

**Knowledge, perceptions, and acceptance of the use of  
blockchain technology for patient healthcare records by  
healthcare workers in South Africa**

**Research Methods and Professional Practice module**

**March 2022**

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The World Bank has designated South Africa as a developing country, characterized by high unemployment and extreme inequality (World Bank Group, 2022). Like many developing nations, South Africa suffers from an inadequate healthcare system. While healthcare is divided into free public healthcare and privatized paid healthcare, the overwhelming majority- 83%, relies on the public system (Ngobeni, Breitenbach and Aye, 2020). Documented handicaps, such as inadequate funding, lack of infrastructure, staff shortages, mismanagement of resources and a high burden of disease hampers the level of care provided (Maphumulo and Bhengu, 2019). While steps have been taken to improve healthcare provision, such as increasing tertiary institutions, increasing funding and the building and revamping of facilities, there is no patient electronic healthcare records system currently in place (Department of Health Republic of South Africa, 2007). Patient records are stored in written format at individual institutions. This in turn leads to administrative redundancies, loss of patient record files, duplication and increased work for healthcare providers by requiring documentation and manual surveillance reporting (Weeks, 2014). Issues arising from patients moving to a different geographic location are prevalent (Li *et al.*, 2018). Referrals from primary clinics to advanced institutions are fraught with complications, relating to inadequate medical history and incomplete records leading to the need for healthcare workers to perform multiple unnecessary patient workups and tests (Luthuli and Kalusopa, 2018).

South Africa has a significant epidemic of HIV, with close to 4 million people living with HIV. A mere 32% of these were on continuous ART treatment, with a significant percentage discontinuing care due to mobility and time issues related to obtaining their treatment (Bisnauth *et al.*, 2021). Migrant workers as well as cyclical migration where

individuals live in rural areas and are employed in metropolitan areas are common. This means that there is limited continuation of care when the worker returns to a rural facility from a city clinic or hospital (Ponthieu and Incerti, 2016). Patients and providers also reported multiple instances of crucial medication being out of stock (Hwang *et al.*, 2019). Tuberculosis has been described as a co-epidemic, with untreated HIV positive individuals deemed more susceptible to the disease (Karim *et al.*, 2009). While highly treatable, 58000 people were identified to have died from TB in 2019 with 62% of them being HIV positive (TBFacts, 2021). The interruption of TB treatment may be particularly dangerous, with the disease able to become resistant to first line medication, as well as becoming highly transmissible (Tola *et al.*, 2019). Patients report similar reasoning for discontinuing treatment, which often results in an increased risk of mortality (Moodley *et al.*, 2020).

Many countries have started to utilize central records management systems, using smartphones or tablets, which connect automatically and store data centrally, and allow for widespread access by healthcare workers across different institutions (Bonomi, 2019). Incorporating telemedicine and drug tracking has allowed patients to receive care and treatment at a location convenient to them, thus increasing treatment compliance (Kakkar, Naushad and Khatri, 2017). This has proved effective, however, reports of data breaches, incompatible systems and downtime have been reported (Bowman, 2013).

An alternative proposal is the utilization of a blockchain based patient healthcare records system. With the blockchain, records are cryptographically stored and storage is decentralized, leading to increased availability and reduced security risks (Xiao *et al.*, 2021). Records may be pseudo-anonymized, as well as implementing access controls, thus increasing privacy for patients (Six *et al.*, 2021). Additionally, records stored are immutable, meaning that they cannot be changed, only appended, thus removing the risk of file tampering and subsequently improving healthcare provider accountability (Agbo, Mahmoud and Eklund, 2019). Blockchain is not without its drawbacks, such as the reliance on proof of work algorithms which are extremely energy intensive, and the need to store additional data such as imaging and lab work off-chain owing to the large amounts of data required (Zubaydi *et al.*, 2019). Research is ongoing with alternative algorithms such as proof stake proposed, which is less energy intensive. Additionally, companies are seeking to effectively connect off chain data with on chain data without increasing the time and cost of retrieving a record. This may allow for a hybrid blockchain, relational database model which would improve efficiency while remaining cost effective (Mühlberger *et al.*, 2020). While still in its infancy, blockchain technology presents a unique opportunity to improve the healthcare system in South Africa, if adopted correctly and uniformly.

## **Research Problem**

Multiple systematic reviews have been conducted to determine the feasibility or impact of the use of blockchain technology for healthcare records worldwide, concluding that a blockchain based healthcare records system would be beneficial to providers and patients alike. (Mayer, da Costa and Righi, 2020; Tandon *et al.*, 2020; Fang *et al.*, 2021). However, none of these studies specifically investigate the South African healthcare system. To date, while framework research in the South African context is available (Ndayizigamiye and Dube, 2019; Ngoepe and Marutha, 2021), there are no known studies examining healthcare workers knowledge, perceptions, and acceptance of a blockchain based healthcare records system. Our research would ideally fill the gap in available research, so as to allow for a more thorough understanding of the challenges and potential roadblocks that may be faced during implementation. This will in turn, assist the National department of health in South Africa to make an informed decision if and when a rollout is planned.

## **Research Question**

How does the knowledge and perceptions of blockchain technology in South Africa affect the potential acceptance and implementation?

## **Aims**

To determine the knowledge and perceptions of blockchain technology in South Africa amongst healthcare workers

To analyse the potential for acceptance and implementation of electronic healthcare records using blockchain technology, by healthcare workers in South Africa.

To determine possible barriers for implementation of an electronic healthcare records management system utilizing blockchain technology in South Africa

## **Objectives**

- To create a survey questionnaire for dissemination to healthcare workers
- To conduct face to face interviews with selected healthcare
- To collate and synthesize evidence recorded regarding healthcare workers knowledge attitudes and perceptions of blockchain technology
- To make recommendations for future research and policy decisions based on the results from our study

## **Methodology**

We plan to perform a mixed methods analysis, incorporating both quantitative and qualitative data to determine the potential for implementing a blockchain based electronic healthcare records management system in South Africa

The quantitative portion of our research would involve an online questionnaire, aimed at healthcare workers in the private and public sectors in South Africa. According to medpages.co.za, the total size of our population is estimated to be 77239 (Medpages.info, 2022). This is made up of:

- Medical practitioners – 27224
- Dental practitioners- 6969
- Pharmacy- 6149
- Nursing practitioners- 19062
- Allied healthcare workers such as Physiotherapists, psychologists, occupational therapists, and radiographers- 17835

This number is merely an estimate of the number of healthcare workers in South Africa. We used 5% as our margin of error, with our confidence interval set at 95%. From these calculations, we estimate the number of responses required to be approximately 383, in order to obtain a representative sample of the population. We will not be limiting participation once this number of responses has been reached so as to increase accuracy. We will set a deadline for responses to the survey to be submitted, after



which the survey link will be shut down. Participants who wish to be notified of the results of the study may indicate so at the end of the survey.

An online survey questionnaire will be created via the university of Essex recommended survey tool – Qualtrics and shared on social media through Facebook and WhatsApp groups incorporating the aforementioned occupations. Additionally, we will be encouraging sharing of the survey amongst colleagues to increase the potential involvement in the survey.

The survey will comprise of a list of 15 questions, which will allow us to gauge the level of understanding and acceptance amongst healthcare workers. The first 5 questions will relate to education level, primary area of practice, demographics (age), and experience level. The next 5 questions will comprise of information related to the attitudes of healthcare workers to their currently used healthcare records management system. The 11<sup>th</sup> question relates to the participants knowledge and exposure to blockchain systems. We will then include a basic summary of what a blockchain is, its potential applications and potential benefits. The last 4 questions will be used to ascertain the current level of interest in utilizing a blockchain based healthcare record management system. The end of the survey will provide an opportunity for healthcare workers who wish to participate in the qualitative aspect of our study.

## Blockchain questionnaire

- 1) What is your profession?
  - a) Medical or medical specialist
  - b) Dental or dental specialist
  - c) Nursing
  - d) Pharmacy
  - e) Other allied such as physiotherapy/occupational therapy/radiology
- 2) What is your highest level of education?
  - a) Bachelor's degree
  - b) Master's degree
  - c) Doctorate Degree (PHD only)
  - d) Nursing diploma/certificate
  - e) Other occupational certificate
- 3) Where are you primarily employed?
  - a) Public sector including government hospitals, clinics, or universities
  - b) Private sector
  - c) Non-governmental or non-profit organization (NGO/NPO)
- 4) What is your age group?
  - a) 18-24 years
  - b) 25-32 years
  - c) 33-45 years
  - d) 46-60 years
  - e) Over 61 years
- 5) What is your level of experience?
  - a) 0-3 years
  - b) 4-7 years
  - c) 8-12 years
  - d) 13- 20 years
  - e) Over 20 years

- 6) What is your attitude towards current methods of patient records management in your primary place of work?
- a) Dreadful
  - b) Poor
  - c) Average
  - d) Good
  - e) Excellent
- 7) How would you categorise the current methods of patient record management in your primary place of work?
- a) Manual file based- Non satisfactory
  - b) Manual files based- Satisfactory
  - c) Electronic- non satisfactory
  - d) Electronic- satisfactory
- 8) What are your main problems relating to the current methods of patient record management in your primary place of work? Please select all options that may apply
- a) Loss of patient records
  - b) Duplicated patient records
  - c) Incomplete or inadequate patient records
  - d) Time related to retrieving patient records
  - e) Cost relating to patient records such as storage or consumables
  - f) Patients presenting to my place of work from other institutions without previous records
  - g) System issues such as down time due to outages or maintenance
  - h) System issues such as inadequate infrastructure (lack of computers/ tablets/ internet connectivity)
- 9) How would you categorise the impact of these problems in Q7 on your ability to manage patients?
- a) Extreme impact
  - b) Moderate impact
  - c) Low impact
  - d) No impact

- 10) How would you categorise patient confidentiality and privacy relating to the currently used patient records management system in your place of work?
- a) Dreadful- no confidentiality or privacy for patients
  - b) Poor- little to no confidentiality or privacy for patients
  - c) Average- Adequate confidentiality or privacy for patients, improvements can be made
  - d) Good- Good confidentiality and privacy for patients, only minor improvements need to be made
  - e) Outstanding- Excellent privacy and confidentiality for patients, no improvements need to be made
- 11) How would you categorise your level of familiarity with blockchain technology?
- a) Never heard of it and don't know what it is
  - b) Heard of it, but don't know much about it
  - c) Heard of it, have some experience using it
  - d) Know quite a bit about it, have used it regularly
  - e) Extremely familiar with it, have in depth knowledge about it and use it regularly

Blockchain technology is simply put, a digital ledger, used to record and approve transactions. The system is decentralized, meaning there is no central authority to manage it. Each participant utilizing the service contributes to approving transactions. Information entered into the blockchain is immutable, meaning the information cannot be changed once approved, only updated. For patient records, this may mean that a patients complete medical history will be available when entered into the blockchain, across all healthcare institutions. Patients data is anonymised and encrypted, meaning that while all records will be available, no personal data may be identified. Additionally, only approved parties may access a patients records after authentication by the patient

- 12) Now that you have a cursory understanding of blockchain, do you feel that it should be used for patient healthcare records management?
- a) No- sounds like a scam
  - b) No, I prefer manual healthcare record management
  - c) No, I prefer the current method of electronic healthcare record management
  - d) Not at this time, but I would like to learn more
  - e) Maybe, the system has potential, but I have reservations, such as cost, training, and others
  - f) Definitely, the system will revolutionize the healthcare industry in South Africa

13) What are your reservations regarding the implementation of the system?

- a) Increased cost due to the need to purchase equipment
- b) Uncertainty due to the volatility of cryptocurrencies
- c) I think a centralized system is better
- d) I am not comfortable with information being publicly available, even if anonymised and encrypted
- e) Potential reservations relating to training for the new system
- f) No reservations, we should implement this now

14) What are your reservations with regards to **the ability of the National Department of Health** to successfully implement this project? Please select all that apply

- a) Corruption. The government will misappropriate the funds and the project will never materialise
- b) Not enough money available in the budget to successfully implement the project
- c) Unstable electricity supply would render this project ineffective
- d) Not enough skilled staff available to implement the project
- e) Administrative ineptitude will cause this project to drag on for years without being implemented
- f) No reservations, I believe that this administration would be successful in implementing this project

15) If correctly implemented, how do you feel you may benefit

- a) No benefit
- b) Decreased administrative workload
- c) Decreased patient complaints
- d) Increased patient satisfaction
- e) Increased standard of care

### Additional questions

Would you like to be contacted to participate in an online face to face interview at your convenience?

- a) Not interested
- b) Yes- please contact me. My email address is:

Would you like to be notified of the results of the study?

- a) Not interested
- b) Yes- please notify me. My email address is:

The qualitative aspect of the study will be in the form of online face to face interviews, conducted over a teleconferencing platform such as zoom or google meet. The rationale for this being to limit potential problems arising from logistical concerns, such as geographic distance, as well as allowing for healthcare practitioners to select a time that would be most suitable to them. Interviews will last for between 15-30 minutes and will include a list of semi-structured open-ended questions, which will be recorded and transcribed following the required informed consent. Interviews will be conducted in English, as all qualified healthcare workers would be fluent, having had completed their education at a recognized tertiary institution.

The semi structured interviews will follow a line of questioning, with open ended answers:

1. Do you believe that the current methods of patient record management are effective? Why do you say so?
2. What are your main concerns relating to the use of blockchain technology for patient record management?
3. What are your reservations relating to the implementation and adaptation of blockchain technology for healthcare record management?
4. Do you think patient care will be improved or hindered by adaptation of such a technology?
5. How concerned are you about privacy and confidentiality for patients and how do you think blockchain technology will affect this? Please elaborate?

Participants will be encouraged to voice any opinions or concerns they may have regarding blockchain use for healthcare management, its implementation, adaptation and potential success or failure thereof.

## **Data analysis**

Data from the survey questionnaire will then be collated. Since the proposed survey consists of a variety of questions resulting in ordinal and categorical data, we will use descriptive and graphical analysis to summarize the responses. Metrics such as frequency would be especially important. Additionally, inferences could be made with data such as age, experience, and education to acceptance of blockchain technology.

The interview transcriptions will be subject to thematic analysis, using software such as NVivo or MAXQDA, whereby we will apply codes to the data, to identify common themes and “problem areas”. The software will enable us to organize and identify themes emerging from the interviews. To maintain confidentiality, interviewees will be assigned a unique numerical identifier.

## **Ethical considerations**

As there are no human trials, we do not anticipate the need to gain ethical approval. We will be following the GDPR(*General Data Protection Regulation (GDPR) – Official Legal Text*, no date) and POPI (POPIA, 2021) acts relating to protection of personal information, and an informed consent form will be required prior to conducting the surveys and face to face interviews. Data collected will be anonymized and no personal details will be disseminated.

To ensure that only registered healthcare professionals complete the questionnaire, we will require entry of the professional registration number at the beginning of the survey.



This information will be cross checked at the time of entry against the HPCSA i-Register automatically and will not be recorded once entered.

### **Timeline of proposed activities**

A timeline was created in the form of a Gannt chart. We planned for 6 phases of the project, allowing for adequate time to complete each phase. The first phase, research protocol, involved determining the feasibility of the project by examining existing literature. Once we established that there was a need for this research, we identified potential articles and the proposed methodology for the project. This phase was completed with the submission of the protocol to the University of Essex for approval and marking.

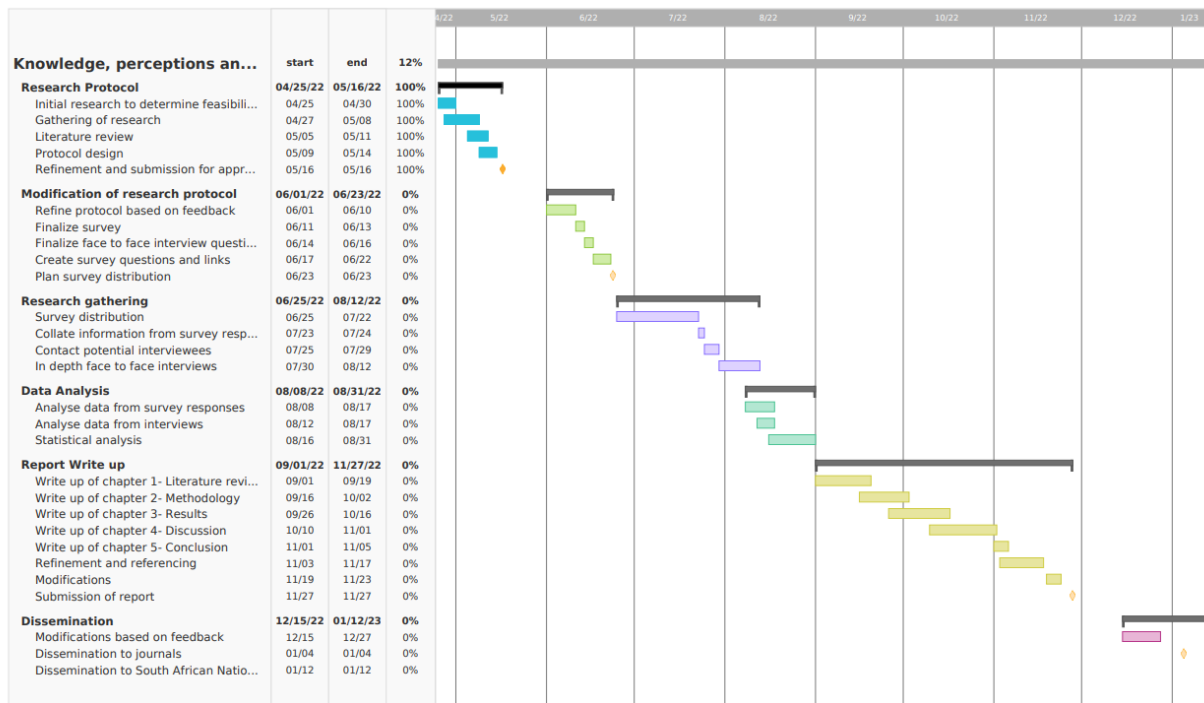
The second phase of the project involved modification of the research protocol based on feedback provided. Surveys and in interview questions are then to be modified.

The third phase of this project relates to information gathering. We have projected approximately 1 month for survey responses so as to allow for maximum dissemination and involvement from healthcare workers. We will then proceed to the face-to-face interviews with potential interviewees who wish to participate further in this study.

The fourth phase of this project will be to perform appropriate data analysis on our collected data.

The fifth phase of this project will be to summarise and report our findings, culminating in the submission of the study to the university for evaluation

The final phase of this project would be to modify the study based on evaluation provided. We will then proceed to submit the study to journals for publication. We will also submit the study to the South African National Department of Health for their use.



## Funding

We will not require any funding due to the use of open source and free software to create and distribute the survey to participants. In depth interviews will take place on a free videoconferencing platform such as Zoom or Meet. Software for data analysis such as SPSS is provided by the University of Essex. Once the project has been completed, we will endeavour to submit the article to an open-source journal, where there are no associated publication fees.

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