Use of Information Systems (IS) to transform the Healthcare Sector in South Africa

The South African healthcare sector faces a great burden of disease, weak management, inadequate resources and infrastructure. The legacy of apartheid which segregated and prioritized the white population over the indigenous and other population groups led to massive inequality, which is pervasive even decades after liberation (Mooney and McIntyre, 2008). The usage of Information systems has improved and revolutionized many sectors around the world, healthcare amongst them. While the South African private healthcare sector has the resources to utilize the latest technologies, the public sector still relies on outdated technology and management(Young M, 2016).

Information systems (IS) refer to a set of interrelated components comprised of software, hardware, and telecom to collect, store, process and distribute data to improve an outcome(Britannica, 2022).

This literature review will serve to present the best available evidence as to how utilization of information systems can be used to transform the healthcare sector in South Africa.

The Problem

South African healthcare has been divided into two components, largely based along socioeconomic lines. Free healthcare is available to all - while those able to afford it subscribe to a medical insurance plan(Gordon, Booysen and Mbonigaba, 2020). Research shows that a whopping 83% of the country's 59 million people rely on the public healthcare system for their everyday needs and emergencies, while only 17% are able to afford private healthcare(Ngobeni, Breitenbach and Aye, 2020). This figure is further reduced once participants of the medical insurance effectively utilize their benefits afforded to them by their specific plan, with the result being additional patients presenting to the public institutions for their ad hoc needs. This places further strain on an already overburdened system resulting in mismanagement, inadequate care and sometimes even death (de Villiers, 2021). In addition to these factors, not all public institutions function at the same level of care. The public healthcare system is divided into three tiers, with the primary tier functioning for basic care (acute illness, dental, optometry) and chronic condition management (Diabetes, TB, HIV, Hypertension). The facilities in the primary tier are largely small clinics, with outpatient departments and satellite clinics. These are mostly based in rural areas to serve outlying communities. The second tier is comprised of mid-size hospitals offering in and outpatient departments, theatre facilities and some specialist cover. The third tier is designated as a “tertiary” tier, functioning alongside universities, offering extensive specialist care, as well as theatre and cancer treatment programs (Africa, 1994). These facilities are mostly based in urban areas, resulting in patients from rural areas requiring extensive travel. Patients attending the tertiary level hospitals require referrals from a second or first tier institution, resulting in delays in treatment. Public facilities are funded mostly by tax collection, as well as international and local donor organizations (Ataguba and McIntyre, 2018).

The high burden of disease caused by the TB and HIV epidemics have resulted in a vulnerable population. South Africa has a disease burden of 17% of the global HIV cases, with a 70% TB co infection rate. In 2007, an estimated 38% of eligible patients received adequate HIV treatment, and a mere 58% of TB patients were cured (Karim *et al.*, 2009, 2010). Numerous interventions have been proposed, with public information campaigns, multiple government initiatives and large stakeholder interventions, however, this has yet to realise significant progress.

What can be done

Paper based medical records are still highly utilized in South Africa(Weeks, 2014). Many disadvantages arise from their use, such as the loss or damage of medical records by the provider or patient, issues arising from referrals to alternate institutions and patients moving geographic location amongst others (Li *et al.*, 2018). Additionally, it not only has the potential to compromise the integrity of the data but is a huge risk to patient confidentiality – which is a ticking time bomb due to the implementation of stringent privacy laws in South Africa.

There is also a risk to patient safety when using paper-based records compared to electronic records. Hong-Ling et al. 2020, conducted a 6-year observational study to determine the impact of EHR (Electronic Health Records) on patient outcome versus patients with no EHR. They reported that the use of EHR resulted in a reduction of medication administration errors, improved clinical communication, and improved information management which led to better treatment decisions. In-hospital mortality was reduced, however, a temporary increase in hospital stay length was recorded during the transition phase, which was attributed to increased complexity and subsequent training required (Lin *et al.*, 2020). Similar findings were reported in a Jordanian study, with an increase in quality of health services in hospitals which utilized EHR (Ayaad *et al.*, 2019). The use of EHR also reduced costs when compared to paper based systems (Pavlović, Kern and Miklavčič, 2009). Additionally, a systematic review revealed that patients perceived an improved level of care and satisfaction when EHR were used (Liu *et al.*, 2013).

Implementing EHR could be done by an immediate or incremental approach (Aguirre *et al.*, 2019). The immediate approach would require a massive resource allocation, as well as intensive staff training (Aguirre *et al.*, 2019). Additionally, infrastructure would need to be in place for this method to be effective. The incremental approach, which involves utilizing EHR for certain tasks would likely be a better option in South Africa. This would allow for familiarity of the system prior to complete implementation. There would be limited to no productivity loss, and staff may be trained at different times. A strict plan would be required to ensure a speedy implementation. This would also allow for adequate infrastructure such as tablets, laptops networks, and servers to be established over time. Additionally, different departments such as pharmacy and radiology may be onboarded simultaneously and incrementally (Aguirre *et al.*, 2019).

Privacy and adequate security of personal information must also be prioritized to improve user acceptance.

South Africa may have an opportunity to capitalize on their prior inadequacies in implementing EHR by utilization of a next generation technology such as blockchain. Since most current EHR are incompatible with the blockchain (Fang *et al.*, 2021), countries which already have an EHR in place would be required to essentially rebuild their EHR systems to move onto the blockchain, which would incur a significant cost in terms of human resources and funding. The lack of a current EHR in south Africa means that we may be able to bypass the costly process of changing over to blockchain, by essentially starting EHR on the blockchain. The blockchain offers significant improvements over the previous generation EHR such as improved information security, and retrievability (Xiao *et al.*, 2021). In addition, by design, records on the blockchain are unable to be modified retroactively, and as such, would result in increased accountability by practitioners, improved safety for patients and may decrease associated lawsuits (Agbo, Mahmoud and Eklund, 2019). The government of Estonia established EHR records on the blockchain for its citizens from 2012 (Heston, 2017). This project has proven to be successful, with the entire public health sector operating on the blockchain through a firm called “Guardtime” (Mettler, 2016). This company has also been contracted to perform the same service for the health sector in the United Arab Emirates (Novikov *et al.*, 2018).

The EHR program would also allow for large scale data analysis to establish problem areas, visualize healthcare facilities efficiency, and allow for targeted interventions (Khennou, Khamlichi and Chaoui, 2018; Zhang *et al.*, 2019). Manual reporting and surveillance procedures for cases such as Covid, Ebola, TB and malaria would also not be required, as the information would be available for use in real time (Klompas *et al.*, 2012). Successful pilot programs have been conducted in Massachusetts and Ohio, however, limitations such as the use of different EHR systems and subjective coding of diseases are present. Systems would need to be standardized or interoperable and adequate training should be provided (Klompas *et al.*, 2012). This system would essentially allow for a population health management system, where big data may be used to transform the healthcare sector from a curative to preventative approach (Razzak, Imran and Xu, 2020).

Almost 55% of patients surveyed in South Africa, experienced a problem when attending a public healthcare facility, ranging from medication being unavailable to long waiting times, to inconvenient opening times (Hasumi and Jacobsen, 2014). Additionally, patients reported indirect costs such as distance to their nearest public facility and associated transport costs, as well as a loss in wages due to being unable to work prohibited them from seeking medical help (Neely and Ponshunmugam, 2019; Pillai *et al.*, 2019). Interestingly, over 90% of the population had access to a smartphone, which may provide an avenue to seeking healthcare remotely (Mzekandaba, 2020).

Mobile health or mHealth is an exciting prospect that has the potential to improve access to healthcare for many impoverished communities. The technology allows for patients to be connected remotely with healthcare providers, to establish referral pathways, elucidate health education, digital therapeutics, and limited diagnostics

(Rowland *et al.*, 2020). In addition, mHealth may be utilized for cancer screening programs and education, such as oral and skin cancer (Haron *et al.*, 2020).

The challenges associated with this program would be for relevant stakeholders to invest in the creation of such a service, as well as implementing a zero-rated data policy for the service to remove the cost from the patient.

The service could be advanced by including telemedicine functionalities, whereby the patient may be able to consult directly with a healthcare provider for certain conditions that do not require a physical examination. Sensors such as blood pressure and glucose meters may be given to patients and would allow for real time evaluation by the clinician to dictate management (Bhaskar *et al.*, 2020). As the infrastructure such as smartphones and 4G connectivity is largely available, this service could provide a useful solution to the impoverished rural community who struggle to access healthcare facilities.

Telemedicine may allow for patients who require a higher level of care to be sent straight to a secondary or tertiary facility, without the need to attend a primary facility to elicit a referral, or conversely redirect a patient from an emergency department to a primary healthcare facility (Carolan *et al.*, 2020).

The current medication supply and distribution system relies heavily on human interaction. Staff are required to monitor supplies and place orders when stock is low. This results in many occurrences whereby the healthcare facility runs out of medication, leaving the patient without the necessary treatment until the stock is delivered. A pilot computerized inventory management system was tested in a province in 2014, with mixed results (Modisakeng *et al.*, 2020). Pharmacy managers interviewed reported that an advantage of the system was that staff could be alerted to medication nearing their expiration date and redistribute those medications to other facilities for immediate use. A disadvantage reported was that the stock levels reported by the system did not correlate with physical stock levels in the warehouse. The discrepancy may be attributed to insufficient training, leading to staff simply not using the system (Modisakeng *et al.*, 2020).

Of concern, is the number of counterfeit medications in developing countries, which is estimated to be between 10-30% of all medications. These counterfeit drugs may differ in composition to their originals, which may lead to undesirable and unpredictable side effects as well as reduced efficacy (Jamil *et al.*, 2019). Blockchain technology may once again be a solution to this problem. Utilizing the blockchain for pharmaceutics from production to transport to storage and finally to the patient, we may be assured of its authenticity and subsequent quality (Uddin *et al.*, 2021). Additionally, this system is useful for pharmaco-surveillance, where if there were to be a fault with a batch, these drugs may be easily tracked and recalled from the market (Sylim *et al.*, 2018). Smart contracts may also be initiated to allow for automatic prescription authentication as well as pharmacy management for when a drug supply is low or reaches a certain threshold, thus reducing the instances for vital medication to be unavailable (Khatoon, 2020).

Conclusion

Information systems have the potential to improve health care systems, individual and community health. Many solutions are available with advancements being made every day. It is time for political powers to enforce adoption for the benefit of all citizens in South Africa.

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