performed in a hospital and within a community, as well as immunization and screening programmes, including the number and type of participants;
clinical and health service research and outcomes of health care intervention, if required;
accurate, reliable and complete statistical information about the uses of health care service within a community;
teaching health care professionals;
working out staffing requirements and planning health care services.

Following the clear definitions of e-health, Health Information Systems, Electronic Health Records and the purpose of e-health, section 5 tabulates e-health benefits as well as e-health challenges as described in previous literature.

FINDINGS

This section outlines the findings after the 57 papers (see section 2) were coded and analysed. This resulted in the two tables which feature the known benefits and challenges of e-health. These benefits and challenges emerged fromprior research in the e-health domain.

For the purpose of the paper, the entire literature study is not provided. Only the most important aspects of e-health were discussed in this paper. Others that were not addressed include: Health Information Systems implemented in South Africa, different e-health terminologies and standards for interoperability. Authors that provided benefits and challenges regarding e-health include:[12], [13], [14], [15], [16], [17], [18], [19], [20], [21],
[22], [23], [24], [25], [26], [27], [28], [29], [30],
[31], [33], [34], [35], [36], [37], [38] and [39].
Consequently the e-health benefits and challenges identified in the research done by the authors mentioned are tabulatedrespectively in section 5.1 and 5.2.

Tabulated E-Health Benefits

Table 4 provides a list of the benefits of e- health. The table consists of e-health benefits along with the relevant sources of literature.

Table 4: Benefits of e-health

E-Health Benefits	Sources	Effect
Cost savings, financial benefits in general	[15], [14], [18]	High
Health safety improvements	[15], [14], [17], [20]	High
Improvement of efficiency and effectiveness of healthcare	[13], [17], [20], [21], [38]	High
Improved decision making	[15], [16], [17], [20], [39]	High
Access to physicians remotely	[22], [17], [19]	High
Reduce medical errors	[17], [19], [39]	High
Sharing of information	[15], [17]	Moderate
Medical science and research	[22], [19]	Moderate
Workflow efficiency	[17], [20]	Moderate
Employee satisfaction	[17], [39]	Moderate
Patient satisfaction	[17], [39]	Moderate
Reduces paperwork	[20], [38]	Moderate
Better data for management purposes	[15]	Low
Quality assurance for forecasting	[15]	Low
Comparative effectiveness	[22]	Low
Improved diagnosis process	[15]	Low
Improved communication	[21]	Low
Standardization of healthcare	[19]	Low
Safety regarding drug dispensing	[19]	Low

Enhancement of self-managing chronic diseases	[19]	Low
Management improvements	[20]	Low
Prevention support	[20]	Low

Table 4 presents 22 benefits of e-health. Financial benefits, health safety improvements, improved effectiveness and efficiency of

healthcare, improved decision making, access to remote physicians and the reduction of medical errors are benefits regarded to have a high effect. These benefits of e-health have each been identified in three or more research studies. Amongst the highly regarded benefits of e-health, there also exist other benefits such as prevention support, management improvements, drug dispensing, safety improvements, forecasting, better data management and others. Although all of the benefits of e-health have not been mentioned in more than one study at this point in time, benefits of e-health could develop and mature as a result of proper ICT solutions for current e-health challenges.
The challenges regarding e-health are tabulated in section 5.2.

Tabulated E-Health Challenges

Table 5 provides a list of the challenges of e-health. The table consists of e-health challenges along with the relevant sources of literature.

Table 5: Challenges of e-health

E-Health Challenges	Sources	Effect
The financial barrier to purchase necessary hardware and cost challenges in general	[23], [15], [13], [20], [24], [25], [26], [34]	High
Lack of IT and clinical resources	[23], [13], [26], [34]	High
Difficulty learning and using the software	[23], [34], [31], [33]	High
Personnel costs	[15], [20], [26]	High
health information systems in small and rural facilities, and not only big hospitals, remains a challenge	[39]	
Data privacy	[17], [24], [25], [28], [29], [34], [39]	High
Interoperability	[17], [20], [30], [24], [28], [34]	High
Sustainability	[31], [24], [26]	High
Data quality	[19], [24], [28], [29], [14], [20]	High
Usability	[19], [25], [34], [36], [33]	High
Transferring data from paper to electronic records	[31], [17], [19]	High
Physicians are hesitant to change existing processes	[13], [26]	Moderate
Forming electronic health records as part of the facilities daily routine	[31], [36]	Moderate
Meeting needs at each provider level, reaching goals	[29], [37]	Moderate
Data access	[28], [35]	Moderate
Government	[26], [39]	Moderate
Logistics	[26], [39]	Moderate
The shortage or absence of the necessary infrastructure, such as internet connections	[23], [34]	Moderate
The patient's medical history isn't always available	[23]	Low
Although it saves time, the drop down menus in health information systems may lack detailed information.	[16]	Low
Nurses' notes may go unread by physicians	[16]	Low
Scalability	[31]	Low
Modernizing existing systems	[29]	Low
Extracting knowledge out of	[30]	Low

Standardizing of all health information systems, since the content and structure of all health information systems should be standardized	[12], [20], [26], [39], [33]	High
It might be time consuming to update the EHR thoroughly	[16], [27], [34]	High
The implementation of	[14], [31],	High

information		
Software	[24]	Low
Patient consent	[28]	Low
Donors	[26]	Low
Fragmentation programmes	[26]	Low
The lack of appropriate software	[23]	Low

order to prevent the occurrence of the same problems. These types of lists can also assist in ensuring that all benefits and challenges are addressed before implementations of these e-health systems.

5 CONCLUSIONS AND FUTURE WORK

Table 5 presents 31 challenges of e-health. Financial barriers such as purchasing of hardware, the lack of IT and clinical resources, difficulty of learning using software, personnel costs, standardization of Health Information Systems, time challenges, implementations in rural areas, data privacy, interoperability, sustainability, data quality, usability and the transfer from paper records to electronic records are challenges with a high effect. Thesechallenges have been identified in three or morestudies. Amongst the highly regarded challenges, there are various other challenges, also presented in Table 5. Some of the challenges with a lower regard include the lack of appropriate software, fragmentation programmes, donors, patient consent, scalability and the lack of patient history.

Finances seem to be both a benefit and challenge to be highly regarded. Although the financial benefit could be high in terms of cost savings [14], [15], [18], the initial costs to implement e-health systems, purchase hardware, hire IT personnel etc. [15], [23], [13],

[20], [24], [25], [26], [34] is a significant challenge of e-health. Proper solutions for the financial barrier of e-health should be implemented to essentially benefit financially from the implementation of e-health.

These tables are theoretical overviews of literature which covers e-health as a domain. The challenges are more than the benefits; however some of these challenges can become benefits if proper ICT solutions can be provided. Countries can learn a lot from each other when it comes to e-health implementations that were successful over a short period of time. These should be shared in

The purpose of this paper was to explore benefits and challenges in the e-health domain. The lists of benefits and challenges could provide guidance in the ongoing implementation and re-engineering of e-health in South Africa. An inductive content analysis research methodology was followed to explore the e-health benefits and challenges presented in this paper. The benefits and challenges are prioritized according to the number of studies in which it is mentioned.

The exploration of the e-health benefits and challenges is supported in this paper by the definition of e-health, descriptions of Health Information Systems, Electronic Health Records as well as the purpose of e-health.

The benefits to be highly regarded for the implementation of e-health include cost savings, health safety improvements, improvement of effectiveness and efficiency of healthcare, improved decision making, accessto remote physicians and the reduction of medical errors,

The challenges that should be highly regarded before implementing e-health include financial barriers, lack of IT and clinical resources, the difficulty of learning and using e-health software, personnel costs, standardization of Health Information Systems, time challenges, the implementation of e-health in rural areas (connectivity), data privacy, interoperability, sustainability, data quality, usability and the transition from paper to electronic health records.

Although the challenges outweighs the benefits in these lists, there is still hope that through proper ICT solutions which address all the challenges identified above, the benefits can grow more rapidly. This can lead to improved

e-health service delivery and citizens in countries can all benefit from this.

Future work could include researching e-health benefits and challenges as experienced in SouthAfrica. E-health interventions could also be done in South-Africa to minimize e-health challenges and to increase

the benefits of e-health.

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