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**A HOSPITAL-BASED STUDY ON THE APPLICATION OF BLOCKCHAIN
TECHNOLOGY ON DATA SHARING IN ONCOLOGY TREATMENT AND VALUE-
BASED CARE IN NAIROBI COUNTY, KENYA.**

VINITA BALBIR SAINI

ADMISSION NUMBER: 138191

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION
FOR HEALTH CARE MANAGEMENT**

**STRATHMORE BUSINESS SCHOOL
STRATHMORE UNIVERSITY**

NAIROBI, KENYA



APRIL 2023

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree from this or any other university. Furthermore, to the best of my knowledge and belief, the thesis contains no material previously published or written by anyone except where due reference is made in the thesis itself.

Name of Candidate: Vinita Balbir Saini

Signature:



Date: 24th July 2023

Approval

The thesis of Vinita was reviewed and approved for examination by the following:

Name: Dr. John Olukuru

Signature:



Date: 24th July 2023

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Abstract

This study deals with the Blockchain Technology (BcT) application for decentralizing Electronic Health Records (EHRs) data to store patient information, including medical reports, to ensure improved patient care. EHRs are entirely controlled by hospitals instead of patients, which makes it more difficult for patients to seek medical care from other providers using their historical data. Patients are the data subjects and the primary owners of the data; therefore, they should have more say and checks on balances on the providers in how their data is being shared and used. The existing system of storing patient details depends on the organization's servers, thus the need for Blockchain using multi-cloud integration to achieve data interoperability. This study will adopt a quantitative research design whereby Blockchain will design an experiment to establish the relationship between patient perspective, level of trust, and transparency in data sharing for oncology patients and value-based care through processing and analyzing the quantitative data from the private cancer center. This study will adopt a quantitative with various stakeholders in Oncology in Kenya. It will also undertake surveys through questionnaires with the chief oncologist, chief medical officer, nurse manager, lab technician, researchers, and IT personnel. The results showed that blockchain technology has the potential to transform the way health records and data are kept and used to treat and care for oncology patients. By combining and integrating data from various sources, healthcare organizations can enhance value-based care, prioritizing patient outcomes and using data to drive decision-making. Furthermore, evidence-based decision-making by extracting data insights is important for designing data-driven healthcare systems. This study provides valuable insights for healthcare policymakers, providers, and researchers in Kenya and beyond. By prioritizing patient outcomes, evidence-based decision-making, and data protection, healthcare organizations can improve the quality of care they provide and, ultimately, the health outcomes of their patients. Furthermore, by leveraging blockchain technology and other innovative solutions, healthcare providers can improve their services' efficiency, effectiveness, and sustainability.

List of Acronyms

ANT – Actor-Network Theory.

BcT - Blockchain Technology.

BSC – Balanced Scorecard

DPA - Data Protection Act.

EHR - Electronic Health Records.

EMR - Electronic Medical Records.

EPHI – Electronic Protected Health Information.

FGDs - Focus Group Discussions.

HIE – Health Information Exchange.

HIT - Health Information Technology.

KEMRI - Kenya Medical Research Institute.

KENCO - Kenya Network of Cancer Organization.

NCCS - National Cancer Control Study.

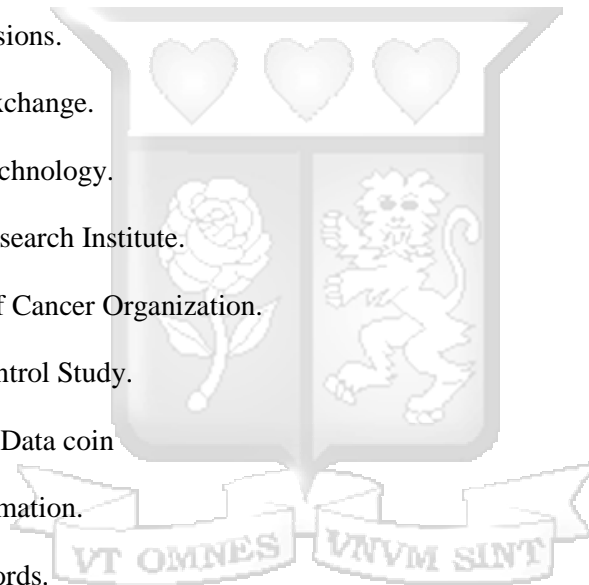
PHD coin – Personal Health Data coin

PHI - Protected Health Information.

PHR - Protected Health Records.

UHC - Universal Health Coverage.

WHO – World Health Organization.



Definition of Terms

Blockchain - is a system for storing and sharing secure information because of its transparency. Each block in the chain is its independent unit containing its information and a dependent link in the collective chain. This duality creates a network related to participants who store and share the data rather than a third party (Chen H. S., 2019)

Cancer - is a generic term for a large group of diseases characterized by the growth and spread of abnormal cells beyond their usual boundaries that can invade adjoining body parts and spread to other organs. Cancer rises from transforming normal cells into tumor cells in a multistage process that generally progresses from a precancerous lesion to malignant tumors. (Arnold, 2022)

Data sharing - As patients can seek treatments in different hospitals and clinics, healthcare facilities must place a system to share data securely.

Electronic Health Records (EHRs) - EHRs are digital versions of a patient's paper medical records and charts that make information available instantly and securely to authorized healthcare practitioners. They contain patients' medical and treatment histories and can store information beyond standard clinical data collected in a provider's office, such as diagnoses, medications, treatment plans, allergies, and lab results (Zhang, 2019)

Interoperability - Interoperability allows two or more systems to exchange information and use the exchanged information. (Zhang, 2019)

Oncology - is a branch of medicine that specializes in the diagnosis and treatment of cancer. It includes medical oncology (the use of chemotherapy, hormone therapy, and other drugs to treat cancer), radiation oncology (the use of radiation therapy to treat cancer), and surgical oncology (the use of surgery and other procedures to treat cancer) (Arnold, 2022)

Smart Contract - Smart contracts are enhancements built atop some Blockchain technologies (such as Ethereum). They are codes that directly control the exchanges or redistributions of digital assets between two or more parties according to specific rules or agreements established between them. They enable the development of a Decentralized app to interact with the blockchain and support on-chain storage (Zhang, 2019)

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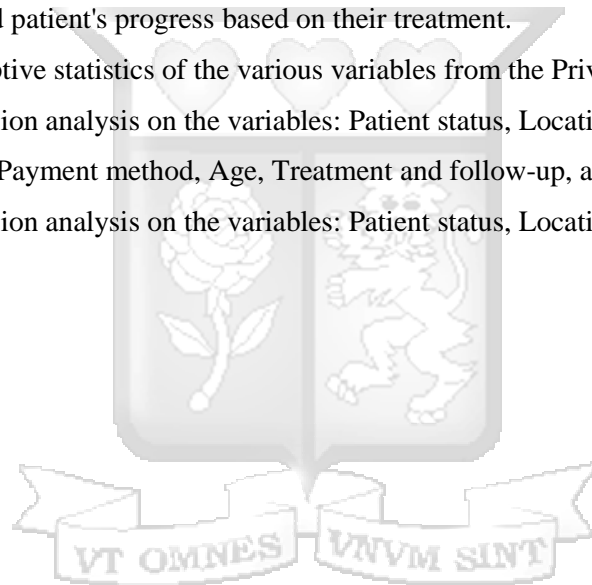
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CHAPTER 1: INTRODUCTION

1.1 Background

According to the World Health Organization (WHO), cancer is Kenya's third-leading cause of mortality after infectious and cardiovascular diseases. Kenya's National Cancer Control Study found that there were about 37,000 new cases of cancer and 28,500 deaths from cancer in the country in 2011. In 2018, the International Agency for Research on Cancer (IARC) Global Cancer Incidence, Mortality, and Prevalence (GLOBOCAN) data projected an increase of 47,000 new cancer cases and 32,987 cancer deaths in Kenya (Cancer, 2022).

Muinga, (2020) in their study said over the last two decades, digital health systems for hospitals and clinics have been rapidly adopted. Hence it moves away from paper-based storage and retrieval of medical information to digital systems, opening the opportunity for new ways of delivering care and a better understanding of the processes and outcomes of the health service. Kenya is now following this trend and replacing paper-based systems with digital one (Muinga, 2020). Innovative healthcare has shown a significant reduction in mortality rates and cost of healthcare while improving quality by reducing emergency room (ER) visits and hospital stays. Healthcare records are best stored in the cloud to enable easy access and sharing of information among the different stakeholders (Alhadhrami, 2017, November). The author further discussed that the security and privacy measures offered by the cloud increase the resiliency of data; however, cloud storage does not allow interoperability between the different care providers. In addition, the integrity and authenticity of the data cannot be guaranteed; one possible technology to enhance the integrity, authenticity, and consistency of stored and exchanged medical records is Blockchains (Paul, 2019).

Blockchains can guarantee the security of sensitive data by tracking access to confidential medical records and ensuring authorized access (Alhadhrami, 2017, November). Blockchain can serve as a distributed database that hardens medical reports against tampering. As a distributed trusted mechanism, Blockchains address security issues associated with a deployed distributed database of patient records which can be managed by different advisories such as caregivers, hospitals, pharmacies, insurance companies, regulators, and the patients themselves (Mounde, 2021). Blockchain technology can apply to accessing and sharing patient medical records (Chen H. S., 2019). Medical records can be challenging to access because they are distributed across different healthcare facilities, and blockchain can give patients full and secure access to all their documents and medical history.

Blockchain technology can help improve global health equity and universal health coverage (UHC). It could also help reduce cancer deaths in the future. Blockchain enhances data security, interoperability, precision medicine, data quality, transaction costs, and access to patient data in a safe and distributed way (Thomason, 2021). UHC ensures that people have access to needed health services (like prevention, promotion, treatment, rehabilitation, and palliation) of high enough quality to be adequate. Furthermore, using these services does not put people in a financial bind (Paul, 2019). UHC is the best way to improve cancer outcomes and make the world fairer. It does this by ensuring that as many people as possible can access good services and protecting their finances before adding new services. (Mounde, 2021)

1.2 EMR in Healthcare

Dubovitskaya, (2017) in their study said Electronic medical records (EMR) are critical but highly sensitive private information for diagnosis and treatment in healthcare, which needs to be distributed and shared among peers such as healthcare providers, insurance companies, pharmacies, researchers, and patient's families, among others. It poses a significant challenge in keeping a patient's medical history current. Sharing of medical records between participants is very challenging because the data might be revealed or tampered during the operational process (Usman, 2020). The author further discussed how blockchain-based electronic medical records management system for efficiently storing and sharing the medical records. This solution ensures the security and privacy of patient's medical records by using permissioned blockchain platform. Usman, (2020) further said that the patients can play an active role in the management of their medical records and can control who can add new records and can view their medical history.

Electronic Health Records (EHRs) are stored and shared in Kenya using cloud infrastructure or local centralized systems. Dubovitskaya, (2017) in their study said that hospitals and healthcare companies must keep data on-site in structures and databases managed locally because of the centralized systems. However, centralized systems face challenges such as patients not owning the data and having no control over it; patients should own and control their data; information becomes scattered as patients seek treatments in different healthcare structures. In addition, (Dubovitskaya, 2017), there are integration and interoperability issues as various hospitals and health facilities have other systems, and sharing health records across additional health facilities is complex and time-consuming. The Kenyan eHealth policy represents a commitment towards using ICT innovations to improve health and wellness of Kenyan. The eHealth policy proposes a comprehensive and innovative approach to addressing a broad spectrum of eHealth practices, research and development that represent a radical departure from traditional healthcare delivery and access models (Mburu, 2018). Moreover, the policy is anchored in the constitution of Kenya 2010, Vision 2030, ICT Policy 2006 and the Health Policy (2014-2030) to accelerate the attainment of Sustainable Development Goals (SDGs) (Makokha, 2019). The

Data Protection Act, 2019 in Kenya aims to regulate the collection, processing, storage, and use of personal data. It establishes principles for data protection and grants individuals' certain rights regarding their personal information. The act applies to both public and private entities that collect and process personal data (Kabata, 2020). Regarding eHealth, the Data Protection Act, 2019 plays a crucial role in supporting data protection and privacy in the healthcare sector. Electronic health (eHealth) systems involve the collection, storage and processing of sensitive health information (Nguyen, 2019). This act ensures that individual's health data is handled in a secure and confidential manner, protecting their privacy rights.



1.3 Interoperability

The Health Information and Management Systems Society defines interoperability as “the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged” (Gordon, 2018). Interoperability has several potential benefits. First, well-communicating systems can improve operational efficiency, reducing time spent on administrative tasks like manually entering data received from faxes. Interoperability can also reduce duplicate clinical interventions like imaging studies or lab orders, decreasing overall health system costs, decreasing waste and improving patient safety by reducing the exposure to radiation or invasive procedures. Finally, interoperability may also improve clinical care, by facilitating improved access to relevant, longitudinal clinical data at the point-of-care (Reddy Jr, 2018)

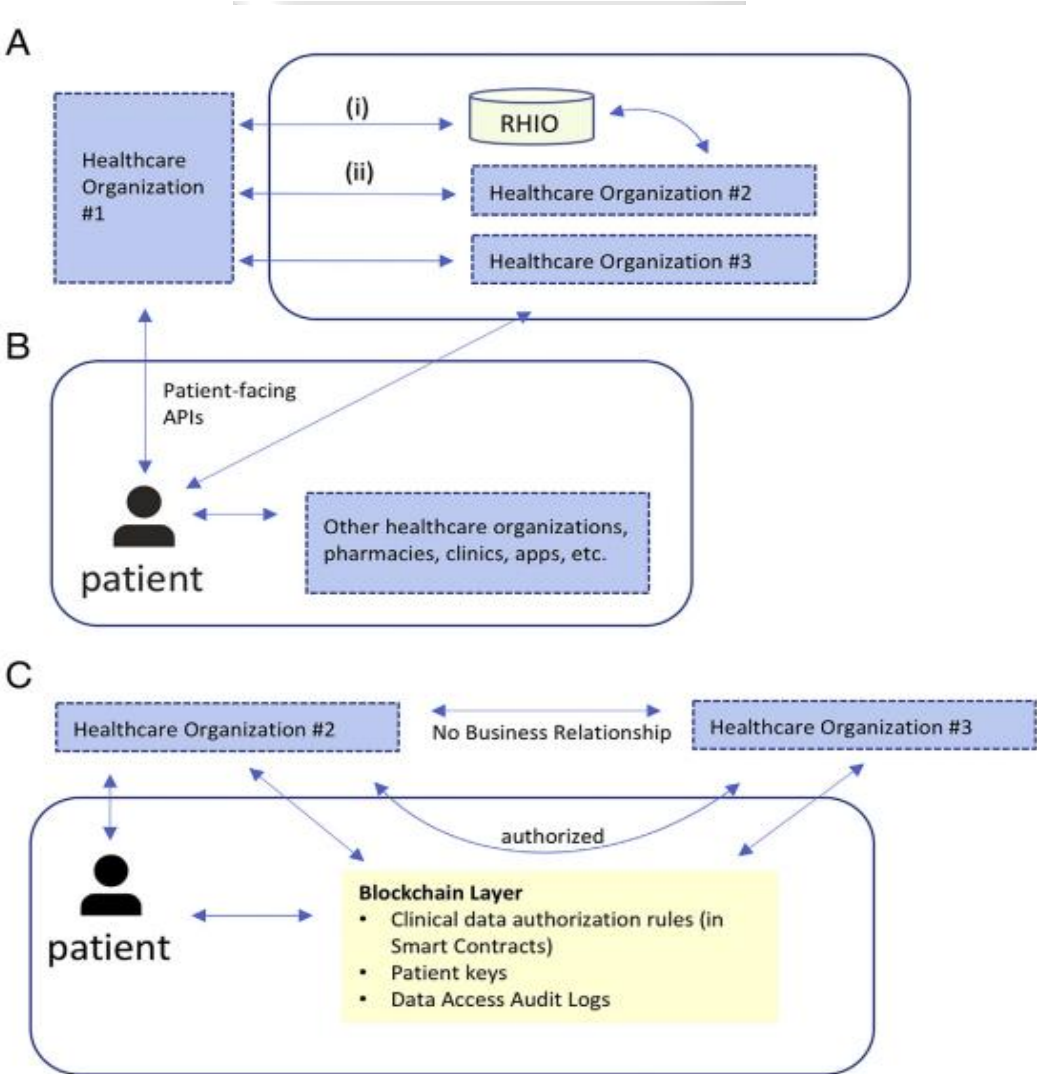


Figure 1.1: illustrates (A) Institution-driver interoperability, (B) Patient-driven interoperability and (C) Blockchain-enabled patient driven interoperability (Gordon, 2018)

Gordon, (2018) figure 1 (A) Illustration of institution-driven interoperability for clinical EHR data. Bi-directional clinical data exchange occurs (i) through an intermediary like a Regional Health Information Organization (RHIO) or (ii) directly between healthcare organizations with specific business agreements. In both cases, data interfaces are entity-to-entity, not entity-to-patient. Since Organization#2 and #3 do not have a specific relationship, there is no bi-directional data flow; providers from Organization #3 can request data from Organization #3 via one-off requests (like a fax). If a patient receives care at all three organization, their health data will be scattered across all three EHRs. (B) illustration of patient-driven interoperability. Data sharing centers on the patient; in this example, patients can directly retrieve their clinical HER data from Organization #1 and Organization #3 using patient-facing APIs. Once retrieved, the patient can share with other organizations directly. Data flow can be bi-directional. RHIO and entity-to-entity relationships may still exist as parallel functions. (C) Blockchain-enabled patient-driven interoperability. The patient can still retrieve data directly from Organization #2; however, blockchain-enabled smart contracts can authorize sharing of clinical EHR data between Organization #2 and Organization #3, which do not have a formal business relationship (Gordon, 2018). The blockchain layer stores these authorization rules, patient public keys (to ensure entity resolution), and data access audit logs. Each organization will manage to link a patient's public key to their internal enterprise master patient index system independently, and patients can update the smart contract-driven authorization rules as appropriate (for example, adding a new institution if they are seeing a new provider)

1.4 Cancer Mortality

Palafox (2018) in their study said that Cancer is one of the leading causes of morbidity and mortality worldwide, with approximately 14 million new cases in 2012. In Kenya, cancer is estimated to be the third leading cause of death after infectious and cardiovascular diseases. Cancer is the second leading cause of NCD-related deaths, accounting for 7% of overall national mortality after cardiovascular disease. The annual incidence of cancer is close to 37000 new cases with an annual mortality of over 28000. The five most common cancers in Kenya are breast, cervical, prostate, esophageal, and colorectal (figure 4). The leading cause of cancer death in Kenya is cervical, followed by breast, esophageal, colorectal, and prostate cancer (figure 5) (Palafox, 2018).

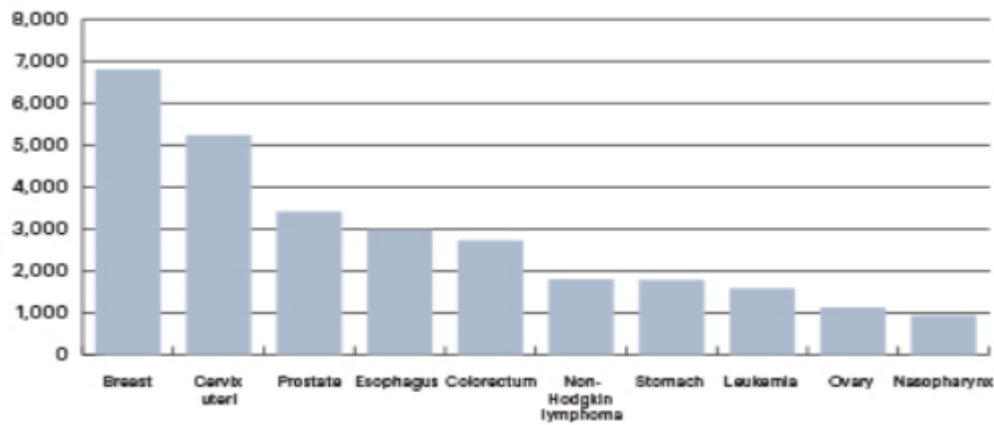


Figure 1.2: Top 10 Cancers by Incidence in Kenya (2020) (Arnold, 2022)

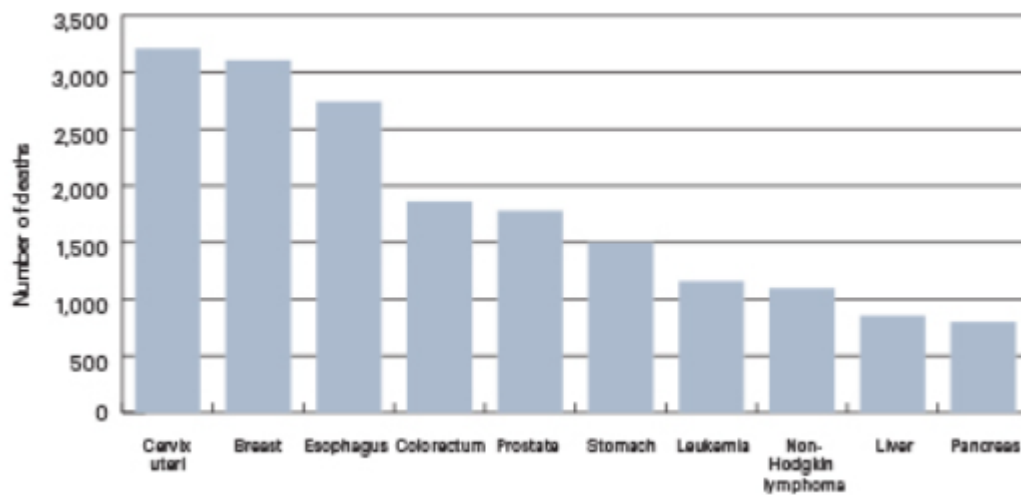


Figure 1.3: Top 10 cancers by mortality in Kenya (2020) (Arnold, 2022).

Due to the complexity of tumors and the number of possible treatments, there are many things to consider when diagnosing and treating cancer. Information from several professionals could help cancer patients get a fresh look at their choices and possibly shorten the time between a possible diagnosis and treatment. Most hospitals in Kenya have a "tumor board" comprised of medical, surgical, radiation oncologists, and other professionals and caregivers (Mounde, 2021). This group discusses specific cancer cases, patients' conditions, and treatment options in depth. However, even though oncologists try harder to get patients and their families to work together, they are still not involved in making decisions. A larger-scale hospital may work with specialists, but a smaller care facility might have fewer resources to expand its tumor boards. Patient disengagement may result in the quality of life that matters to cancer patients being overlooked (Kerr, 2021).

1.5 Problem Statement

Patients and healthcare practitioner are faced with the challenge of accessing, managing, integrating and sharing health records securely. Patients should be able to manage their health records anywhere in the world, keep track of medical background, give access to data and share those with any healthcare professional securely (Attaran, 2022). Current technologies in use by the healthcare industry do not adequately address these requirements due to limitations related to privacy, security and fill ecosystem interoperability.

Cancer is a severe illness that may require long-term treatment and close monitoring for the rest of the patient's life. Patients need to keep track of their medical history and be able to access or share their medical information during treatment and after treatment (Dubovitskaya, 2017). Because patients move around, keeping track of the data created during each visit can be challenging, especially since healthcare data is sensitive. A patient often visits multiple disconnected hospitals (Niranjanamurthy, 2019). Patient must keep a history of all his data and maintain the updates. This leads to situations when required information may not be available. Because the information is unavailable, patients may have to repeat some tests to get lab results. This is common when the results are stored in another hospital and cannot be immediately accessed. Healthcare data is sensitive, and its management is cumbersome (Ramachandran, 2020). Still, clinical practice does not have a privacy-protecting system that makes it easy for patients to follow access control policies. Sharing data between healthcare providers may require significant effort and be time-consuming (Dubovitskaya, 2017).

This is how it works when a cancer patient needs to be moved from hospital 1 to hospital two or from one tumor board to another. First, the patient must sign a consent document stating what information will be sent and who will get it (hospital 2). Then, the information has to be printed and mailed to the recipient. Concept management and data transfer can become complex and inconvenient in this situation. For example, the patient may need to contact the caregiver and sign a consent form in the hospital where he is no longer getting care (Niranjanamurthy, 2019). Also, transferring data can take time, and when a clinician gets the hard copy of a patient's information, they have to re-enter it into the system. This method makes it hard for the patient to control who can access and see his data. This makes it hard to fully picture the patient's historical data life cycle (Dubovitskaya, 2017). Another example would be if a cancer patient required emergency care and was relocated to the ER of another hospital. The ER staff must analyze the patient's medical records to detect possible drug interactions. Additionally, the patient receiving treatment in the emergency room must be disclosed to the patient's main oncologist (Dubovitskaya, 2017). At Hospital 1, a patient with cancer may also see an oncologist. However, if it is a hassle, they might consider receiving

chemotherapy or radiation treatment at a different institution. However, the management of consent and data transfer makes it challenging. It may become difficult and uncomfortable for the patient in this situation. Also, each case of cancer is different and needs as much information as possible to make the best treatment decisions. The more data there is and the more it is shared, the better clinicians can determine how to treat their patients best. Inherited gene mutations are strongly linked to 5–10% of all cancers (Sheikh, 2015). A family history of cancer is vital in determining who needs genetic counselling and testing. Unfortunately, we have a problem with the lack of comprehensive family history records (Niranjanamurthy, 2019).

Ramzan, (2022) in their study said that Blockchain Technology is likely to take medical science to a new level by reducing the monitoring cost, configuration, and availability of a centralized system in the same way healthcare is modified. The authors further said that due to the synchronized digital data availability, the processing time will reduce. Because when a patient enrolls, all of its data will be available (Ramachandran, 2020). Furthermore, patients would not need to worry about another doctor's opinion because of data transparency. Likely, doctors too do not have to worry about giving patients truthful medical history because of the opportunity to imagine recorded real, original and accurate data. Therefore, this study seeks on the application of blockchain technology on data sharing in Oncology treatment and Value-based care (Ramzan, 2022).

1.6 Research Purpose

This study aims to understand how Blockchain could change how health records and data are kept and used to treat and care for oncology patients in Kenya so everyone can access health care.

1.6.1 Specific Objectives

1. To identify the key factors influencing data consolidation and integration from multiple sources in the health sector.
2. To determine relationship between value-based care, trust and transparency in the healthcare industry.
3. To map the distribution of Oncologist, Cancer diagnosis and the characteristics of patients with cancer across the country.
4. To develop policy recommendations to ensure effective data protection in the health sector.

1.6.2 Research Questions

1. What are the key factors that influence data consolidation and integration from multiple sources in the health sector?
2. What is the relationship between value-based care, trust, and transparency in the healthcare industry?
3. How can we effectively map the distribution of Oncologist, Cancer diagnosis and the characteristics of patients with cancer across the country
4. What policy recommendations can be formulated to ensure effective data protection in the health sector?

1.7 The scope of the study

This study will determine the significance of the application of blockchain technology in healthcare records and how it would enhance the treatment and care of oncology patients in Kenya. The modelling for Blockchain for oncology patients would be based on data collected from the National Referral Hospital, Kenyatta National Hospital (KNH) from 2013 to 2022 and the Private Cancer Center in Nairobi from 2018 to 2021. Kenyatta National Hospital (KNH) is a public hospital located in Nairobi, Kenya and is the largest referral hospital in the country (Mbui, 2018). The hospital has a dedicated Cancer Treatment Center offering cancer treatment and care services. The Cancer Treatment Center at Kenyatta National Hospital has a well-established Cancer Department specializing in diagnosing, treating, and managing different types of cancers. In addition, the department offers various cancer treatment options, including chemotherapy, radiation therapy, surgery, and hormonal therapy (Kenyatta University Teaching, 2023). Private Cancer Center, a partnership between HealthCare Global Enterprises Limited and Cancer Care Kenya Limited, is now the first private comprehensive cancer center in the East African region, a collaboration between India and Kenya (parklands, 2023). The Cancer Centre works on interactive consultations between various subspecialties in the Tumor Board to decide on the best possible treatment.

1.8 The significance of the Study

By examining the advantages of Blockchain, this study aims to show how it is essential for attaining value-based treatment for cancer patients. Through proper EMR management, healthcare data protection, patient involvement in managing their health records, point-of-care genomics care management, seamless transitions of care and care coordination, and timely sharing of EHRs (Electronic Health Records) for cancer patients, blockchain will advance UHC.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will present a theoretical review, an empirical review, the research gaps, and the conceptual framework. The theoretical review will present theories related to healthcare information systems. The empirical review will present studies on the benefits and challenges of BcT to the healthcare industry. The research gap will outline gaps in the empirical literature about data sharing in Kenya. At the same time, the conceptual framework will present the hypothesis relation between various features and the target variable.

2.2 Theoretical Review

2.2.1 Health Disparities Theory

Health disparities theories provide framework for understanding the unequal distribution of health outcomes and access to healthcare among different population groups (Arcaya, 2015). Socioeconomic Status (SES) Theory highlights how factors like income and education contribute to disparities, while Social Determinants of Health Theory emphasizes the influence of social factors such as employment, housing, and discrimination. Structural Racism Theory focuses on systemic racism's role in perpetuating disparities, while Intersectionality theory recognizes the compounded effects of multiple social identities (Niederdeppe, 2008). Cultural Competence Theory underscores the importance of cultural understanding in healthcare. These theories help identify, analyze and address the underlying factors driving health disparities, guiding interventions and policies to promote health equity (Arcaya, 2015).

In a global context, the application of health disparities theories and data sharing can contribute to addressing disparities in oncology care and outcomes across diverse populations (Martin, 2019). Data sharing can uncover disparities in cancer incidence, treatment access, and outcomes among different countries, regions, ethnicities, socioeconomic groups and genders. This information can guide the development of targeted interventions and policies to reduce disparities, improve access to cancer prevention, diagnosis and treatment and promote equitable outcomes for all (Organization., 2020). By sharing data globally, policymakers, researchers and healthcare providers can collaborate, exchange best practices, and implement evidence-based strategies to reduce health disparities and ensure that all individuals, regardless of their backgrounds or circumstances, have equal opportunities for optimal oncology care (Arcaya, 2015).

Integrating health disparities theories into data sharing for oncology patients in Kenya can contribute to addressing the unequal distribution of cancer outcomes and healthcare access across different population

groups (Ngwa, 2002). By analyzing and sharing data on cancer incidence, treatment utilization, and outcomes among Kenyan patients, health disparities can be identified, specifically within demographic factors such as ethnicity, socioeconomic status, and geographical location. This information can guide the development of interventions and treatment approaches that are tailored to the specific needs and challenges faced by different Kenyan populations (Ngwa, 2002). Moreover, data sharing can support the implementation of precision medicine in Kenya by including diverse patient populations, allowing for a better understanding of genetic variation and the development of personalized treatment plans (Pereira, 2021). Assessing healthcare delivery through data sharing can help identify disparities in cancer care quality and accessibility, enabling policy makers and advocates can use the evidence generated to drive policy changes and advocate for targeted interventions that aims to reduce cancer-related health disparities in Kenya and promote equitable access to high-quality oncology care for all Kenyan patients (Ngwa, 2002)

2.2.2 Actor-Network Theory (ANT)

Actor-Network Theory (ANT) is a sociological and philosophical framework that focuses on the relationship between human and non-human actors in shaping social phenomena (Vicsek, 2016). In the context of healthcare, Actor-Network Theory (ANT) provides a unique perspective on the dynamics and relationships within the healthcare system. ANT views healthcare as a network of interconnected actors, including healthcare professionals, patients, technologies, policies, organizations, and, more. ANT offers valuable insights into the dynamics and relationships between actors involved in the process (Díaz Andrade, 2010). ANT helps understand how blockchain technology and various actors interact and shape data sharing practices within the healthcare context (Vicsek, 2016).

Actor-Network Theory (ANT) offers valuable into the relationship between data sharing, blockchain technology, and healthcare actors in Kenya (Faraon, 2018). ANT recognizes the active role of blockchain technology in reshaping data sharing practices, emphasizing the importance of both human and non-human actors within the healthcare ecosystem (Díaz Andrade, 2010). It highlights the associations and negotiations that occur among healthcare professionals, patients, technology providers, and regulatory bodies to establish rules and protocols for data sharing using blockchain. ANT also emphasizes the translation processes involved, where stakeholders collaborate to develop governance mechanisms and policies for blockchain-based data sharing in Kenya. By applying ANT, researchers and policymakers can gain a comprehensive understanding of how blockchain technology influences data sharing in healthcare, enabling the development of effective strategies and frameworks to foster secure and efficient data sharing practices in Kenya (Faraon, 2018).

2.2.3 Diffusion of Innovations Theory

Diffusion of innovation theory is used to understand and facilitate the adoption of new treatments, technologies and practices (Dearing, 2009). It helps researchers and healthcare professionals identify factors such as the perceived benefits, compatibility, complexity, and relative advantage that influence the successful implementation and widespread adoption of new treatments and technologies, behavior change, organizational change, telemedicine and digital health, health policy implementation, and patient engagement. By understanding these factors, stakeholders can develop strategies to overcome barriers and accelerate the adoption of beneficial healthcare innovations.

It helps to explain the adoption of new treatments and medical technologies by healthcare providers and organizations, shedding light on the factors that affect their decision-making process (Ward, 2013).

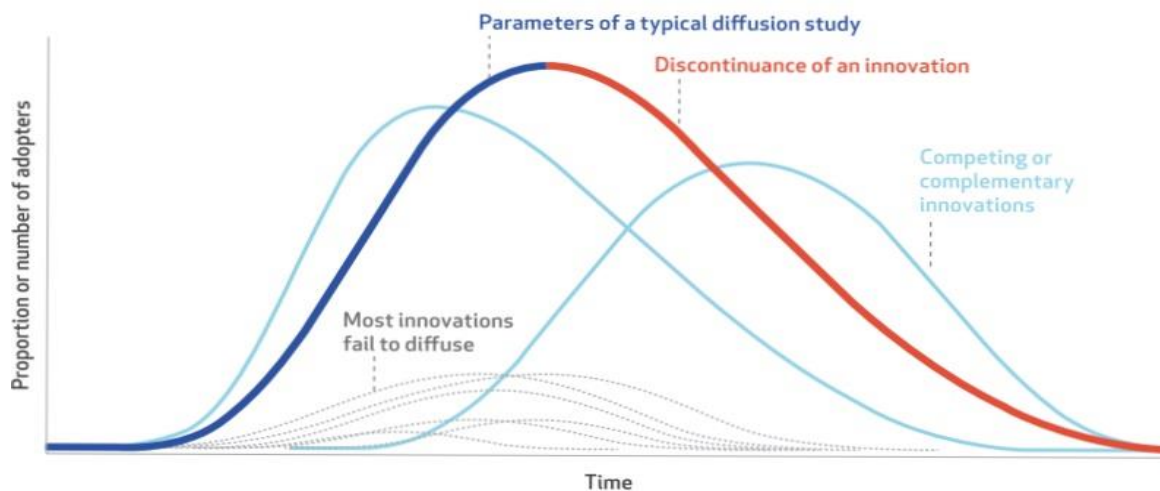


Figure 2.1: Diffusion of Innovation Theory (Ward, 2013)

The diffusion of blockchain technology in the global healthcare demonstrates the stages of adoption as outlined by the diffusion of innovation theory (Reddick, 2019). Increasing knowledge and awareness of blockchain's potential applications in healthcare have been facilitated through research studies, industry conferences, and reports by organizations like the world health organization. Persuasive use cases, such as MedRec and Estonia's e-Health system, have influenced healthcare stakeholders to consider blockchain for addressing challenges in health record management, data security, and interoperability (Dutta, 2020). Implementation examples, like Dubai's Blockchain Strategy and Shivom's genomic data storage, highlight the successful integration of blockchain technology in healthcare systems. The confirmation of blockchain's benefits in terms of data security, privacy, and patient empowerment further encourages its wider acceptance (Reddick, 2019). Factors such as regulatory frameworks, collaborations, and technical challenges impact the

diffusion of blockchain in healthcare globally. Strategies involving education, regulatory support, collaboration, and pilot projects can foster its adoption and realization of its potential in healthcare (Reddick, 2019).

In Kenya's healthcare sector, the diffusion of blockchain technology is evident through various initiatives that align with the stages of adoption in the diffusion of innovation theory (Kar, 2021). Efforts to increase knowledge and awareness of blockchain's potential benefits have been undertaken by the Kenyan Ministry of Health and technology-focused forums, Persuasive use cases, such as Heathland Kenya's promotion of blockchain as a solution. AfyaRekod has raised awareness about blockchain's benefits in healthcare, influencing stakeholders to consider its use (Team, 2020). The company's implementation of blockchain for secure health data management and personalized healthcare recommendations demonstrates the practical application of the technology. AfyaRekod's success contributes to the wider acceptance of blockchain in Kenya's healthcare sector, aligning with the stages of adoption outlined by the diffusion of innovation theory (Team, 2020).

2.3 Empirical Review

2.3.1 Healthcare Information System

Ogwel, (2020) in their study said that cloud computing has emerged as a technological paradigm to reduce information technology cost, foster collaboration while increasing productivity, availability, reliability, flexibility and minimizing response times (Odhiambo-Otieno, 2020). Despite cloud computing offering numerous benefits to the health sector, there are only few successful implementations (Ogwel, 2020). Adoption is slower in healthcare sector compared to other industries. Furthermore, the author said that there is little concerning the adoption of cloud computing in Kenyan healthcare sector technological readiness (skilled in using cloud computing and technological infrastructure), service quality (security and privacy), expert scarcity (availability of deployment experts and availability of integration experts), top management support (adequate budgetary allocation), firm size, perceived usefulness (improved efficiency), perceived ease of use (easy to learn and easy to use to accomplish tasks) and social influence (other hospitals currently adopting cloud computing) were all significant constructs of cloud computing adoption (Odhiambo-Otieno, 2020). Policy, individual difference factors and trust were found to be insignificant predictors of cloud computing adoption (Ogwel, 2020)

Healthcare practices generate extensive data, which can be seen as a data domain where it is regularly accessed, created, or stored daily (Esposito, 2018). Technology can play an essential role in boosting the

quality of patient treatment and reducing costs by using resources such as practitioners and equipment (Esposito, 2018). Different kinds of healthcare technology are used to achieve other objectives, with the ultimate focus on improving patient outcomes and enhancing patient experience in health facilities (Alzahrani, 2020). The use of centralized data storage in health institutions is considered the main limitation standing in the way of interoperability because it is regarded as an issue for healthcare providers where they store all the data/records in a data bank or one central database. The problems that result from using a central storage database are health data fragmentation, lack of quality of data, low-speed access to medical data, and unavailability of system interoperability (Azaria, 2016). Durneva, (2020), in their study, said that although Blockchain presents significant potential for disrupting healthcare, most ideas are in their infancy. With 51% of the research focused on medical information systems such as EHR and EMR and 53% on data security and privacy issues, this review shows that HIT research primarily focuses on using blockchain technologies to address the current challenges HIT faces (Durneva P. C., 2020). The key drivers for using benefit blockchain in Kenya are data security, UHC, data interoperability, and seamless data accessibility. UHC becomes one of the most critical targets given the massive gap in healthcare financing and the low insurance penetration level. Future research can focus on how Blockchain can disrupt patient care and help overcome the challenges in healthcare delivery for oncology by creating decentralized organizations, applications, and services. Emerging technologies will address issues with the current system, including the interoperability of electronic health record (EHR) software, the inefficient and insecure transfer of protected health information (PHI), an inland effective payment system for value-based, and the evolving need for patient-centered care. Creating and implementing a blockchain-based healthcare network can address these problems in a revolutionary way. However, as novel technologies are developed, it is up to clinicians to maintain an accepting yet inquisitive attitude, a willingness to implement new ideas, and a philosophy of feedback rather than absolute dismissal. Here in Kenya, healthcare data interoperability, ownership centralization, and seamless data sharing are still in their infancy (Yaqoob, 2021). Several limitations, including cost, have been the most significant impediments to ensuring this success.

Patients might want a second opinion from a different doctor, such as by going to another country or seeing a different oncologist in their own country (Van der Velden, 2021). The patient's current doctor must give them copies of their medical records containing essential information like their family history, visit history, prescriptions, current diagnosis, and treatment suggestions. And so on. However, once a doctor treats or gets access to patient information, that doctor owns that information forever. Therefore, when patients want a second opinion from a different doctor, they must get their medical records and give them to the new doctor on paper or electronically (Zhang, 2019). This method of acquiring and exchanging medical records is inefficient. It is slow, insecure, incomplete, and may lack context. Also, all of these reports will be sent

to the new provider to avoid delays in treatment. Patients with severe conditions should not be included in the manual data exchange process (Van der Velden, 2021).

2.3.2 Healthcare System in Kenya

Sangale, (2022) studied data protection in processing health data through EMR systems in Kenya. He further argued that the Kenyan health sector has heavily integrated into the EMR system. EMR systems serve as data management tools in health facilities, storing patients' health data for treatment and beyond. The author also informed that the standards and guidelines on implementing EMR systems govern the development and implementation of EMR systems in Kenya. It was developed long before the country enacted the 2019 Data Protection Act (DPA). The author highly suggested revising the standards and guidelines to reflect the DPA holistically. Aligning the standards and guidelines with relevant provisions under the DPA through revision or developing a new set of regulations will strengthen data protection in the functioning and use of EMR systems. The Data Protection Act, 2019 in Kenya aims to regulate the collection, processing, storage, and use of personal data (Staunton, 2020). It establishes principles for data protection and grants individuals' certain rights regarding their personal information. The act applies to both public and private entities that collect and process personal data (Kabata, 2020). Regarding eHealth, the Data Protection Act, 2019 plays a crucial role in supporting data protection and privacy in the healthcare sector. Electronic health (eHealth) systems involve the collection, storage and processing of sensitive health information. This act ensures that individual's health data is handled in a secure and confidential manner, protecting their privacy rights (Staunton, 2020).

The use of Blockchain and AI technologies could be transformative across several key sectors in Kenya including healthcare, agriculture, education and government services (Mhlanga, 2020). The improved efficiency transparency and accountability of Blockchain can considerably benefit government services in which several emerging markets struggle with inefficient legacy infrastructures and an inability to provide citizens with fast, accountable and transparent service delivery (Kingiri, 2019)

2.3.2.1 Current status of Healthcare Record-Keeping and Medical History

The Healthcare industry is very inefficient, where most medical records are still stored on paper and distributed location (Attaran, 2022). They cannot be used to coordinate care, measure quality or reduce medical errors. Healthcare data are digitally collected in diverse point, it is important to extract the best benefits out of this healthcare data without complicating the processes. A crucial challenge facing the healthcare industry is the ability to record and store information easily and economically and share it securely across disparate applications and systems (Paranjape K, 2019). Singh, (2020) The following are characteristics

of the current healthcare records keeping and data collection systems: it relies on the interaction between patient and physician, it keeps failing to take advantage of the data, it creates a long and tedious process of getting healthcare, critical patient information is scattered all over the systems, it lacks critical data availability, therefore many healthcare systems fail to provide the necessary treatment to the patients, it negatively impacts management system as many players are not equipped with the right information for a smooth process and it provides poor healthcare data security and reliability (Pirtle C, 2018)

2.3.3 Data Privacy in Healthcare.

Zyskind, (2015) said that centralized institutions, both private and public, gather sensitive and confidential information. In terms of the data on individuals which has been stored, these individuals usually have little or no control over data and how it is used. The authors suggested that personal and sensitive data should not be trusted by third parties, where they are susceptible to attack and misuse; instead, users should own and control their data without compromising security or limiting companies' and authority's ability to provide personalized services. In their study said that Blockchain's most evident and outstanding benefit is that it removes the need for centralized trusted third parties in distributed applications (Agbo, 2019). By enabling two or more parties to carry out transactions in a distributed environment without centralized authority, Blockchain overcomes the problem of a single point of failure, which a central authority would otherwise introduce, as illustrated in *Figure 6*. The authors further suggested that it also improves transaction speed by removing the delay introduced by the central authority. At the same time, it makes transactions cheaper since the transaction fees charged by the central authority are removed (Zyskind, 2015).

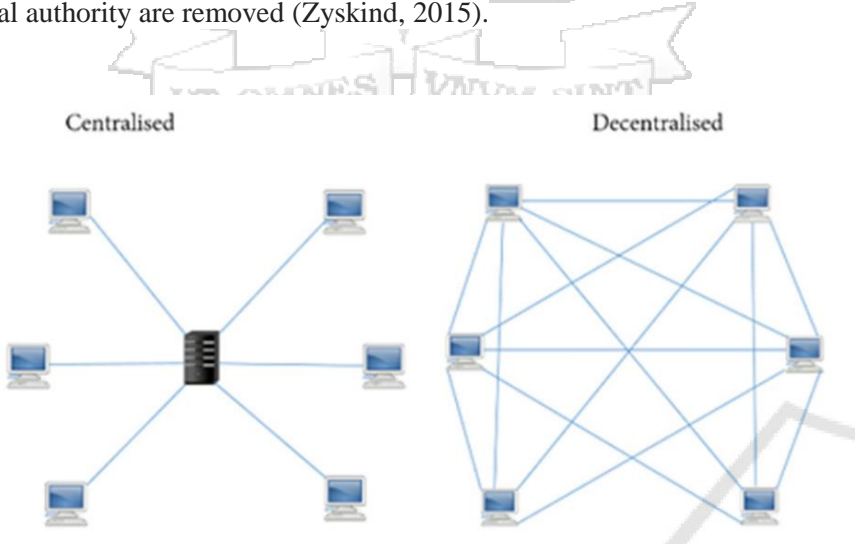


Figure 2.2: Centralization Vs. Decentralization (Zyskind, 2015)

2.3.4 Data Security in Healthcare.

Healthcare organizations are often the targets of sophisticated cyber-attacks due to the depth of information stored by healthcare providers (Kiser, 2021). Loss of access to patient records and other critical information can be crippling to any provider costing victim organizations millions of dollars. Healthcare organizations are investing in advanced security technologies like better data backups, advanced data encryptions, AI, and real time security platforms to prevent threats before they start posing serious issues (Attaran, 2022). Concerns surrounding data security and patient privacy and the rise in the number of cyberattacks have created a pressing need for better IT security.

2.2.6.1 Blockchain Solution for Data Security.

Blockchain can provide several advantages for healthcare data security. It can curb threats and keep private data out of the wrong hands (Niranjanamurthy, 2019). Blockchain encrypts data when added to the chain and make it immutable and impossible to decipher. It authorizes transactions with a private identification key, known only to the individual. Thus, unlike the healthcare data technology of today, a healthcare provider would be able to access to the blockchain record (Yaeger, 2019). Better data collaboration between providers increases the probability of an accurate diagnosis and the likelihood of successful treatments and enables healthcare facilities to deliver cost-effective care. Blockchain can keep patient information safe and secure while still enable them to share it with any service providers of their choice. It provides proof of ownership of medical records and guarantee authenticity for anti-counterfeiting technique (MB., 2017)

2.3.5 Data Sharing in Healthcare.

Cyran, (2018) discussed that centralized data sharing is currently struggling to fulfil the accessibility, scalability, and security requirements of the healthcare sector. The author is also concerned that providing scalable and secure data exchange is essential to offer patients efficient collaborative treatment and care decisions. Furthermore, patients visit multiple and different clinical institutions during their lifetime; the health providers need to keep their patients' conditions and data updated. The study (Ivan, 2016) said that nowadays, almost all health data is stored in EMR systems, although the data remains non-portable. The author also tells the difficulty in moving and sharing health information securely and promptly harms patient care. He says that entities sharing health records will allow patients to seek care services from different institutions. However, owing health records by providers will make the patient keep coming and stick to the same clinic. In addition, he says that health providers consider patient's medical data to be their property (Flanagan, 2013).

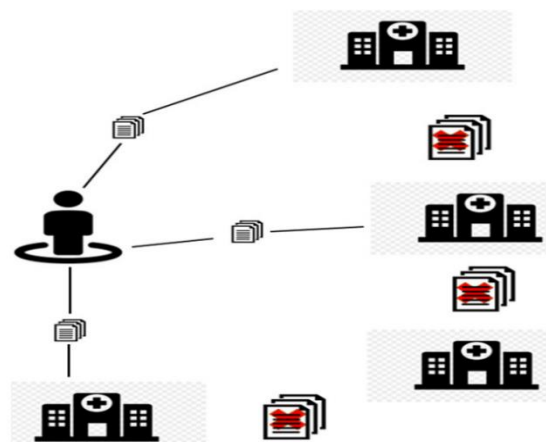


Figure 2.3: lack of sharing data between hospital (Ivan, 2016)

Medical records are digitally stored in a centralized IT system that makes sharing difficult (Attaran, 2022). Requesting, sending, receiving and compiling patient data is tedious, time-consuming and costly. Tech development in medical data management has been very slow due to regulations, incompatible backend systems and fragmented shared medical information. Attaran M, (2022) further in their study discussed that the lack of collaboration and data sharing between the healthcare storage systems make it difficult to transmit, retrieve and analyze data. As a result, most of the data is contained in silos databases and limit patients' ability to engage with their medical history (Flanagan, 2013).

2.2.7.1 Blockchain Solutions for Data Sharing

Blockchain technology could make the process of sharing healthcare data significantly easier and can help end the interoperability problem in the healthcare industry (Attaran, 2022). In the permissioned healthcare blockchain, the patients are identified via their hash ID, which will be their unique and secure the privacy of the user. Patients would oversee sharing the decryption key for their own associated blocks of data with their chosen healthcare provider(s). It enhances security, privacy, interoperability and could put patients at the center of the ecosystem (Paranjape K, 2019). Patients and providers would greatly benefit from accurate, up-to-date and comprehensive medical records.

2.3.6 Factors Associated with Health Data Sharing

2.3.6.1 Trust in Data Sharing

Ancker, (2012) suggested that trust relationships are essential for digital health infrastructure. Consumers are expected to permit their ePHI to be accessed and shared, and providers and organizations are expected to be responsible for the safe and secure storage, use, and exchange of ePHI. Factors that contribute to Trust

relationships are; the perceived trustworthiness of other people/ local businesses/ large corporations and government, Trust in providers to use the minimum set of information necessary, the belief that providers will keep data private and secure in their databases, the knowledge that providers act on behalf of patients and in their best interest when information is used and shared, and consumer awareness that limited information sharing may harm the provider-patient relationship (Schwei, 2014). Platt, (2018) states that it is essential to trust organizations with health information and share it as a unified, integrated health information system. First, because the web of relationships that must function to deliver coordinated care is sufficiently complex, any opportunity for Trust rather than direct oversight of the facility's operations enhances efficiency. Second, Trust is important because there is considerable information asymmetry between the public and the health professionals that control and manage access to health information if the public trusts the health system to act in their best interests (Abdelhamid, 2017). However, this information gap is an acceptable one. And finally, despite hugely robust technology and policy to manage information throughout its life cycle – from collection to analysis to transfer and storage – that can essentially maintain privacy and confidentiality (Platt, 2018). Their study (Platt, 2018) developed a single measure of Trust in integrated health information-sharing systems (i.e., system trust). We examined four dimensions: Fidelity, Competency, Integrity, and Trustworthiness. *Fidelity* captures benevolence; a trustee prioritizes the trustor's needs and interests. At the system level, this means that the organizations that share health information value and prioritize the needs of the public whose health information they have. *Integrity* is defined as honesty or following the principles of nondeception by not hiding mistakes or being fair in treating people. The authors further discussed competency as the ability and expertise to minimize errors and achieve goals. *Finally, trustworthiness* captures an individual's institution rather than their rational or calculative basis for Trust (Abdelhamid, 2017).

2.3.6.2 Transparency of Data Exchange

Transparency generally relates to the right to know and public access to information. Transparency is present when a consumer understands the type of information shared, with whom, for how long, and for what purpose. Consumers want the same level of health data transparency that they have come to expect with their credit card and financial information (Moon, 2017). (Moon, 2017) suggested factors associated with affirmative data sharing preference for data transparency include the availability of audit logs and audit trails, consumer notification when ePHI accessed, decentralized data storage, use of limited data sets for specific purposes, and increased availability of consumer-accessible portable health care devices.

Esmailzadeh, (2019), in their study, suggested five dimensions of fair information practice principles: Notice, Access, Choice, Security, and Enforcement. Notice Principle articulates what health information is collected and exchanged, the purpose of data exchange, how such information will be used internally, and whether

patient data will be disclosed to third parties. The choice principle delineates the consent process and permission requirements. This dimension provides options to patients regarding using their health data and disclosing such records to other third-party entities (Esmaeilzadeh, 2019). For instance, by relying on this dimension, patients can limit the exchange of personal information or voluntarily disclose their medical data for research. The access principal entails granting the right to patients to obtain, review and amend their personal information to ensure data accuracy and completeness (Chang, 2018). Security principle implies adopting reasonable measures and technical security steps to protect health information from unauthorized access, improper use, loss, unapproved alteration, or unanticipated disclosure during data exchange processes. The retention principle clarifies the acceptable duration of keeping and processing shared health information by healthcare providers. Esmaeilzadeh, (2019) further discussed that the dimension articulates the reasonable steps to permanently delete shared personal data if it is no longer required for the consented purpose. Finally, the Enforcement principle highlights self-regulation, such as privacy seals, that informs the public that the exchange procedures correspond to the legal requirements to protect information privacy.

2.3.6.3 Value-Based Care

A balanced scorecard (BSC), a hybrid performance measurement system for analyzing organizational performance, is used in the study to analyze value-based care (Tan, 2017). The BSC balances financial and non-financial measures and has been applied in evaluating organization-based performance. It comprises four performance views essential to an organization's success: finance, customers, internal processes, and learning and growth (Wu, 2012). Wu, (2012) proposed a hierarchical structure for BSC to examine IT payoff in the healthcare sector in his study. This structure considers placing finance and customer at the top (the same level), internal process at the next, and learning and growth at the bottom. However, the author claimed that because other organizational practices were segregated from the IT performance measure, executives might obtain false information about organizational performance while making critical decisions.

Health care sector indicates human-based and knowledge-intensive property (Wu, 2012). The author suggested that the balanced scorecard (BSC) may be feasible to overcome IT productivity. The BSC is a hybrid performance measurement system that considers various organizational practices in measuring organizational performance. It includes four performance perspectives, finance, customer, internal process, and learning and growth, which are critical to an organization's success. The author further suggested that the system balances financial and non-financial measures and provides a set of forward-looking performance indicators linking strategy to specific actions. Meinert, (2018) suggested that Blockchain offers the potential to address issues (e.g., interoperability, difficulty in providing optimal personalized care due to lack of comprehensive medical records, and maintaining integrity records) critical for effective value-based care. The

authors use the Balanced Score Card (BSC) approach as a performance evaluation system. Their approach integrates financial and non-financial perspectives (internal processes, learning and growth, and customer perspectives) (Tan, 2017). Their study (Wu, 2012) proposed a new BSC structure for hospitals, as in *Figure 8* But, again, the customer perspective relocates at the top, while the financial Perspective is at the next. This is because financial performance may not often be the primary goal of non-profit organizations. Instead, the learning and growth perspective constitutes the foundation for success in other organizational practices.

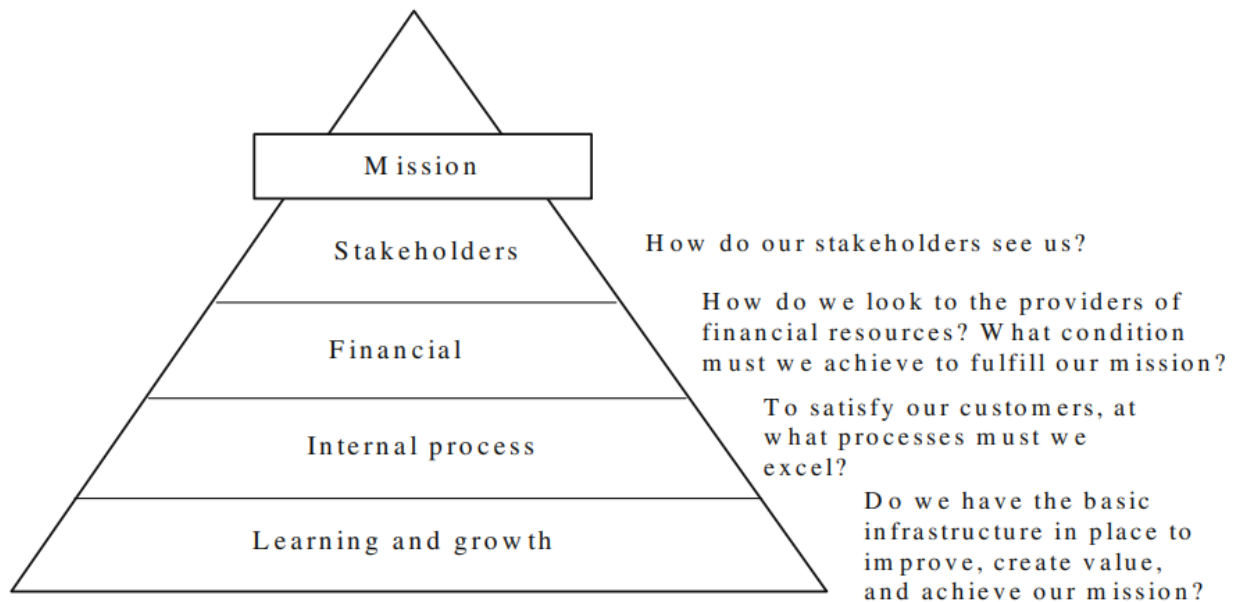


Figure 2.4: The BSC for a non-profit organization (Wu, 2012)

2.3.6.3.1 Customer (Patient) Perspective

Healthcare data should be owned and controlled by customers (patients) quickly and securely without violating privacy (Zhang, 2019). With the help of Blockchain, which simplifies data authentication and authorization, patients can easily and speedily control their medical data access. Blockchain enables healthcare stakeholders to access patients' complete, relevant, and secure data, improving information quality. The authors discussed that Blockchain supports data immutability and auditability, thereby improving the service quality of medical information systems. As a result, healthcare organizations enhance their medical service quality and patient satisfaction. According to the author (Wu, 2012), there are three subconstructs for customer perspectives: healthcare service attributes, customer relationships, and hospital image.

2.3.6.3.2 Financial Perspective

Blockchain's auditability and traceability features enable more secure and efficient revenue management. Blockchain can support healthcare financing tasks, such as automatic claims processing using smart contracts, preauthorization of payments, and alternative payment models (Zhang, 2019). A distributed ledger makes claims processing and payment transactions more efficient and cost-effective. (Zhang, 2019) the authors further also discussed that blockchain technology could help eliminate information asymmetry and mistrust between stakeholders in healthcare. With blockchain technology's inherent immutability, transparency, and traceability, medical products can be traced from manufacturer to patient, reducing medication and medical equipment fraud. According to the author (Wu, 2012), there are three subconstructs for financial perspectives: asset utilization, new revenue opportunity, and profitability.

2.3.6.3.3 Internal Perspective

Zhang (2019) With blockchain applications, healthcare organizations can build time-stamped, tamper-proof, immutable ledger systems that will improve an organization's auditing and reporting capabilities. In addition, organizations can use intelligent contracts to encode internal logic (e.g., validating identity and tracking the participation of various stakeholders such as patients and health providers), which will enhance service quality. Service quality can be reflected in measures such as reducing diagnostic errors, readmission rates, and data security incidents, lowering costs. Wu, (2012) according to the author, there are two subconstructs for internal perspectives: the operations management process and the innovation process.

2.3.6.3.4 Learning and Innovation Perspective

Blockchain enables healthcare stakeholders to learn and improve their services, enhancing their competitiveness and sustainability, according to a (Zhang, 2019) in their study. The system's interoperability enabled by blockchain technology can help healthcare professionals learn about opportunities to innovate their services. The authors further said that the technology also supports organizations in reassessing existing processes and resources and identifying opportunities for improvement. For example, auditability and traceability improved by Blockchain can help streamline insurance claim processes and make them easier to manage. In addition, blockchain can significantly reduce administration costs and potentially eliminate previously needed data integration intermediaries. The authors also discussed that aggregated healthcare data could help healthcare organizations reconfigure their procedures and innovate medical services for patients. In addition, with enhanced traceability and transparency supported by Blockchain, organizations can learn how to optimize the healthcare supply chain. Wu, (2012) the author suggested three subconstructs for learning and growth perspective: Human capital, Organization capital, and Information capital. Wu (2012) The authors

proposed a health sector hypothesis for the links between IT-enabled capabilities and the four BSC performance perspectives.

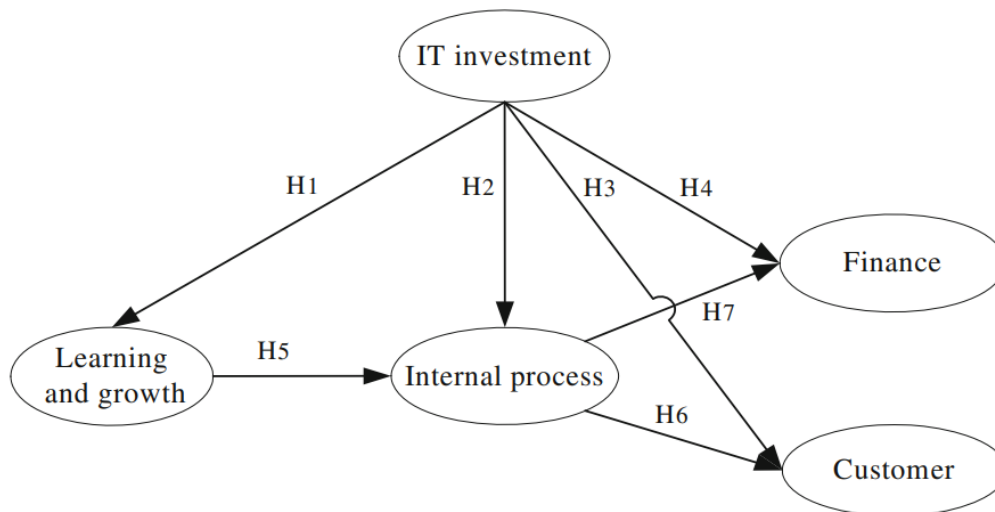


Figure 2.5: Performance Framework (Wu, 2012)

Hypothesis 1: Higher IT investment will help to drive higher learning and growth capabilities.

Hypothesis 2: Higher IT investment will help to drive higher internal process capabilities.

Hypothesis 3: Higher IT investment will help to drive higher customer performance.

Hypothesis 4: Higher IT investment will help to drive higher financial performance.

Hypothesis 5: Higher IT-enabled learning and growth capabilities will drive higher internal process capabilities.

Hypothesis 6: Higher IT-enabled internal process capabilities will drive higher customer performance.

Hypothesis 7: Higher IT-enabled internal process capabilities will drive higher financial performance.

Table 2.1: The Balanced Scorecard measures IT value in the Health Sector (Wu, 2012)

Perspectives	Objectives	Measures
Financial	Asset Utilization	Improve medical instruments or facilitate utilization
		Control occupancy ratio of beds
		Increase the turnover ratio of beds.
	New revenue opportunity	Increase revenue from self-payment medical services.
		Increase revenue from new customer markets.
		Increase revenue from community activities.
	Profitability	Increase return on investment.
		Increase revenue
		Increase profit margin
		Increase market share
Customer	Healthcare service attributes	Improve the availability of medical service
		Improve accessibility of medical services.
		Improve the quality of medical service.
	Customer relationship	Improve patient satisfaction

		Improve medical staff satisfaction.
		Improve administrative staff satisfaction.
		Improve payer satisfaction
	Hospital image	Promote hospital reputation in a customer survey.
		Promote hospital rank in a customer survey.
		Increase hospital recognition rate in a customer survey.
Internal process	Operations management process	Improve administrative process
		Improve the medical service process.
		Avoid medical errors or incidents.
	Innovation process	Identify more innovative opportunities for hospital business.
		Develop innovative medical services.
		Design innovative administrative services.
Learning and growth	Human capital	Improve employee skills
		Improve employee talent
		Improve know-how capabilities

		of employees.
		Provide more opportunities for employee training.
	Organization capital	Improve sharing of work knowledge.
		Improve awareness of the shared vision, objectives, and value.
		Improve the availability of qualified leaders.
		Improve alignment of goals and incentives with strategy.
	Information Capital	Improve the quality of information.
		Improve capabilities of knowledge management.
		Improve accessibility of various information.

2.3.7 Blockchain Technology and EMR in Health Care

Ramzan, (2022) the author in their study said that the process of storing this sensitive data in a safe, secure and scalable manner is a big challenge. Sometimes we need to share or exchange these records. Blockchain provides electronic health records (EHRs) (Shahnaz, 2019). All data and records are stored electronically and we can share the patient information among different healthcare providers through EHR. Blockchain technology consists of six key elements: 1) decentralization: it is an open-access database network system, so everyone can connect with the network through the access key and share, monitor, store, and update the data on multiple nodes or systems, 2) autonomy: Blockchain technology provides an independent and autonomous system. It makes a trustworthy system, you can access, store, change or update data on each node. Nobody can hack your data, 3) Open-source: Blockchain technology provides an open-source system. You can check your record connected to the node and make your applications, 4) Immutable: Blockchain technology is

immutable. Nobody is immutable. Nobody can change your data so easily. When any user sends a request to the node, the transaction is transmitted to all nodes. And provide authenticity. If 51% of nodes approved, the change. So, it is very difficult and impossible for a hacker or unauthorized user, 5) Transparent: Blockchain technology provides a transparent facility to your records or stored data. You can easily update the data, and 6) anonymity: Blockchain technology safe and secure your data (Ramzan, 2022). The exchange or transfer of data node to node, identify individually so that your data is more secure and reliable. Now a days many hospitals and clinics uses blockchain in order to securely store their patient's medical records (Sharma Y. B., 2020). The author further discussed that when a medical record of a patient is generated and tested, it can be added on to the blockchain network, which offers patients with the perfect and assurance that the record cannot be altered. These personalized health records could be encrypted and kept on the blockchain network with a private key, which allows only verified users to access the health records in crucial time, thereby ensuring the privacy of the patient (Ramachandran, 2020).

Blockchain bridges the gap between the existing EHR system showing the secure workflow of patient records and activities. Uddin, (2021) in their study It comprises of seven (7) steps: Step 1: initially, the patient visits the physician (doctor) by registering itself to the hospital counter. This patient data consists of medical history, current problem and other physiological information and is stored in the local database connected to the system. Step 2: An EHR is generated from the initial data collected in step (1) for each patient. Additionally, other medical information such as laboratory test results, medical imaging, nursing care, and drug history-related data will also encompass the EHR. Step 3: The patient who is the owner of EHR has the sole authority to give different access rights and permissions of sharing and using the sensitive information to various stakeholders of the healthcare ecosystems to achieve data privacy and secrecy. Step (4-6): the EHRs have now been stored permanently in the blockchain ledger and other decentralized storage systems. The local database is used to make sure that patient records at initial stage can be modified and stored locally before being updated at the ledger. Step 7: Hospitals are one of the critical stakeholders who have authorized access to the blockchain ledger to provide better and efficient medical services to the patient using the EHRs. This blockchain-enabled EHR system ensures the secure and transparent transfer of EHRs to various healthcare providers in the globe so that the patients records can be made available and accessible any time at any place validated and verified through a distributed ledger (Uddin, 2021)

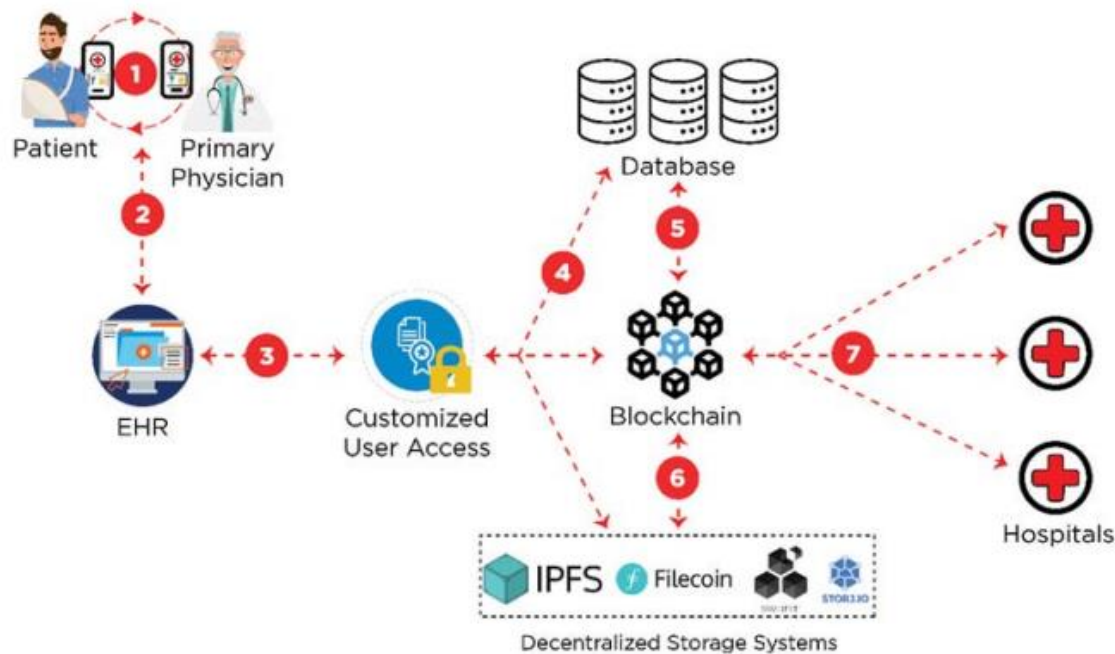


Figure 2.6: Blockchain enabled EHRs management in healthcare (Uddin, 2021)

2.3.7.1 Blockchain Technology (BcT)

Blockchain is a peer-to-peer distributed ledger technology initially used in the financial industry. Based on how the identity of a user is defined within a network, one could distinguish between permission and permission less blockchain systems. Dubovitskaya, (2017) Every user can add a new block to the ledger, even if they do not know the other users. Hence, it is called a permission less system. In a permissioned blockchain, an identity provider controls a user's identity. The identity provider is trusted to track who has access to the network and what rights a user has to reach a consensus or validate a new block (Dubovitskaya, 2017). Blockchain technology makes it possible to be both open and private simultaneously. Each transaction can be seen by anyone who has permission to use the system (Niranjanamurthy, 2019). Still, users can hide their identities or prove who they are. Once a transaction is added to the database, its records are permanent, listed in order of when they happened, and can be seen by everyone on the network. Finally, transactions can be tied to computational logic and programmed. Blockchains have features like decentralization, transparency, and the fact that they cannot be changed, which could be used to improve interoperability in healthcare. People are interested in how programmable Blockchain could help solve significant problems like the slow delivery of clinical reports and broken health record (Niranjanamurthy, 2019).

There are innovative applications of Blockchain in healthcare due to inherent encryption and

decentralization (Niranjanamurthy, 2019). It enhances the security of patient’s electronic medical records, promotes the monetization of health information, improve interoperability among healthcare organizations and helps counterfeit combat medicine (Haleem, 2021). The author further concluded that blockchain potential in healthcare depends significantly on the adoption of associated advanced technologies in the ecosystem. It includes system tracking, healthcare insurance, medicines tracing and clinical traits. Haleem, (2021) the authors also concluded that Blockchain technology would significantly enhance and eventually revolutionize hoe patients and physicians treat and used clinical records and improve healthcare services.

2.3.7.2 Significance of Blockchain Technology

Yaeger, (2019), in their study, said there is a significant challenge in distributing medical records across healthcare platforms, for example, between two independent hospitals. This makes it hard to get accurate health data and makes it hard to share important health information like allergies and medications. However, a health system can combine a person's medical records into a block using new technologies (Niranjanamurthy, 2019). The authors said the block could then be encrypted and stored in nodes across a distributed blockchain. Permitted providers can then access the block remotely and update it with new medical information. This would prevent patients from bringing paper or electronic records to a new healthcare environment, allowing providers to access their medical data on the Blockchain (Yaeger, 2019). Blockchain technology offers a platform that could be used for many potential applications in healthcare (Niranjanamurthy, 2019). Many organizations have proposed solutions that have the potential to increase healthcare data transparency and operating efficiency (Angraal, 2017)

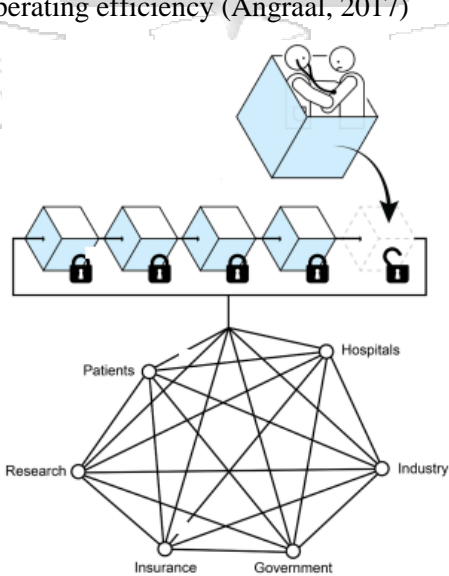


Figure 2.7: Theoretical Schematic of Blockchain Technology in Healthcare (Yaeger, 2019)

During a healthcare interaction, an institution's EMR platform is used to record medical data. The encrypted meta-data results are then put into a single "block." Next, this block is presented to network participants for

inclusion in the blockchain. Finally, the whole chain is sent to everyone in the network to have an exact copy of all the data. The resulting blockchain is decentralized (no central authority owns it), immutable (if one node changes the data in the blockchain, the consensus immediately rejects it), and easy for any network participant to access (Yaeger, 2019). Dubovitskaya, (2017), in their study, discussed that Blockchain provides a unique opportunity to support healthcare. Sharing the ledger among entities (such as medical doctors, medical institutions, insurance companies, and pharmacies) will facilitate patient medication and cost management, especially in chronic disease management. In addition, providing pharmacies with accurate, updated prescription data will improve the logistics. The authors further discussed that access to a shared ledger would allow transparency in the whole treatment process, from monitoring if a patient follows the prescribed treatment to facilitating communication with an insurance company regarding the cost of the treatment and medications (Niranjanamurthy, 2019). Trusted peers would form the network. The peers will run a consensus protocol and maintain a distributed ledger. The patient (or his relatives) can access and manage the data through a web interface. The key management and the access control policy will be encoded in a chain code, thus, ensuring data security and patient privacy (Makokha, 2019).

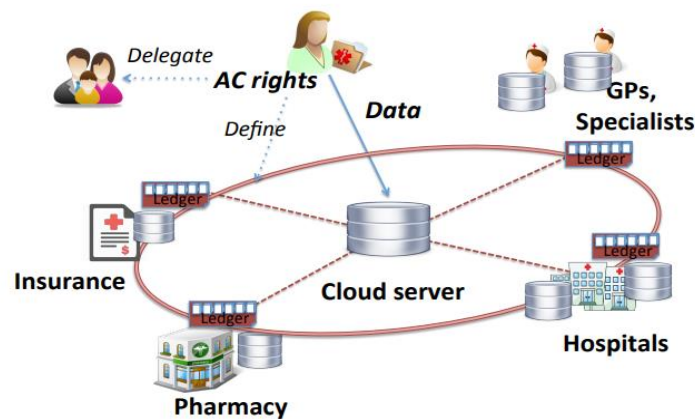


Figure 2.8: Connecting different healthcare players for value-based care. (Dubovitskaya, 2017)

2.3.7.3 Blockchain’s Role in Patient-Driven Interoperability

As interoperability becomes more patient-centric, there is an opportunity to leverage blockchain technology to facilitate this exchange and give patients greater control over their data (Gordon, 2018). Blockchain technology could first improve patient-driven interoperability by managing digital access rules (Niranjanamurthy, 2019). For example, clinical data stored off-chain or on-chain is linked to the public key of a patient. The patient can use properties of the blockchain, like smart contracts, to assign access rules for the data. For example, authorizing release to a research patient registry for a fixed period. The author said that the BcT could foster patient-driven interoperability through data aggregation. A patient connects to different

institutional interfaces with institution-specific logins (like a patient portal) and provides that institution with their blockchain public key and permission to transmit data to the blockchain securely (Gordon, 2018). Done across multiple institutions, clinical data (or references towards clinical data) can thus be aggregated using the technology (Gordon, 2018).

Data liquidity (rapid access) to clinical information is a third major way blockchain technology could improve interoperability in the patient context (Gordon, 2018). High time-sensitive clinical data – for example, advanced care planning “code status” or medication allergies, can be published on a public blockchain, ensuring ready, liquid access to this information as appropriate. A fourth-way blockchain might facilitate the transition to patient-driven interoperability around patient identity. Patients can manage their public keys – perhaps through a multi-sig wallet or mobile device and use the public-key infrastructure (PKI) to establish their identity for retrieving clinical data from the blockchain and adding new information (like home monitoring devices) (Zaghloul, 2020). PKI ensures that providers and institutions can trust that the patient is generating the data. Finally, the importance of data immutability; Clinical data is securely distributed across multiple entities, ensuring integrity, lowering the risk of loss, and offering an audit trail (in case of the malicious actor). Append-only model of blockchain ensures all providers with access to information have a complete clinical picture (Gordon, 2018).

2.3.7.4 Blockchain Based Healthcare Application

Blockchain technology is redefining data modeling and governance deployed in many healthcare applications (Khezr, 2019). Emerging blockchain-based healthcare technologies are conceptually organized into four layers, including data sources, blockchain technology, healthcare applications, and stakeholders (Niranjnamurthy, 2019). Initially, all the data from medical devices, labs, social media, and many other sources are consolidated and create raw data that subsequently grew in scale to big data. This data is the essential ingredient of the whole blockchain-based healthcare, and it is the principal component which creates the first layer of the stack. Blockchain technology sits on the top of the raw data layer that is considered the core framework in pursuit to create a secured healthcare architecture that is divided into four components. Each blockchain platform has different features such as consensus algorithms and protocols (Saraf & Sabadra, 2018). The primary components of the blockchain are smart contracts, signatures, wallet, events, membership and digital assets. For communicating with other programs and frameworks, or even across different networks, a wide range of protocols could be used, this may include for instance, P2P, centralized, decentralized, and distributed. Blockchain-based healthcare applications can be classified into three broad classes. Firstly, data management, including global scientific data sharing for research and development (R&D), data management, data storage (e.g. cloud-based application) and EHRs (Gordon, 2018). The second class represents SCM

applications, including clinical trials and pharmaceuticals. Finally, the third class covers the IoMT, including a confluence of healthcare IoT and medical devices, healthcare IoT infrastructure and data security and AI. Finally, at the top of the hierarchy comes the stakeholder layer, which consists of parties who are benefiting from blockchain based healthcare applications such as business users, researchers, and patient. The main concerns of users at this layer is to effectively share, process and manage data without jeopardizing its security and privacy (Kheizr, 2019).

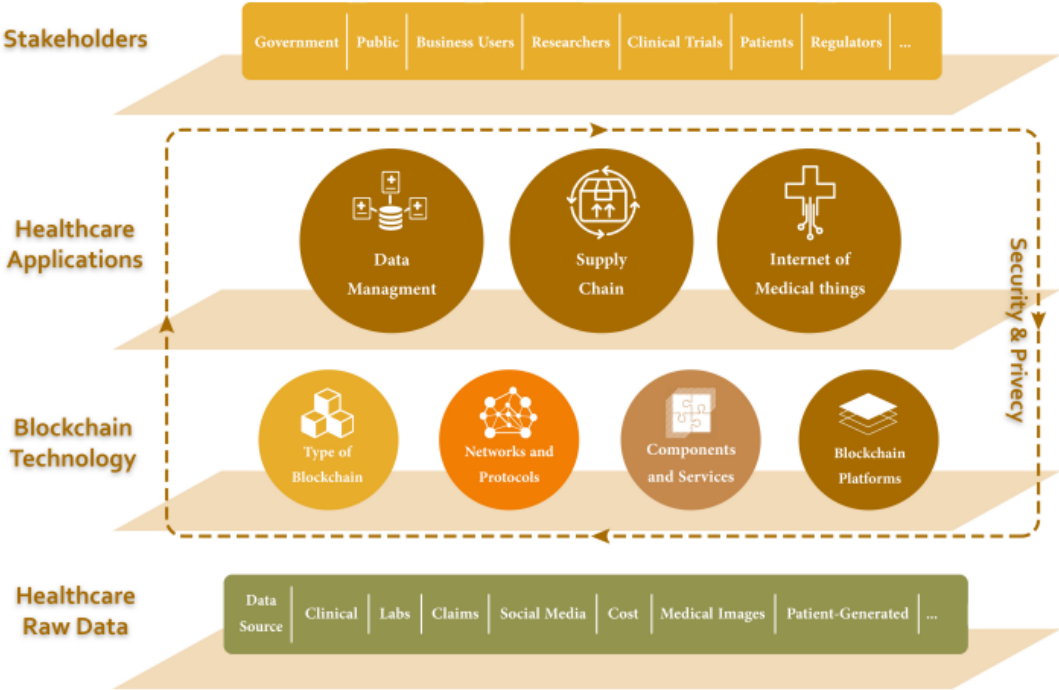


Figure 2.9: A workflow of blockchain-based healthcare applications (Kheizr, 2019)

2.3.7.5 Blockchain-Based Healthcare Data Management System

The following are the steps of Blockchain-based data management system for healthcare (Ramzan, 2022)
Step 1: First, the primary data are generated with the communications of the patient and doctor. This information or data are about patient history, current problems and medications. *Step 2:* In the second place, the EHR collected all information or primary data from the first step, including patient history, drugs or any other included EHR. *Step 3:* The owner of the sensitive EHR is a patient, and the owner also provides customized access control. If someone requires any information, he/she sends a request to the customized access control then the owner decides to give access to data. *Step 4, 5 and 6:* These three-steps are database combinations, blockchain, and cloud storage. Database and cloud storage store the data and information in a distributed manner. However, Blockchain technology provides the facility of security and authenticity using cryptography. *Step 7:* Healthcare providers are a clinic, hospitals or other community healthcare centers and

end-users that want to access the data with safety and security that will be authorized by the owner by a distributed ledger. Blockchain allows healthcare providers to carry on their work at the moment (Zaabar, 2021).

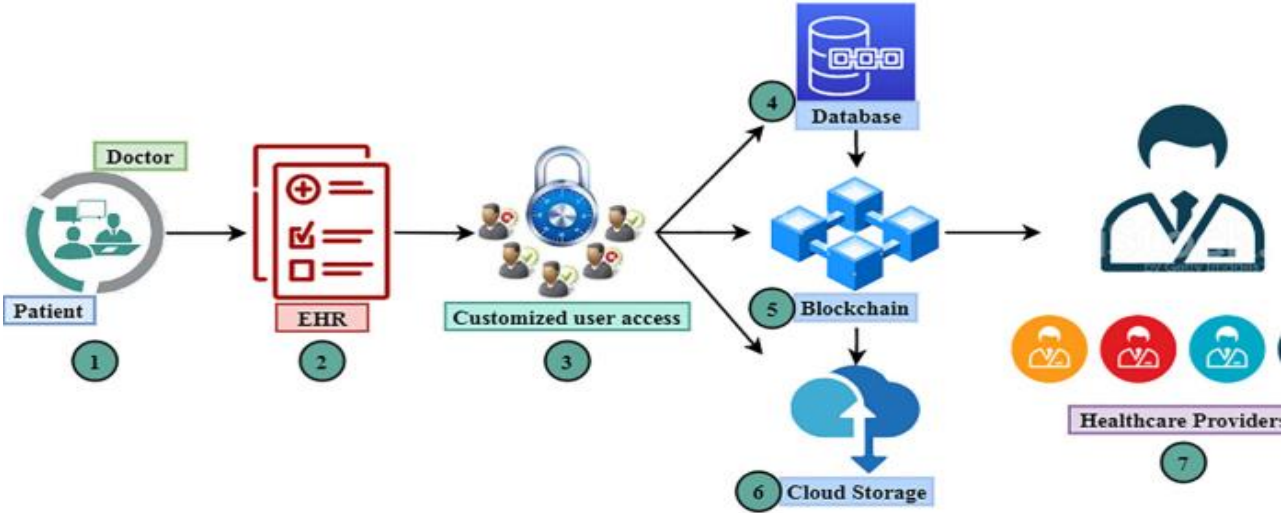


Figure 2.10: Blockchain-based healthcare data management system (Ramzan, 2022)

2.3.7.6 Current Use of Blockchain Technology in Healthcare, Globally

Alzahrani, (2020) discussed how blockchain technology could be used to handle EHR, and they proposed an architecture that could be used to improve the current EHR and the challenges behind its widespread. The authors chose the Ethereum framework to implement the ledger of the proposed changes. They stressed that a person's medical records are the complete information about who they are and must be kept safe. The authors also concluded that every person in the chain would have a full copy of everyone else's medical record. The authors also planned to: strengthen the design of the interface application with login access to allow easy and trusted user interaction; add pointers to get patient databases; deploy on the main Ethereum; and investigate the storage capability of the Blockchain. Dubovitskaya, (2017) developed ideas for how blockchain technology could be used in primary care, medical research, and connected health. First, they discussed how to maintain an immutable and transparent ledger, which keeps track of all the events happening across the network. They also presented the framework's architecture for specific radiation oncology data-sharing needs. Finally, they put it into action, and now they have a prototype that protects privacy, security, availability, and fine-grained access control for highly sensitive data (Chen Y. S., 2018).

A blockchain allows a distributed database where each party can access the entire database and its history. No one party has control over the data, and each party can check the records of its transaction partners directly

without the need for an intermediary. This system allows for peer-to-peer transmission, meaning two peers can talk now or through a central node. Each node stores and forwards information to all other nodes. Iansiti, (2017) In developing countries, health systems are often decentralized, making it hard to centralize information (like national reporting) and share data between nodes (like how a patient is treated at different health service sites). Distributed databases are, by design, intended to address these issues. Mwashuma, (2018) states that Blockchain would be necessary to build a global health ecosystem connecting patients, clinicians, researchers, insurers, and clinical laboratories. The author also said that Blockchain could improve data security, data sharing, interoperability, patient engagement, big data analytics, the exchange of health information, the fight against fake drugs, research processes, and AI-based diagnostics (Mwashuma, 2018).

Ndayizigamiye, (2019) the authors conducted a study in South Africa and came up with a promising conclusion that BcT can enhance healthcare systems by providing a platform whereby transactions are immutable and traceable within a decentralized ledger. The authors argued Blockchain could strengthen South African public healthcare by fostering accountability and transparency in patient-centered services. However, the authors suggested that since Blockchain is a relatively new technology, there is a need for developing standards that define how data is imported from outside the Blockchain distributed ledger. The authors also said there is a need for a regulatory framework that governs when and how a third party can access data within the public healthcare continuum.

2.3.7.7 Current Use of Blockchain Technology in Healthcare, Africa

Imodoye Abioro, CEO of Healthbotics Limited in Nigeria, is a young medical doctor who developed a game-changing solution to advance healthcare infrastructure in Africa. These include Lend an Arm, and Mediverse, Africa's first AI-powered cloud-based Electronic Medical Record system built on the Blockchain. Blockchain has been helpful in terms of the immutability of blockchain records. It is used to store the metadata of each request made. This metadata includes anonymized information like location, time of day, date, etc. Blockchain is also used in their EHR for a similar purpose. Each patient data is stored as a data module with an API endpoint, and the metadata is stored on the Ethereum blockchain, making HER one of the most foolproof for medico-legal reasons (Kotelnikov, 2023).

Kenyan-based AfyaRekod, the first-ever blockchain-based healthcare solution, has launched a fully automated Universal Patient Portal (UPP). John Kamara, the CEO, built a blockchain-based technology to give patients and their medical professional's real-time access to health data and medical history, ensuring effective ongoing medical management and timely information in an emergency. He emphasizes that medical records are a vital tool in managing health, notifying healthcare professionals of medications, chronic illness,

past problems, and procedures, and ultimately allowing them to determine the most accurate course of treatment. He also says that misdiagnosis is a serious misstep and can delay treatment of the actual condition. (Signé, 2021)

2.3.7.8 Challenges of Blockchain Technology in The Healthcare System, Globally

Ahmadi, (2017) did a study in 2022 that shows how blockchain technology could be used in the Malaysian healthcare industry and why it is essential. They concluded that the government, policymakers, and managers of healthcare facilities need to make and change laws, guidelines for medical practice, and policies at the national and organizational levels. They must also change how medical data is shared and who owns it. The authors say that the BcT implication could help the paradigm shift in the healthcare industry by making it easier for stakeholders to work together in the desired way. Also, it could make the healthcare ecosystem more focused on the patient's needs, making patients safer. Durneva P. C., (2020) says that BcT for HIT protects the privacy and security of This improves healthcare quality by enabling interoperability of heterogeneous HITs. Also, security and privacy worries, user resistance, not knowing enough about technology, high implementation costs, and technology problems (such as inefficient consensus algorithms and integrating BcT with existing HIT) can make it hard to use. However, user resistance issues have not been discussed in detail. The study also breaks down EMR/EHR architecture-based research (51%), data security, and privacy-focused research (53%), but it does not say anything about the status of BcT adoption research (Durneva P. C., 2020).

Sharma, (2021) looked at India as a developing country and came up with 15 things that make it hard to use BcT, such as a lack of data storage, standardization, scalability, and high costs at the start and over time. The study also shows that the lack of research on how people use technology is one of the main reason's individuals use BCT. At the organizational level, there are problems with not having enough management support, not having enough infrastructure, not having enough experts, and bad project management. Also, laws about managing medical data need to be changed because they do not work well with Blockchain. Most studies on using BcT in the healthcare industry have focused on the evidence that BcT works (Vishwakarma, 2023).

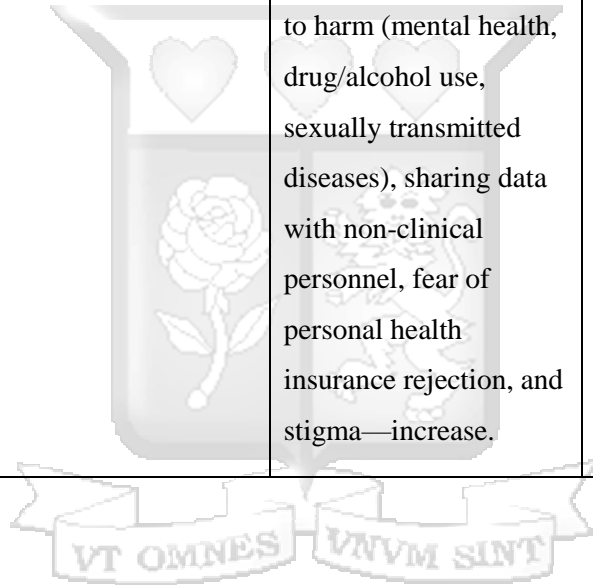
2.4 Research Gaps

Table 2.2: Research Gap

Author	Title	Findings	Research Gap
(Wu, 2012)	A Balanced Scorecard Approach in Assessing IT Value in Healthcare Sector: An Empirical Examination.	IT investments are imperative for hospitals to improve operational efficiency and knowledge management capabilities.	IT performance measures have been isolated and separated from other organizational practices. Thus, executives may receive misleading signals of organizational performance in making decisions.
(Morgan, 2018)	Cancer Act of 2012 (changed in 2015)	The registries can fill the gaps in Kenya's cancer incidence and mortality statistics. Cancer registries will gather data that will assist the nation in monitoring the disease and planning for adequate resources to make it simpler for people to receive a cancer diagnosis and treatment when necessary.	According to NCCS 2017–2022, a national cancer registry is necessary to supplement our data. Kenya's cancer incidence and mortality data currently have gaps that a registry can fill. It will be created to improve and strengthen nationwide cancer surveillance. To accomplish this, however, hospitals in each county must set up cancer registries that

			will use Blockchain Technology to send data into the national cancer registry.
(Tandon, 2020)	Blockchain in healthcare: A systematic literature review, synthesizing framework and future research agenda.	Privacy and information security play a pivotal role in healthcare.	The author advocates policy and service development-oriented research to further safeguard user's privacy and the information stored in blockchain-based systems
(Khezzr, 2019)	Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future research.	Blockchain allows for health records to be time-stamped so that no one can tamper with them after becoming part of the distributor ledger.	The author advocates for future research on regulation, standardization and cross-border health data retrieving policies.
(Attaran, 2022)	Blockchain technology in healthcare: Challenges and Opportunities.	Blockchain can improve access control, interoperability, provenance and data integrity. Blockchain Technology could be used to securely coordinate and combine information from multiple providers, improve patient engagement, help to	Legal and regulatory issues need to be addressed. Blockchain in healthcare today is in its infant stage, but it holds much promise for the healthcare industry.

		<p>ensure availability of patient information, allow direct and secure communication between patients and providers.</p>	
(Dimitropoulos, 2009)	<p>A state-based approach to privacy and security for interoperable health information exchange</p>	<p>When Trust is low, preferences for disclosing harmful data such as those connected to harm (mental health, drug/alcohol use, sexually transmitted diseases), sharing data with non-clinical personnel, fear of personal health insurance rejection, and stigma—increase.</p>	<p>The need for proactive quality lets the recipient weigh their risk tolerance concerning information privacy or confidentiality against their personal experience.</p>



2.5 Conceptual Framework

The figure below demonstrates the relationship between the Independent and Dependent variables in the study.

Factors associated with data sharing
(Independent Variable)

Blockchain Technology

Value-Based Care
(Dependent Variable)

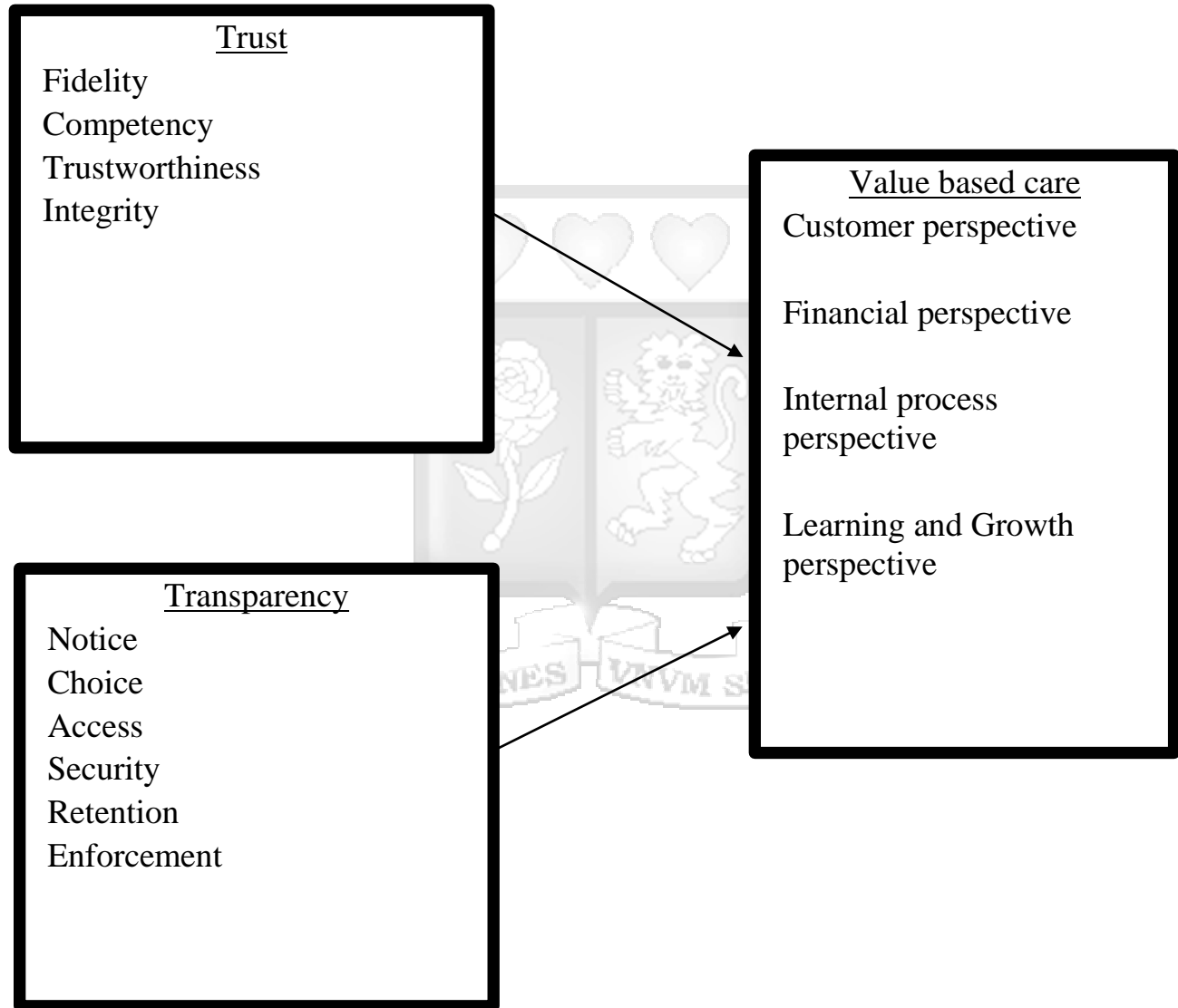


Figure 2.11: Relationship between Independent and Dependent variables (Source:Author, 2023).

2.6 Operationalization of Variables

The table below summarizes the sub-variables considered in assessing their primary constructs, their sourcing, and the level of measurement to be utilized in collecting data.

Table 2.3: Operationalization of Variables

	Variables	Measures	Source
Dependent variables	Value-Based Care <ul style="list-style-type: none"> • Customers Perspective. • Financial Perspective. • Internal Control Perspective. • Learning and Growth Perspective. 	5-points Likert Scale	(Wu, 2012)
Independent variables	Trust <ul style="list-style-type: none"> • Fidelity. • Competency. • Trustworthiness. • Integrity. 	4- points Likert Scale	(Platt, 2018)
	Transparency of data exchange <ul style="list-style-type: none"> • Notice. • Choice. • Access. • Security. • Retention. • Enforcement. 	5-points Likert Scale	(Esmaeilzadeh, 2019)

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the methodology employed in conducting the study. Specifically, it will describe the research philosophy, research design, population, and sample size. data collection methods, Inclusion and Exclusion criteria, data analysis tools, and the ethical considerations of the study.

3.2 Research Philosophy

Research philosophy refers to the adopted strategy for data collection, analysis, and consumption (Abbas, 2021). It is vital when contextualizing how to conduct a study detailing how the researcher will conduct themselves during the study duration (Stoll, 2006). Creswell, (2014) notes that four key philosophies are helpful when researching contemporary research on business subjects. They include positivism, critical realism, constructionism, and pragmatism. This research employed a positivist approach. Creswell, (2014) Notes that in this approach, the researcher is independent, external, and objective of the subject under research. Fatoki, (2014) positivism depends on observations that can be measured to allow for statistical analysis. Positivism was adopted as the underpinning philosophy, where "factual" knowledge gained through quantifiable observation and measurement of quantifiable results leading to statistical analysis was relied upon for observation results. Positivism was associated with a self-understanding of scientific activity in which social science is independent of the reality it describes. The role of the researcher was limited to data collection and interpretation, thereby negating personal values and leading to objective results.

3.3 Research Design

This study adopted a mixed research design whereby Blockchain was used to design an experiment to establish the relationship between patient perspective, level of trust, and transparency in data sharing for oncology patients and value-based care and more over processing and analyzing the secondary data from National Referral Hospital, Kenyatta National Hospital and Private Cancer Centre. Research design focused on the approaches and procedures in data collection and analysis (Creswell, 2014). This study adopted a quantitative study with various stakeholders in Oncology in Kenya. It also undertakes surveys through questionnaires with the chief oncologist, chief medical officer, nurse manager, lab technician, researchers, and IT personnel.

3.3.1 Location of the Study

The study was conducted in Nairobi, the capital city of Kenya, located in the country's central region. Nairobi has over 4 million people and is home to several healthcare facilities, including major hospitals and cancer treatment centers. The study was conducted in public and private hospitals within the city, namely the Kenyatta National Hospital and the Private Cancer Center, all major healthcare institutions serving the local population. The hospitals are located in different parts of the city, each with unique characteristics and patient populations.

3.4 Target Population and Sample Size

3.4.1 Target Population

Target population refers to the entire population of persons, events or objects showing common observable features (Meyer, 2000). The study involved surveying a sample of registered oncologists and their patients. A cursory search of the official Kenyan medical practitioner's database shows less than 100 oncologists are serving 54 million Kenyans in 2020, translating to an oncologist-to-patient ratio of 1:540,000 (Abdihamid, 2022). The registered oncologist population is 100, and the total number of oncologist patients is 540,000. A sample of 80 oncologists have been targeted as respondents to the questions on the questionnaire on the features of Trust and Transparency, and a sample size of 100 public and private healthcare providers, organizations that are already using Blockchain driven healthcare platforms, and research institutions healthcare managers; IT personnel, researchers were target respondents to the questions on the questionnaire on features of Value-Based care.

3.4.1 Sample Design and Sample Size

According to (Kothari, 2004), random sampling is the scientific practice of examining an entire population by investing a subset of the population. The exact size was determined using the sample size calculation formula by Slovin (Kumar, 2020). Where n is the sample size, e is the margin of error (0.05 with a confidence level of 95%), and N is the population of the oncologists under study, 100. Therefore, by substitution, the sample size (n) for oncologists is computed as 80 doctors.

$$n = N / (1 + Ne^2)$$

$$n = 100 / (1 + (100 * 0.05^2))$$

$$n = 80 \text{ Oncologists}$$

3.5 Data Collection and Procedures

Data collection methods enable the researcher to accumulate information about people, objects, or a phenomenon and about the setting in which they occur and are essentially categorized into primary and secondary data collection methods (Abukhait, 2020). The researcher employed primary data, which was collected through structured questionnaires that were self-developed by the researcher. The closed-ended questions were in the Likert scales because they are reliable and give increased data volumes compared to the rest. The questionnaires contained background information about the respondents as well as questions regarding the objectives of the study. Primarily, researchers deal with generating, collecting, processing, cleaning, exploratory data analysis, visualization, and reporting on the results. This study used primary and secondary data; the former refers to information obtained from key informants. Therefore, the protocol for data collection was followed attentively.

3.5.1 Secondary Data Collection

Secondary data was collection through readily available information from the Private Cancer Center and the National Referral Hospital, Kenyatta National Hospital (KNH), was used in modelling to determine critical components recommended for data sharing.

3.5.1.1 The Private Cancer Center

The data had datasets for the following years and months: 2018: Jan – Dec 2019: Jan – Dec 2020: Jan – Dec 2021: Jan, Sept-Dec. All the above datasets were merged into one dataset to prepare the data for data cleaning steps. Filtered out the following dates: 21/10/2002, 03/01/2022, 11/03/2010, and 15/10/2010, as it appears these are typos since they do not cover the data ranges specified above and they had no information on the other column variables. The patients' confidential information (Name, telephone contacts, and email addresses) was removed for data protection. The dataset's scan date, start date, and end date variables were present to monitor the treatment progress; however, these variables had an average of 88% missing values and were thus removed from the merged dataset. Several errors in some variables, i.e., spelling errors in the location names and clinical diagnosis, were amended accordingly. Converted the name of the 'County' variable to 'Location' as it also contained names of other countries.

The variables used for the private cancer center data set are:

Variable name	Short description
Date	Date of entry
CCK No.	Patient unique identity
Gender	The gender of the patient (Male, Female)
Location	The patient's residence
Age	The patient's age
Doctor Name	The name of the attending doctor
Referral From	The name of the doctor/clinic/hospital from where the patient has been referred or first seen.
Clinical Diagnostics	The type of cancer the patient was diagnosed with.
Treatment	The type of treatment given to the patient. This variable was merged with the RX and Technique variables as they contain the same content, i.e., treatment.
Payment	The type of payment used by the patient to pay for the services.
Pt Status	Type of patient (New or Referral)
RT Fractions	The dosage is given to patients undergoing radiotherapy treatment.
Treatment Follow-up	The steps were taken following the first treatment to check on the patient's status.

Table 3.1: Variables used for the private cancer center data set

3.5.1.2 The National Teaching and Referral Hospital, Kenyatta National Hospital (KNH)

The National Teaching and Referral Hospital data was from records covering 2013 - 2022. The cleaning steps corrected the years' value as some had five values instead of 4. The variables used for the National Referral Hospital dataset are:

Variable name	Short description
Year	Calendar year of entry
DOD	Date of diagnosis
Disease code	The unique identity of the diagnosed illness.
Disease name	The name of the disease (cancer)
Operation Procedure	The treatment received for the diagnosis
Age	The age of the patient.
County	The location of where the patient is from.
Clinical Diagnostics	The type of cancer the patient was diagnosed with.
Gender	The gender of the patient (Male / Female)
Patient Outcome	The outcome of the patient (Dead / Alive)

Table 3.2: Variables used for the National Teaching and Referral Hospital, Kenyatta National Hospital (KNH) (Source:Author, 2023)

3.6 Validity and Reliability of the Research Instrument

3.6.1 Pre-test

A pre-test was conducted before the questionnaire to test the instrument's validity. 10% of the respondents (6 respondents) were used during pre-testing. The data collection instrument was also pre-tested for consistency, timing, accuracy, and reliability.

3.6.1.2 Validity and Reliability of Research Tools

The content validity was ascertained by performing a pre-test to standardize the data collection tool. The university supervisor then validated the Questionnaire before data was collected. Furthermore, the reliability of the Questionnaire was established through a test-retest technique whereby the instrument was administered

twice to the same group of participants during the pilot study. Regarding the qualitative data, the credibility, dependability, confirmability, and transferability of the data were checked with the researcher and the supervisor before the analysis.

3.7 Data Analysis

The analysis process is designed to understand the data collected in context (Ranney, 2015). The quantitative data was analyzed as follows:

3.7.1 Analysis of Quantitative Data

Multiple regression model for the secondary data to determine the critical features of data sharing.

Model 1:

Value-Based Care α fn (Trust and Transparency)

$$Y = B_0 + B_1 * X_1 + B_2 * X_2$$

Where:

Y is the dependent variable, Value-Based Care.

B₀ is the Y intercept/constant.

B₁ is the amount of impact our X₁ has on our Y.

X₁ is the independent variable, Trust.

B₂ is the amount of impact our X₂ has on our Y.

X₂ is the independent variable, Transparency.

Model 2:

Patient Status α fn (Gender, Location, Age, Clinical diagnosis, Payments, Dosage, and treatment & Follow-up)

$$Y = B_0 + B_1 * X_1 + B_2 * X_2 + B_3 * X_3 + B_4 * X_4 + B_5 * X_5 + B_6 * X_6 + B_7 * X_7 + B_8 * X_8$$

Where:

Y – is the dependent variable, Patient Status

B₀ is the Y intercept/constant.

B₁ is the amount of impact our X₁, Location has on our Y.

X₁ – is the independent variable, Location.

B₂ is the amount of impact our X₂, Reference Source has on our Y.

X2 – is the independent variable Reference Source.
B3 is the amount of impact our X3, Gender has on our Y.
X3 - is the independent variable Gender.
B4 is the amount of impact our X4, Clinical Diagnosis has on our Y.
X4 - is the independent variable Clinical Diagnosis.
B5 is the amount of impact our X5, Payment Method has on our Y.
X5 - is the independent variable Payment method.
B6 is the amount of impact our X6, Variable Age has on our Y.
X6 - is the independent variable Age.
B7 is the amount of impact our X7, Treatment and follow-up has on our Y.
X7 - is the independent variable Treatment and follow-up.
B8 is the amount of impact our X8, RT dosage has on our Y.
X8 - is the independent variable RT dosage.

3.8 Ethical Consideration

(Hoyle, 2002) posit those ethical standards are good practices in research undertakings. Therefore, the researcher will be guided by ethical standards to ensure that no rights of any respondents are violated. Before commencement, the Strathmore University Institutional Research and Ethics Committee (SU-IREC) reviewed and approved the study. A NACOSTI permit was also sought. Although the study was conducted in the healthcare context, it was designed not to require individual patient consent. All databases accessed were encrypted during transmission with password-protected access. The research relied exclusively on deidentified data and did not include documentation of patient names, contact information, identification numbers, physically identifiable characteristics, or other established identifiers. Nonetheless, the eligible stakeholders in the Department of Oncology involved in the key informant interviews were asked for prior written consent upon understanding the risks and benefits of voluntary participation.

3.9 Dissemination Plan

The study findings were presented in a report form to the Institute of Healthcare Management (IHM), Strathmore University Business School, for library reference. In addition, all participant counties and the National Ministry of Health may receive copies of the report upon request.

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESEARCH FINDINGS

4.1 Introduction

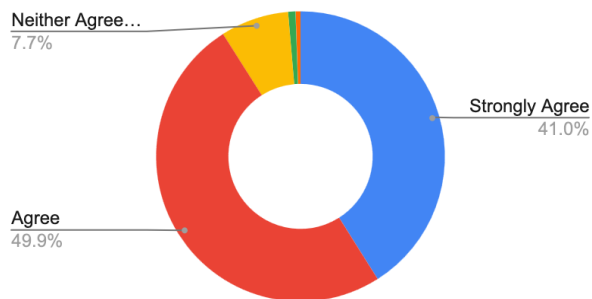
This chapter focuses on the potential of blockchain technology to transform how health records and data are managed and used to improve oncology patient care in Kenya. It discusses the interpretation and presentation of the findings obtained from the field that would enhance value-based care in healthcare organizations. It also discusses a model for evidence-based decision-making that can help empower health industry experts with data-driven decisions with the patient as a priority.

4.2 Response Rate from primary data

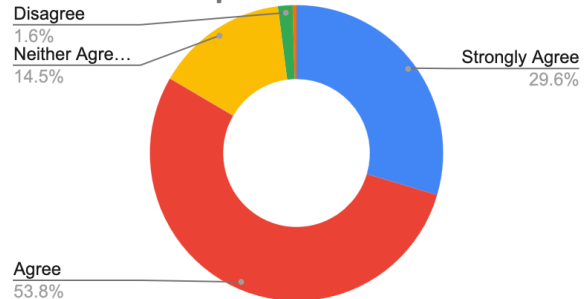
4.2.1 Value-Based Care Responses

The value-based care responses were obtained from questionnaires refer to *Appendix IV* sent to oncologists in Kenya. The questionnaires assessed the organization's performance across four perspectives of the Balanced Scorecard: Customer, Financial, Internal Process, and Learning & Growth. In addition, respondents were asked to rate the organization's performance on a scale of 1 to 5, with 5 indicating the highest level of performance. The results presented in this report are based on the responses received from the questionnaires. Based on the results shown in *Figure 14*, the oncologists who responded to the questionnaires are generally satisfied with the organization's performance in meeting customer needs and expectations, financial performance, and employee development and innovation. However, there may be some areas for improvement in the efficiency and effectiveness of internal processes.

Customer Perspective



Financial Perspective



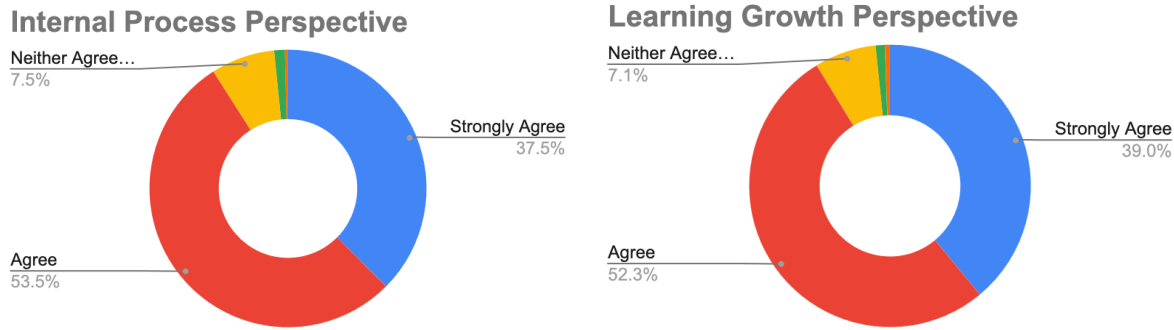


Figure 4.1: Responses received from the oncologists across four perspectives of the Balance Scorecard (Source:Author, 2023).

Referring to *Figure 14* above high score from the Customer Perspective suggests that the oncologists believe that the organization is doing well in meeting the needs and expectations of their patients. This could indicate a focus on patient-centered care and a commitment to improving the patient experience. Finally, the Financial could indicate effective financial management and a focus on achieving financial goals. The relatively lower score in the Internal Process Perspective from *Figure 14* may indicate that the oncologists believe there are opportunities to improve the efficiency and effectiveness of internal processes such as patient care delivery, communication, and information management. It could be an area of focus for the organization to improve patient outcomes and reduce costs. The high Learning and Growth Perspective score from *Figure 14* suggests that the oncologists believe the organization is doing well regarding employee development and innovation. In addition, it could indicate a commitment to professional development, training, and a culture of innovation. In summary, these results suggest that the oncologists who responded to the questionnaires believe that the organization is doing well in some areas but may have opportunities for improvement in others. By addressing areas of improvement, the organization can further improve patient outcomes and achieve its strategic goals.

	Customer Perspective	Financial Perspective	Internal Process Perspective	Learning Growth Perspective
Mean	729	693	483	644
Standard Deviation	862	772	582	773
Median	279	504	180	228

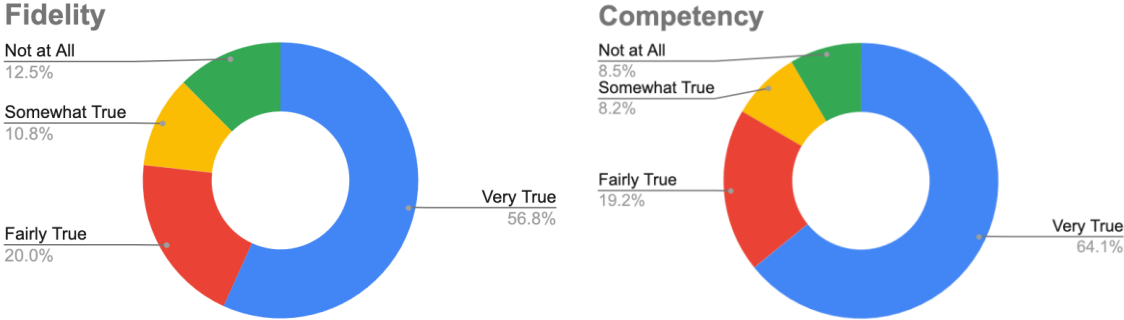
Table 4.1: Descriptive statistics for the value-based care responses (Esposito, 2018) (Source:Author, 2023).

The descriptive statistics for the value-based care response in *Table 6*, with a mean score of 729 and a standard deviation of 862 from the customer perspective, suggest that, on average, the organization performs well in this area. However, the scores have a high degree of variability, indicating that some customers may be more

satisfied than others. The descriptive statistics for the value-based care response in *Table 6*, the mean score of 693 and standard deviation of 772 from a financial perspective, suggest that the organization is doing reasonably well financially, but again, a wide range of scores indicates that some areas may require improvement. Furthermore, the descriptive statistics for the value-based care response in *Table 6*, the mean score of 483 and standard deviation of 582 from an internal process perspective, suggests that there may be some areas of weakness in the organization's internal processes and that there is a significant degree of variability in the scores, indicating that some processes may be working well while others need improvement. Lastly, the descriptive statistics for the value-based care response in *Table 6*, the mean score of 644 and standard deviation of 773 in the learning and growth perspective, suggest that the organization is doing reasonably well in this area. However, there is a high degree of variability in the scores, indicating that some areas of the organization may be more successful in learning and growth than others. The median scores provide a measure of central tendency that can help to give a clearer picture of the typical score within each perspective. However, the fact that the medians are generally much lower than the means suggests that the data may be skewed, with some scores being much higher or lower than the majority of scores. It may be something to investigate further the areas of the organization that are performing exceptionally well or poorly within each perspective.

4.2.2 Trust Responses

The trust responses were obtained from a survey of the general public's opinion of trust in hospitals. The survey assessed hospitals across four metrics: Fidelity, Competency, Trustworthiness, and Integrity refer to *Appendix V*. In addition, respondents were asked to rate the hospitals on a scale of 1 to 5, with 5 indicating the highest level of trust, as shown in *Figure 15*. The results presented in this report are based on the responses received from the survey.



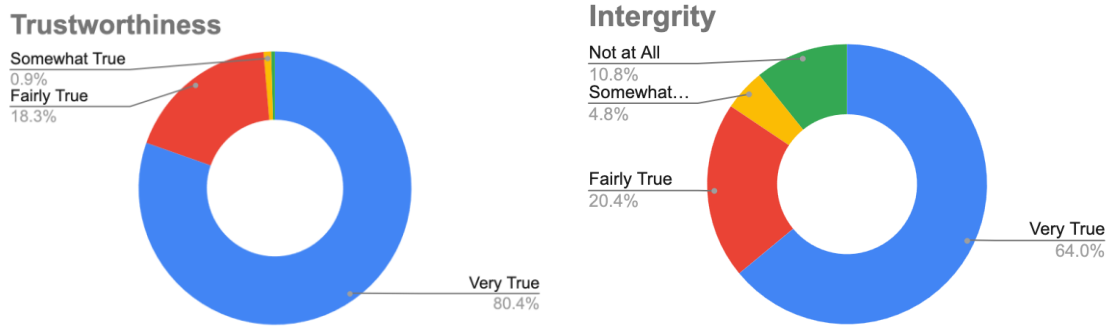


Figure 4.2: Responses from the general public's opinion of the hospital trust (Source:Author, 2023).

Based on these results, the public generally perceives trust in hospitals regarding fidelity, trustworthiness, and competency, although there may be some integrity-related concerns. For example, the high score in fidelity, as shown in *Figure 15*, suggests that the public believes that hospitals are performing well in terms of being faithful to their commitments and obligations. This could indicate a focus on delivering quality care and ensuring patient safety. The score in trustworthiness also shows that the public trusts hospitals to provide reliable care and services, which is essential for building and maintaining relationships with patients and the wider community. However, the lower score in integrity, as shown in *Figure 15*, may indicate that the public has concerns about hospitals' honesty and ethical behavior. This could be an area of focus for hospitals to improve their reputation and regain the public's trust. Hospitals need to maintain high ethical standards to ensure that they remain credible and trustworthy in the eyes of the public. Finally, the score in competency, as shown in *Figure 15*, indicates that the public believes that hospitals are performing well in terms of their ability to provide effective care and services. Again, this could indicate a focus on continuous improvement and adopting best practices and evidence-based approaches to care delivery. These results provide valuable insights into the public's perception of trust in hospitals, highlighting areas where hospitals perform well and areas for improvement. Hospitals can build and maintain trust with the public by addressing these areas of concern and continuing to provide high-quality care and services.

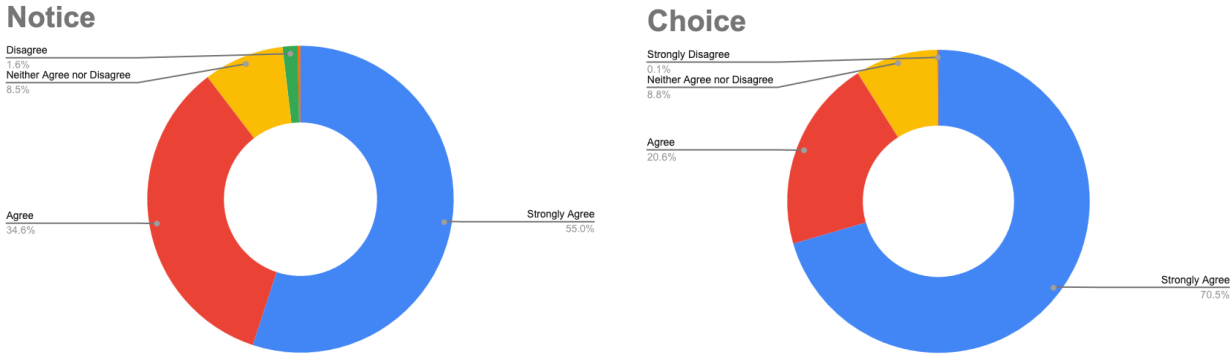
	Fidelity	Competency	Trustworthiness	Integrity
Mean	116	86	111	63
Standard Deviation	100	91	168	67
Median	76	48	43	39

Table 4.2: Descriptive statistics for the trust responses (Source:Author, 2023).

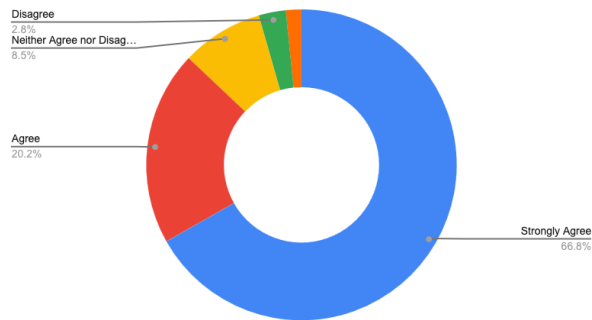
The descriptive statistics for the trust response in *Table 7*, The mean score of 116 and standard deviation of 100 in fidelity, suggest that, on average, the respondents or organizations scored relatively high. However, the high standard deviation means a wide range of scores, indicating that some respondents or areas of the organization may have achieved much higher or lower fidelity than others. The descriptive statistics for the trust response in *Table 7*, The mean score of 86 and standard deviation of 91 in competency, suggest that, on average, the respondents or organizations scored moderately. However, the high standard deviation implies significant variability in the scores, indicating that some respondents or areas of the organization may have achieved much higher or lower competency than others. The descriptive statistics for the trust response in *Table 7*, with A mean score of 111 and a standard deviation of 168 on trustworthiness, suggest that, on average, the respondents or organization scored moderately high. However, the high standard deviation indicates a wide range of scores in this variable. The descriptive statistics for the trust response in *Table 7*, The mean score of 63 and standard deviation of 67 on integrity suggest that, on average, the respondents or organizations scored moderately. However, the high standard deviation indicates significant variability in the scores. The fact that the medians for each variable are generally lower than the means suggests that the scores may be skewed, with some respondents or areas of the organization scoring much higher or lower than the majority of scores.

4.2.3 Transparency Responses

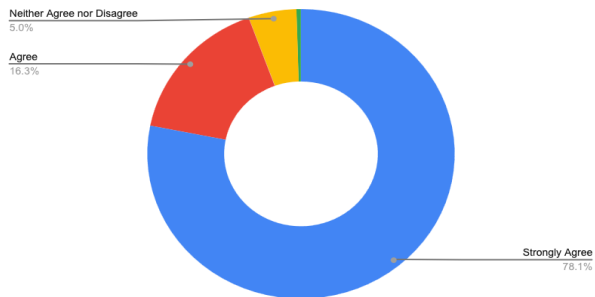
The transparency was obtained from a survey of the general public's opinion of a hospital's transparency regarding patient data protection. The survey assessed hospitals across six metrics: Notice, Choice, Access, Security, Retention, and Enforcement refer to Appendix V. In addition, respondents were asked to rate the hospitals on a scale of 1 to 5, with 5 indicating the highest level of transparency, as shown in *Figure 16*. The results presented in this report are based on the responses received from the survey.



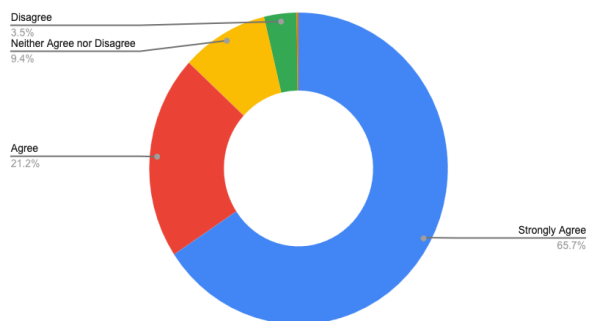
Access



Security



Retention



Enforcement

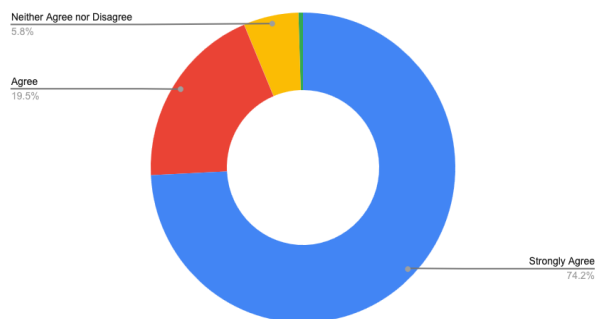


Figure 4.3: Responses from the general public's opinion of hospital transparency (Source: Author, 2023).

Based on the metrics and scores provided, the public has a generally positive perception of a hospital's transparency regarding patient data protection. The high scores in notice, choice, and retention suggest that the public believes hospitals are performing well in notifying patients about their data practices, providing patients with choices about their data use, and retaining patient data. The score in access, as shown in *Figure 16*, indicates that the public believes hospitals could improve in providing patients with easy access to their health data. This is an important aspect of transparency as it gives patients greater control over their data and enables them to make informed decisions about their care. The score in security, as shown in *Figure 16*, indicates that the public believes hospitals could improve in protecting patient data from unauthorized access and breaches. This area is of concern as data breaches can compromise sensitive patient information, leading to negative consequences for patients and hospitals. Finally, the score in enforcement, as shown in *Figure 16*, suggests that the public believes hospitals could improve in enforcing their data protection policies. This is an important aspect of transparency as it ensures that hospitals are held accountable for their data protection practices and gives patients greater confidence in their data security.

	Notice	Choice	Access	Security	Retention	Enforcement
Mean	72	50	41	23	44	27
Standard Deviation	152	201	134	138	136	129
Median	54	60	42	21	48	24

Table 4.3: shows the descriptive statistics for the transparency responses (Source:Author, 2023).

Notice pertains to the extent to which the organization or system provides clear and accurate information to its users. The descriptive statistics for the trust response in *Table 8*, the mean score of 72, median score of 54, and a relatively high standard deviation of 152 suggest that while the organization or system can generally provide notice, there may be some variability in the quality and accuracy of the information provided to users. Choice measures the extent to which the organization or system offers users meaningful data control options. The descriptive statistics for the trust response in *Table 8*, the mean score of 50, the median score of 60, and the high standard deviation of 201, suggest that the organization or system may need to provide more choices to users and possibly enhance the overall user experience. Access relates to the ease with which users can access their data. The descriptive statistics for the trust response in *Table 8*, the mean score of 41, the median score of 42, and the standard deviation of 134 suggest that the organization or system may need to improve its data accessibility to enhance the user experience. Finally, security refers to the measures the organization or system takes to protect user data. The descriptive statistics for the trust response in *Table 8*, the mean score of 23, the median score of 21, and a standard deviation of 138 suggest that the organization or system may need to significantly improve its data security protocols to protect user data from unauthorized access and other security threats. Retention measures how well the organization or system retains user data securely and reliably. The descriptive statistics for the trust response in *Table 8*, the mean score of 44, the median score of 48, and the standard deviation of 136 suggest that while the organization or system may retain user data, there may be some variability in the quality of the retention protocols. Enforcement pertains to how well the organization or system enforces data management policies and protocols. The descriptive statistics for the trust response in *Table 8*, the mean score of 27, the median score of 24, and the standard deviation of 129 suggest that the organization or system may need to improve its enforcement mechanisms to ensure user data is properly managed and protected.

4.3 Regression Analysis on value-based care, trust, and Transparency

Regression analysis is a statistical technique widely used in healthcare research to explore the relationships between different variables. For example, in the context of value-based care, trust, and transparency, regression analysis can be used to identify the factors that influence these key metrics and understand how

they are interrelated. Value-based care is an emerging approach to healthcare delivery that emphasizes the quality of care and patient outcomes over the number of services provided. Trust and transparency are critical components of value-based care, as patients need to have confidence in their healthcare providers and understand the care, they are receiving to make informed decisions.

Variable	Coefficients	Standard Error	T Statistic	P Value
Intercept	8805.19	4947.01	1.78	0.33
Trust	-5.39	5.45	-0.99	0.50
Transparency	-7.42	6.64	-1.12	0.47

Table 4.4: shows the regression analysis on the variables: value-based care, trust, and transparency (Source:Author, 2023)

Therefore, the established multiple linear regression equation referring to Table 9 becomes:

$$Y = 8805.19 - 5.39X_1 - 7.42X_2$$

Where:

Y – Value-based care

X₁- Trust

X₂ – Transparency

The output in the estimated coefficients for the intercept and each predictor variable and their standard errors, t-values, and p-values. Intercept: The intercept (or constant term) represents the expected value of the response variable when all predictor variables are set to zero. In this case, the intercept estimate is 8805.19 from Table 9, which means that the expected value of the response variable is 8805.19 when trust and transparency scores are both zero. It indicates that even when trust and transparency are zero, organizations can still attain Value-based care. Hence if trust and transparency are further achieved by implementing Blockchain Technology, Value-based care would further increase, thus adding value to the operating system of the hospital. Figure 20 shows the Regression Analysis of Value-Based Care, Trust and Transparency

Trust: The coefficient estimate for trust is -5.39 from Table 9, which means that a one-unit increase in the trust score is associated with a decrease of 5.39 units in the response variable. However, the p-value for trust is 5%, which indicates that the relationship between trust and the response variable is not statistically significant at the 0.05 level. Transparency: The coefficient estimate for transparency is -7.42 from Table 9, which means that a one-unit increase in the transparency score is associated with a decrease of 7.42 units in

the response variable. However, the p-value for transparency is 0.47, which indicates that the relationship between transparency and the response variable is not statistically significant at the 0.05 level. Additionally, the multiple R-squared value was 0.57 from *Table 9*, representing the proportion of the variance in the response variable explained by the predictor variables. The adjusted R-squared value of -0.30 considers the number of predictor variables and adjusts the R-squared value accordingly. The F-statistic value of 0.65 and its associated p-value of 0.66 test the overall significance of the model, which in this case is not statistically significant at the 0.05 level. Currently, the coefficient estimate for trust and transparency is a Negative figure. This means people do not believe in it, so the confidence is not there. Hence the need for Blockchain Technology to enhance patient’s trust and transparency as the figure for the coefficient for trust and transparency should be positive. Therefore, based on these results, we cannot conclude that trust or transparency significantly impacts the dependent variable in this model. However, it is important to note that these results may be subject to certain limitations, such as the sample size, measurement error, or omitted variables.

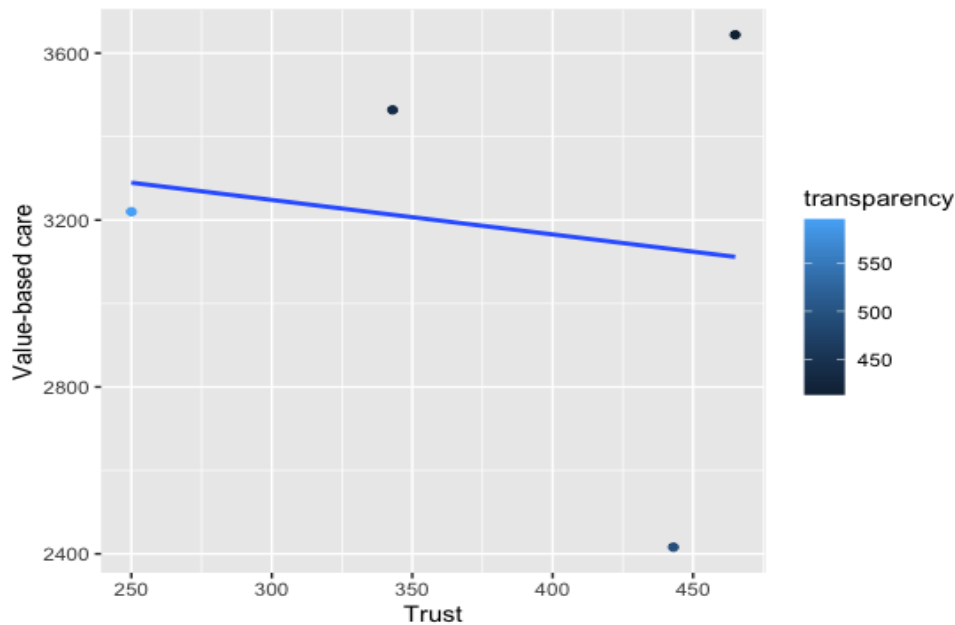


Figure 4.7: shows the Regression Analysis of Value-Based Care, Trust, and Transparency (Source:Author, 2023).

These values were obtained from R software programming.

4.4 Demographic Information

4.4.1 Demographic Information from Oncologists

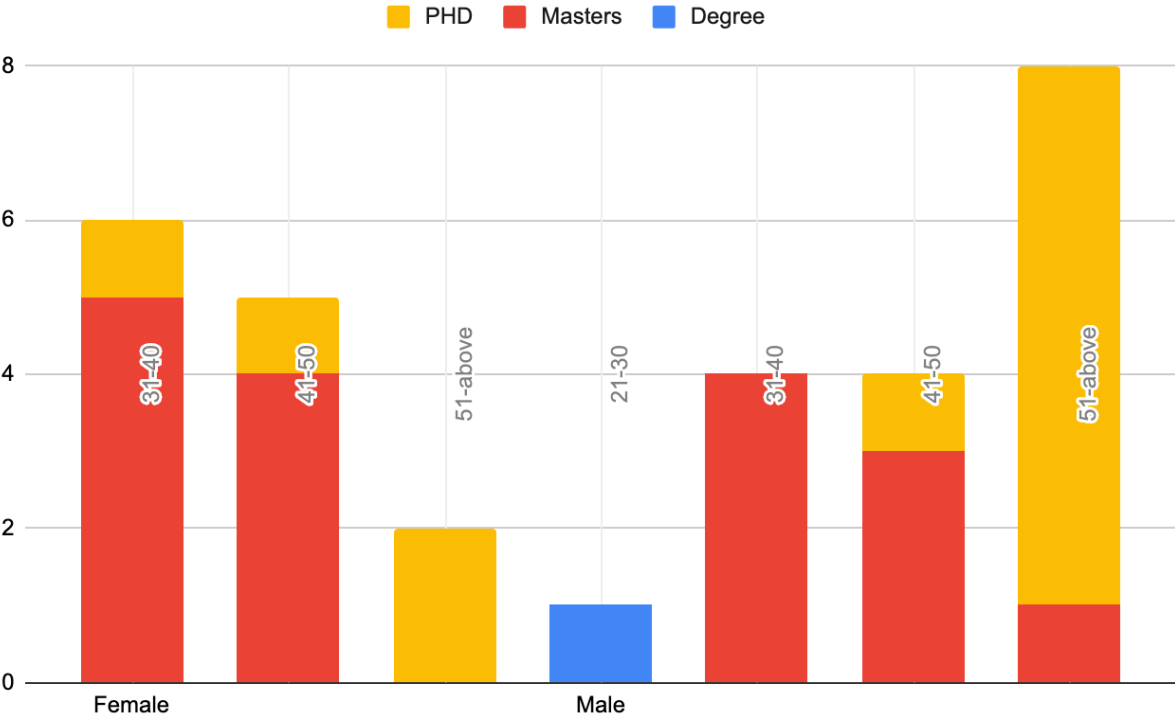


Figure 4.4: shows the highest level of education received for different age brackets, comparing the females and males (Source: Author, 2023).

Based on the results of the survey referring to *Figure 17*, it can be observed that there is a gender and age gap in terms of degree attainment. Females comprise the majority of respondents in the 31-40 and 41-50 age brackets, with nine female respondents holding Master's degrees and 4 with PhD degrees. On the other hand, males make up the majority of respondents in the 51 and above, with only one male respondent holding an undergraduate degree, eight male respondents holding a Master's Degree, and another eight male respondents holding a PhD. Interestingly, *Figure 17* shows a higher number of male respondents holding PhDs in the 51-above age bracket than female respondents. This suggests that barriers may Overall, the results indicated a need for greater gender equality and diversity in higher education and the workforce to ensure that both men and women have equal opportunities for education and career advancement.

4.4.1.1 Demographic Information from the Public

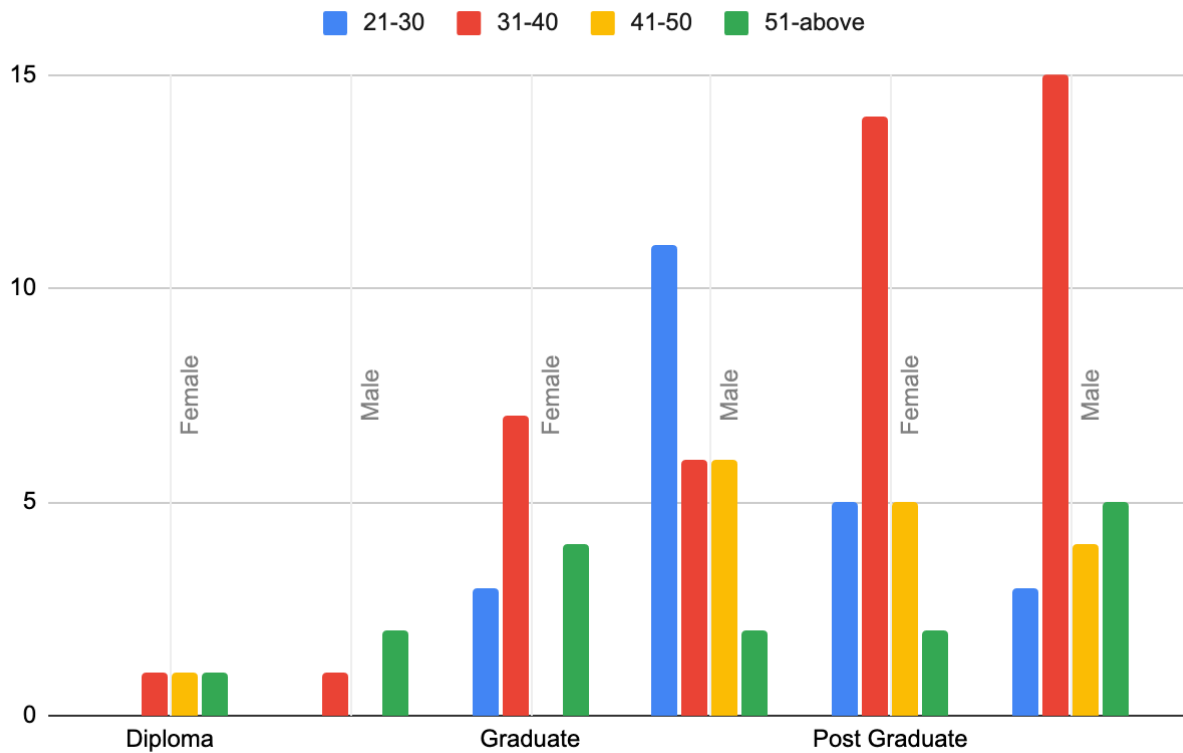


Figure 4.5: shows the distribution of age and educational attainment between males and females (Source: Author, 2023)

Based on the survey results referring to Figure 86, Most respondents are graduates, with a total of 39. Of these, 14 are female, and 25 are male. The age bracket with the most respondents is 31-40, with a total count of 44, followed by 21-30, with 22 respondents. Regarding gender distribution from Figure 18, there are more male respondents than female respondents in all educational levels and age brackets except for the post-graduate level, where there are more female respondents.

4.4.1.1 Demographic Information of Males and Females across various industries and their positions

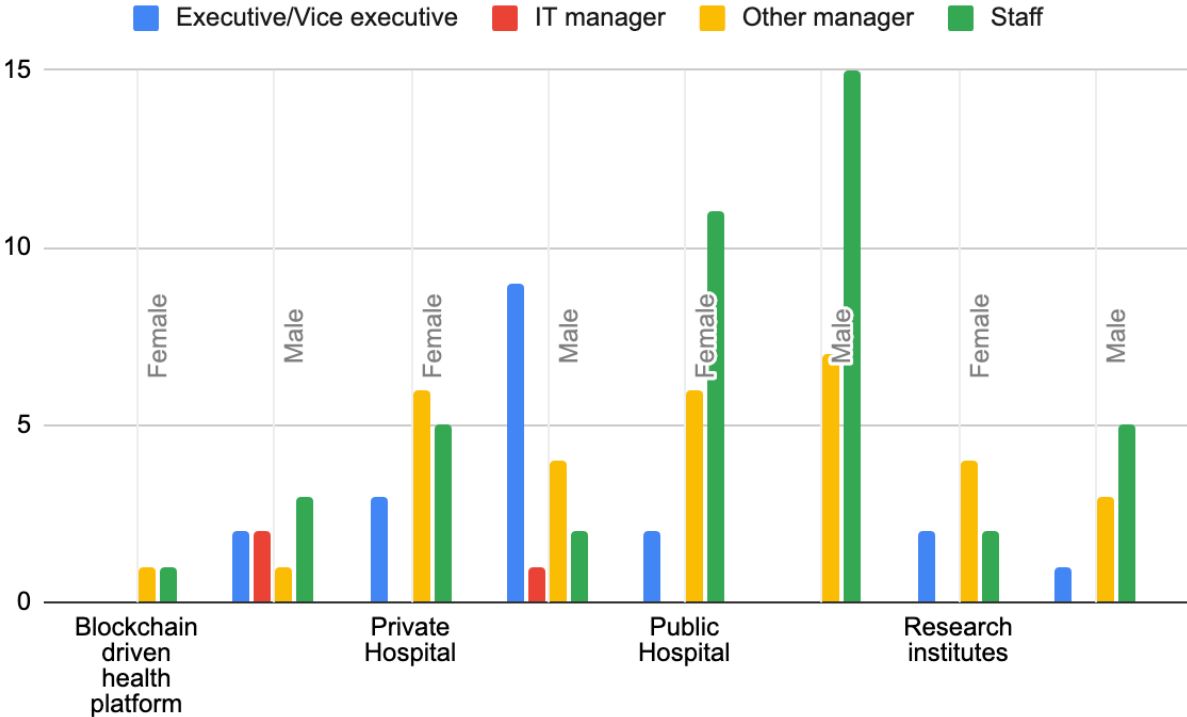


Figure 4.6: shows the distribution of males and females across various industries and their positions (Source:Author, 2023)

Referring to Figure 19, among the respondents, there were more male participants than females across all organizations. The Blockchain-driven health platform had a smaller sample size of respondents compared to the Private and Public Hospitals and Research institutes. Among the Blockchain-driven health platform participants, most respondents held staff positions, while the executive/vice executive positions had the lowest response rate. In Figure 19, the Private Hospital category, the highest number of respondents held executive/vice executive positions, followed by other managers. In the Public Hospital category, the highest number of respondents held staff positions, followed by other managers. In Figure 19, the highest number of respondents in the Research institutes category held other management positions. Again, the Public Hospitals had the highest number of respondents, followed by the Private Hospitals and Research institutes. These interpretations can help us understand the gender distribution and job positions of the respondents across different healthcare organizations. It can also provide insights into the respondents' participation rate and position distribution in each category. However, we cannot generalize these findings to represent the entire population of healthcare workers in Kenya.

4.4.2 Distribution of cancer cases in Kenya using the National Referral Hospital

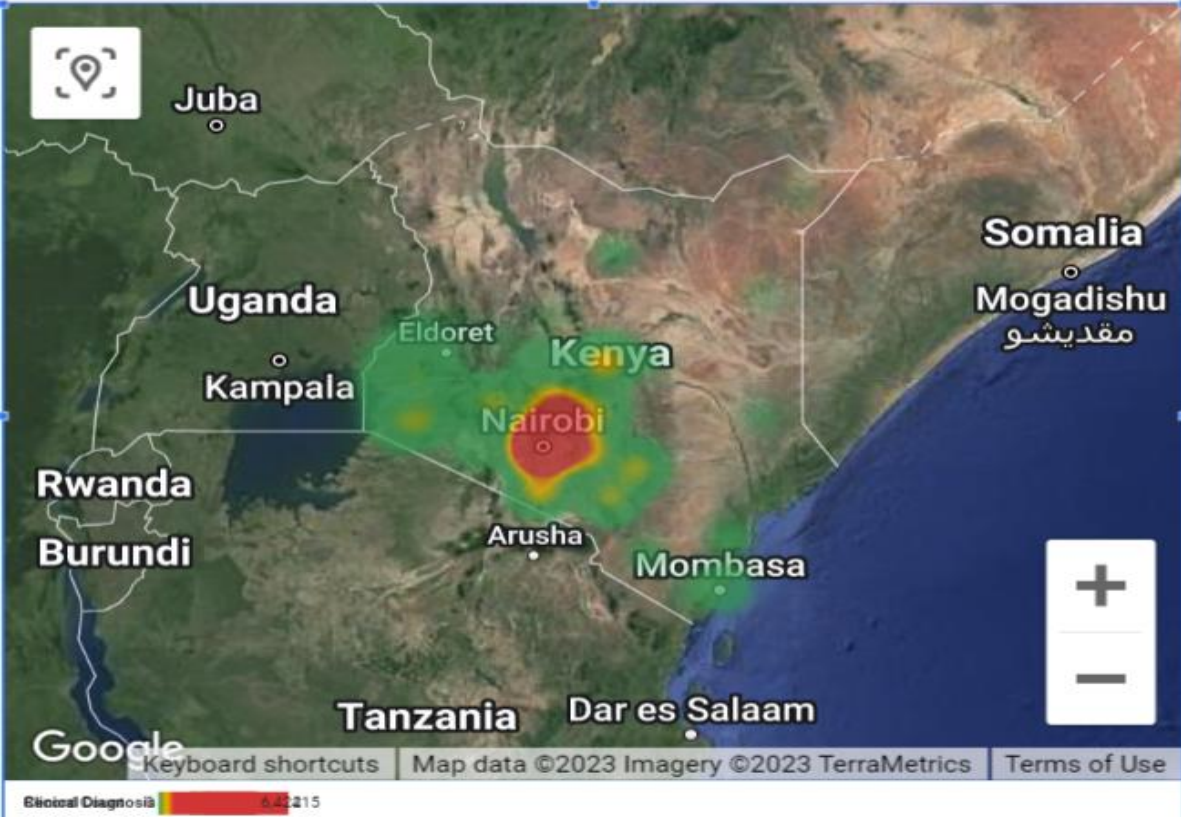


Figure 4.8: shows a map distribution of cancer cases in Kenya using the National Referral Hospital data (Source: Author, 2023)



4.4.2.1 Distribution of cancer cases in Kenya using the Private Cancer Center data set.

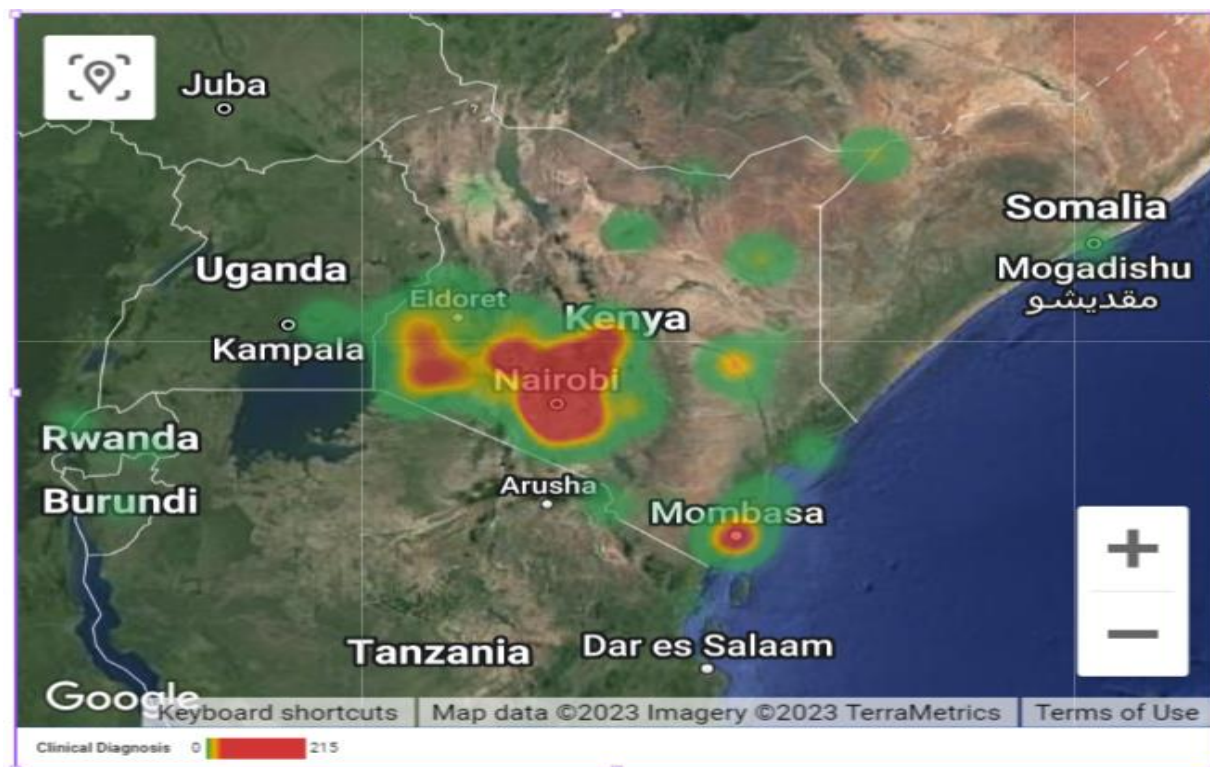


Figure 4.9: shows a map distribution of cancer cases in Kenya using the Private Cancer Center data (Source: Author, 2023)

The data analysis reveals notable differences in cancer distribution between the National Referral Hospital and the private cancer center. For example, figure 21 indicates a high concentration of cancer cases in certain regions, represented by red, while green highlights areas with insufficient attention. Figure 22, representing the private cancer center, also shows a similar pattern, with high cancer cases in Central, Coastal, and Western Kenya. However, it is interesting that Northern Kenya has fewer cancer cases than other regions. This finding raises questions that require further investigation to understand why there is a disparity in cancer cases in this region. It is possible that the lack of access to health facilities or the overall health status of the population in this region could be contributing factors. Further analysis and research are necessary to determine the underlying causes of this trend.

Thus, when patients move from county hospitals to referral hospital its been observed that the Health records are either left in the county or they come with incomplete health records. Hence lead to challenges in providing seamless continuity of care and may results in delay, duplication of tests and potential errors in treatment decisions.

4.4.2.2 Trend Analysis on the Number of reported cancer cases

Trend analysis on the number of reported cancer cases

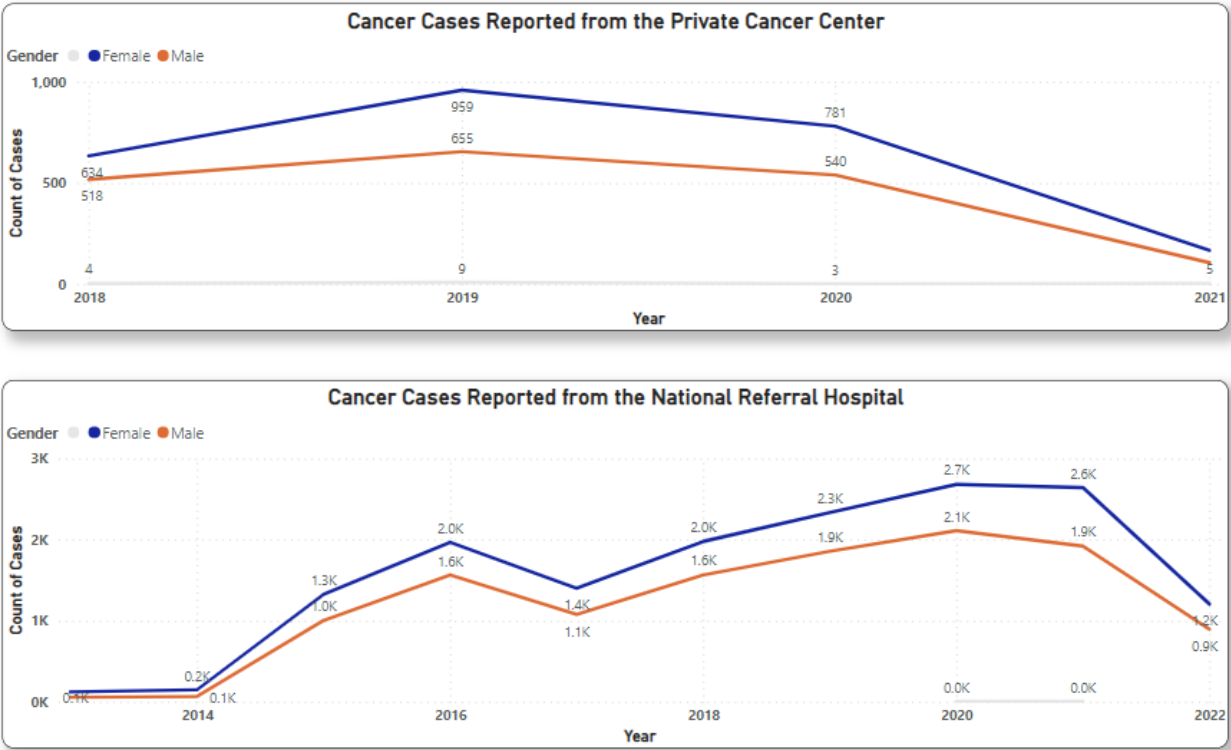


Figure 4.10: shows cancer cases reported from the Private Cancer Center and the National Referral Hospital data (Source: Author, 2023).

Based on the analysis from Figure 23, it can be observed that the National Referral Hospital had a larger patient coverage than the private cancer center. Furthermore, 2020 and 2021 had the highest number of cancer cases reported at the National Referral Hospital. The high number of cases reported in these two years may be attributed to the COVID-19 pandemic, which led to increased hospital visits by patients with recurring symptoms to ascertain their health status. It is essential to note that the COVID-19 pandemic significantly impacted the healthcare system globally, which could have affected the number of patients seeking medical attention for cancer-related issues. However, it is also possible that the National Referral Hospital is more accessible to patients than the private cancer center Figure 23, leading to more cancer cases reported at the hospital. Therefore, further data analysis is necessary to determine the underlying factors contributing to the observed trends in cancer cases between the National Referral Hospital and the private cancer center Figure 23. This information can aid healthcare policymakers and stakeholders in making informed decisions to improve cancer care and management in Kenya.

4.4.2.3 Male vs Female Cancer Diagnosis Analysis

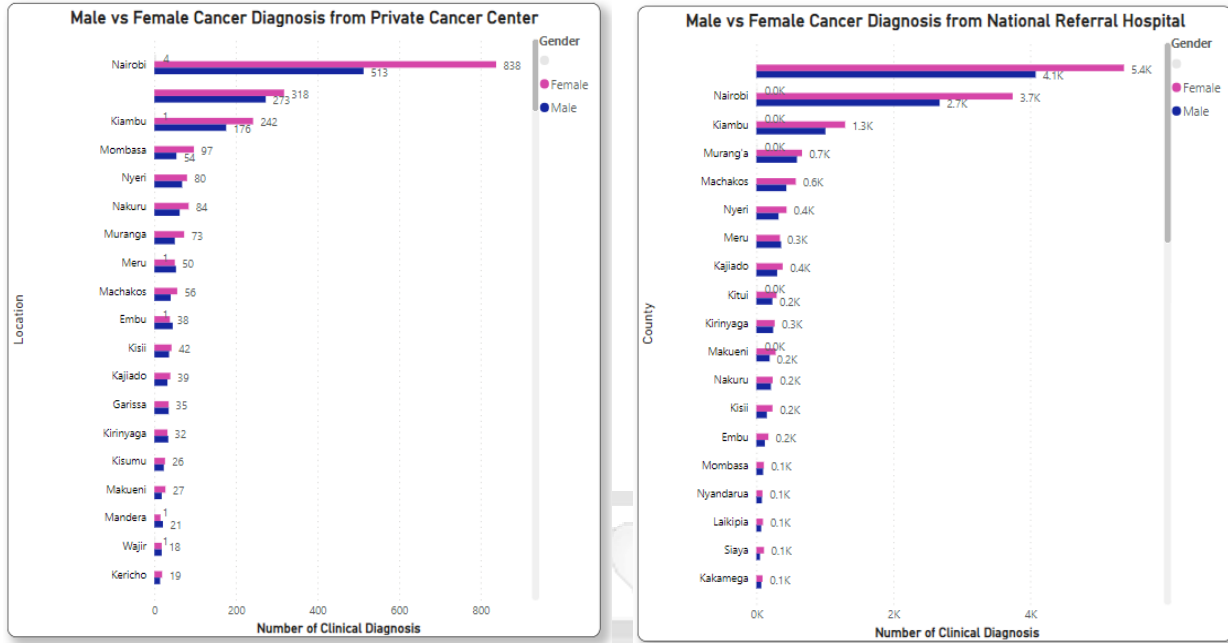


Figure 4.11: shows the distribution of male and female cancer cases across the various counties in Kenya from the Private Cancer Center and the National Referral Hospital data (Source:Author, 2023).

Referring to figure 24 shows the distribution of male and female cancer cases across the various counties in Kenya from the Private Cancer Center and the National Referral Hospital data, and Figure 25 shows the breakdown of male and female cancer cases from the private cancer center and the National Referral Hospital data. It shows that private cancer centers have reported the highest number of cancers diagnoses in several regions of Kenya, including Nairobi, Kiambu, Mombasa, Nyeri, and Nakuru. Meanwhile, the National Referral Hospital has reported the highest number of cancers diagnoses in Nairobi, Kiambu, Muranga, Mombasa, and Machakos. Furthermore, the analysis indicates that females are the most affected by cancer in both facilities, with more cancer patients than males. This is further supported by the chart analysis, which highlights the prevalence of cancer among females across both facilities.

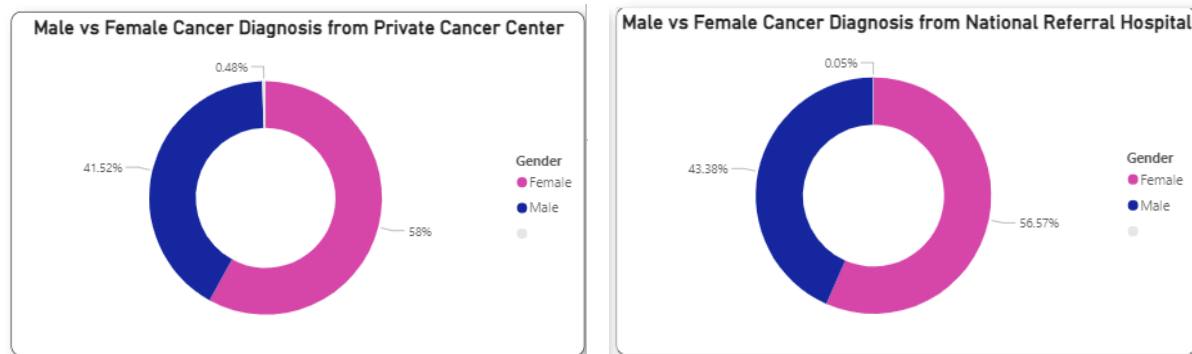


Figure 4.12: shows the breakdown of male and female cancer cases from Private Cancer Center and the National Referral Hospital data (Source:Author, 2023).

4.4.2.3 Age Distribution of the cancer cases

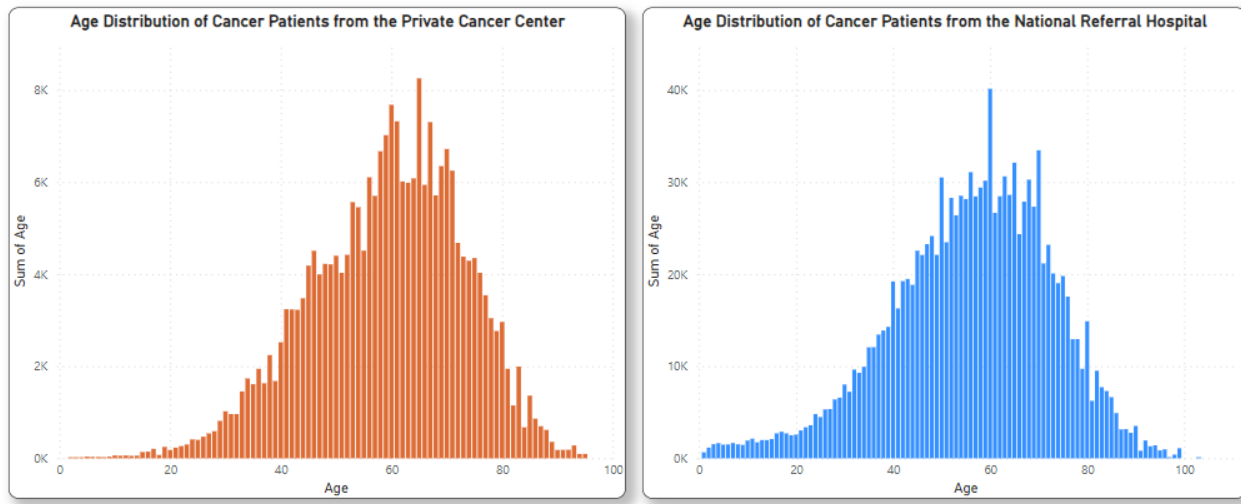


Figure 4.13: shows the distribution of cancer cases from the Private Cancer Center and the National Referral Hospital data (Source: Author, 2023).

In both datasets, *Figure 26* shows the distribution of cancer cases from the Private Cancer Center and The National Referral Hospital; the charts show a normal distribution with the highest number of cancer cases reported at 65. However, there is a difference in the distribution of cases among different age groups between the National Referral Hospital and the private cancer center. The National Referral Hospital had more cases reported below 20 years of age, which can be attributed to the fact that the hospital has a wider coverage and serves patients from all over the country, including children. On the other hand, the private cancer center had fewer cases below 20 years of age, which may be because the hospital mainly serves adult patients. Nevertheless, the normal distribution of cases across age groups suggests that cancer is not biased toward any specific age group and that all age groups are equally susceptible to the disease.

Thus, from the finding from the distribution of Cancer cases from the Private Cancer Centre and The National Referral Hospital data it is evident that the lack of data sharing by patients could have negative consequences for their health outcomes and potentially lead to adverse events. Here are few potential scenarios: misdiagnosis or delayed diagnosis, Medication interactions or allergies, Treatment complications and preventive measures and screening (Dubovitskaya, 2017). Hence actively sharing relevant health data, patients can help ensure that they receive appropriate care and minimize potential risks or adverse events.

4.4.2.4 The top cancer cases reported

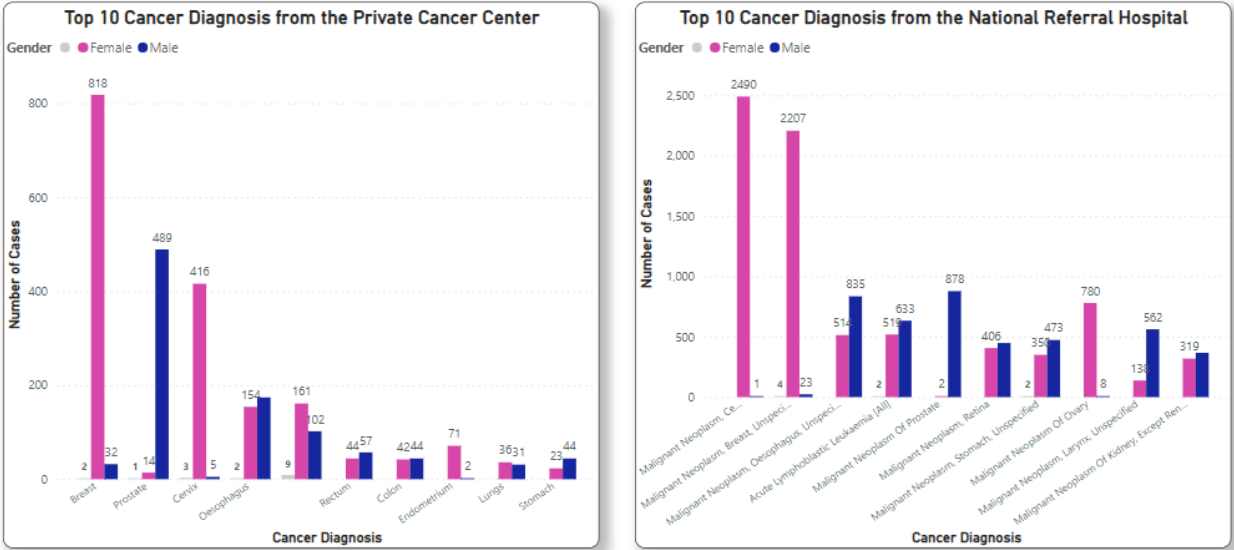


Figure 4.14: shows the top 10 cancer diagnoses (Males vs Females) from the Private Cancer Center and the National Referral Hospital data (Source: Author, 2023).

Upon analyzing, as shown in Figure 27, the top 10 cancer diagnoses (Males vs Females) from the Private Cancer Center and the National Referral Hospital data, the data from private cancer centers, the top 5 cancer diagnoses reported are breast, prostate, cervix, esophagus, and endometrium. On the other hand, the top 5 cancer diagnoses reported from the national referral hospital data are cervix cancer, breast cancer, prostate cancer, esophagus cancer, and ovary cancer. It is worth noting that breast, prostate, and esophagus cancer are common cancer diagnoses reported in both datasets. The difference in the ranking of cancer diagnoses could be due to various factors, such as differences in the patient population and diagnostic procedures.

4.4.2.5 A review of patients who go for review and those who are deceased

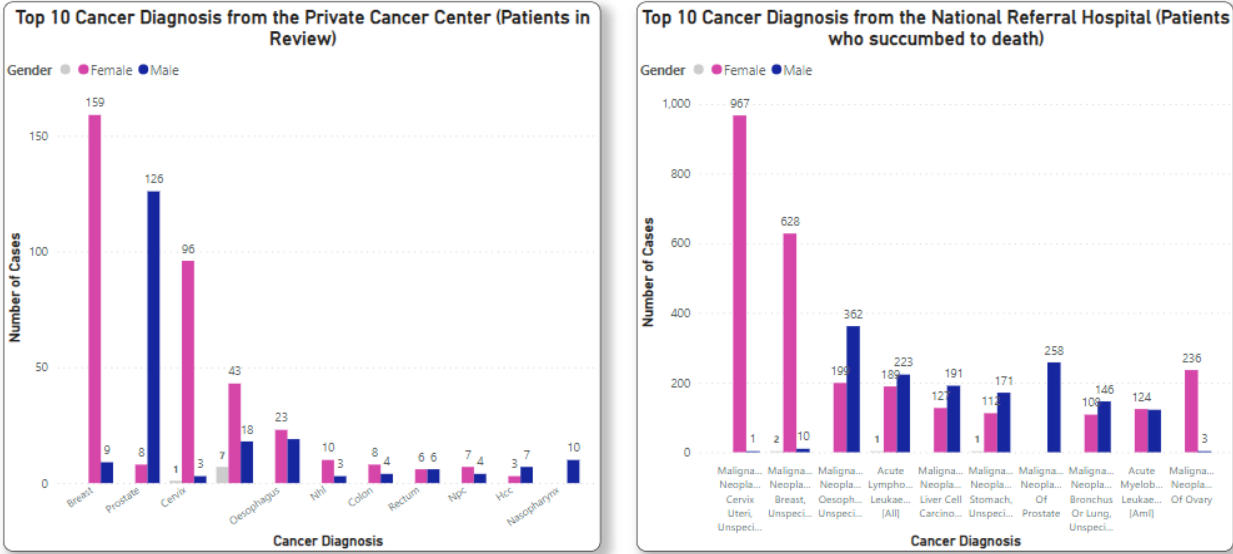


Figure 4.15: shows the status of the patients from the Private Cancer Center and the National Referral Hospital data (Source:Author, 2023).

The above Figure 28 shows the status of the patients from the Private Cancer Center and the National Referral Hospital data. The private cancer centers dataset proved valuable in identifying whether a patient was new or under review, thanks to the availability of this variable. Technology solutions can leverage this information to keep track of patients who have not gone for their scheduled reviews, allowing for timely interventions. For example, upon analyzing the first table, it was found that patients with the top cancer diagnoses reported, except Endometrium, had gone back for a review. In contrast, the national referral hospital dataset did not have information on patient reviews, but it did provide information on the patient's status, whether they were alive or deceased. Interestingly, the top 5 cancer diagnoses reported by the national referral hospital data were the same as those reported by the private cancer center data, and these were also the diagnoses with the highest fatalities.

Percentage of patients who travelled to India for treatment Private Cancer Center dataset	1.60%
Percentage of patients who succumbed to death from the Private Cancer Center dataset	1.39%
Percentage of patients who succumbed to death and had travelled to India from the Private Cancer Center dataset	0%

Table 4.5: shows the tracked patient's progress based on their treatment at the private cancer center
(Source:Author, 2023).

Referring to the above, *Table 10* shows the tracked patient progress based on their treatment at the private cancer center. The dataset from the private cancer center had additional variables that tracked patients' progress based on their treatment. Interestingly, 1.60% of the patients opted to seek further treatment abroad, with some travelling to India. Encouragingly, those who went to India did not succumb to their diagnosis. This finding emphasizes the importance of specialized and tailored treatment in prolonging the lifespan of a patient.

4.5 Descriptive Results

The descriptive analysis of cancer patient data provides insights into the characteristics of patients with cancer, including their age, location, and type of cancer diagnosis. Understanding these characteristics is essential for developing effective prevention and treatment strategies and improving patient outcomes. The analysis will provide a comprehensive overview of the distribution of cancer patients by age, gender, and location, as well as the types of cancer diagnoses. It will also explore any significant trends or patterns in the data. By examining the characteristics of cancer patients, healthcare providers and policymakers can gain a deeper understanding of the needs of cancer patients in different regions and age groups. This understanding can inform the development of targeted interventions and policies to reduce cancer incidence and mortality and improve cancer patients' quality of life.

4.5.1 Descriptive statistics of the variables in the private cancer center dataset

Descriptive statistics provide insight into the distribution of various variables in the dataset. They can be useful for identifying potential trends or outliers in the data and informing further analysis or modelling.

	Mean	Standard Deviation	Median
Gender	0.42	0.5	0
Location	83.26	33.48	90
Age	54.58	15.79	56
Clinical Diagnosis	9.28	4.47	11
Payment	9.28	4.47	11
Patient Status	0.71	0.86	0

RT Fractions (Dosage)	6.77	11.61	0
Treatment & Follow-up	947.80	485.87	868

Table 4.6: shows the descriptive statistics of the various variables from the Private Cancer Center Dataset

(Source:Author, 2023).

Table 11 shows the descriptive statistics of the various variables from the Private Cancer Center Dataset. The mean for age is 54.58, indicating that the average age of patients in the dataset is 54. The standard deviation is 15.79, suggesting some variability in patient age. The median is 56, indicating that 50% of patients are older than this age and 50% are younger. Both clinical diagnosis and payment have the same mean and standard deviation values of 9.28 and 4.47, respectively, as from Table 11. This suggests that both variables have a similar distribution in the dataset. In addition, the median for both variables is 11, indicating that most patients have a clinical diagnosis or payment score of 11. From Table 11, the mean for patient status is 0.71, indicating that most patients in the dataset have a good patient status. The standard deviation is 0.86, indicating a fair amount of variability in patient status. The median is 0, indicating that 50% of patients have a patient status score below this value and 50% above it. From Table 11, the mean for RT fractions (dosage) is 6.77, indicating that the average patient in the dataset received a relatively low dosage. The standard deviation is 11.61, indicating a fair amount of variability in the dosage of RT fractions received by patients. The median is 0, indicating that most patients received no RT fractions. The mean for treatment & follow-up is 947.80 from Table 11, indicating that the average patient in the dataset received a relatively high level of treatment and follow-up. The standard deviation is 485.87, indicating a fair amount of variability in the level of treatment and follow-up received by patients. The median is 868, indicating that 50% of patients received treatment and follow-up above this value and 50% received below it.

4.5.2 Correlation Analysis

Correlation analysis is a statistical technique to explore the relationship between two or more variables. In the context of the cancer dataset, correlation analysis can help identify patterns and relationships between different variables, such as age, gender, location, and cancer diagnosis. By examining the correlations between these variables, we can gain insights into how they may be related and identify potential risk factors for cancer.

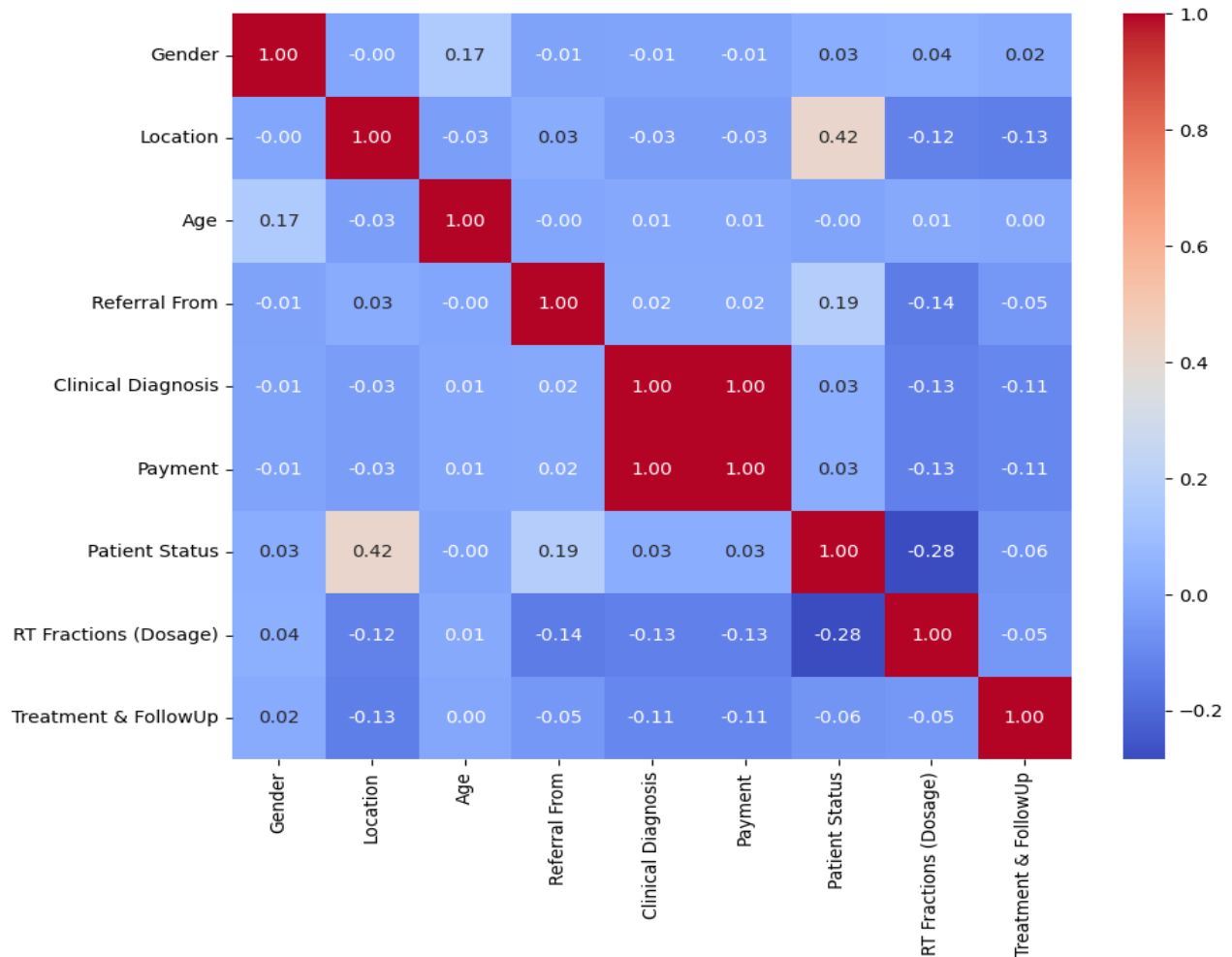
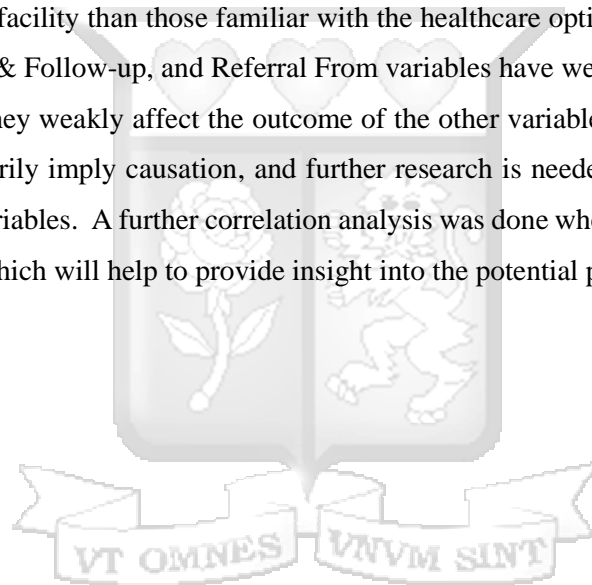


Figure 4.16: Shows the Correlation Analysis of the variables from the Cancer Diagnosis Dataset (Source: Author, 2023)

In a correlation heatmap, as shown above, Figure 29 shows the Correlation Analysis of the variables from the Cancer Diagnosis Dataset; the colors indicate the strength and direction of the correlation between two variables. A positive correlation (when one variable increases, the other also tends to increase) is shown in shades of red, while a negative correlation (when one variable increases, the other tends to decrease) is shown in shades of blue. The color's intensity reflects the correlation's strength, with darker shades indicating stronger correlations. Neutral or weak correlations are shown in shades of white or grey. The dataset had categorical variables first converted to numerical values to allow for an easier interpretation of the results. The above heatmap analysis positively correlates with the payment type and clinical diagnosis. One possible explanation is that individuals with insurance coverage may have better access to healthcare services, including screening and diagnostic tests, which can lead to earlier detection and treatment of diseases like cancer. On the other hand, individuals who pay with cash may have limited access to healthcare services and

delay seeking medical attention until their condition has progressed to a more advanced stage, leading to a more serious clinical diagnosis, as shown in *Figure 29*. Another possible explanation is that individuals with insurance coverage may have a higher socioeconomic status and better health behaviors, such as regular exercise and healthy eating habits, which can reduce the risk of developing certain types of cancer. Conversely, individuals who pay with cash may have lower socioeconomic status and engage in unhealthy behaviors, which can increase their risk of developing certain types of cancer.

It's interesting to note the moderate relationship between location and patient status (new or under review) in *Figure 29*. This could suggest that the location of a healthcare facility may play a role in determining whether a patient is new or returning for follow-up care. For instance, patients who live near a healthcare facility may be more likely to return for follow-up care than those who live far away. Additionally, patients new to an area may seek care at a different facility than those familiar with the healthcare options in their community. Age, Dosage, Gender, Treatment & Follow-up, and Referral From variables have weak correlations with the other variables. This means that they weakly affect the outcome of the other variables. It is important to note that correlation does not necessarily imply causation, and further research is needed to understand the complex relationships between the variables. A further correlation analysis was done where the patient status was used as the dependent variable, which will help to provide insight into the potential predictors of the patient status variable.



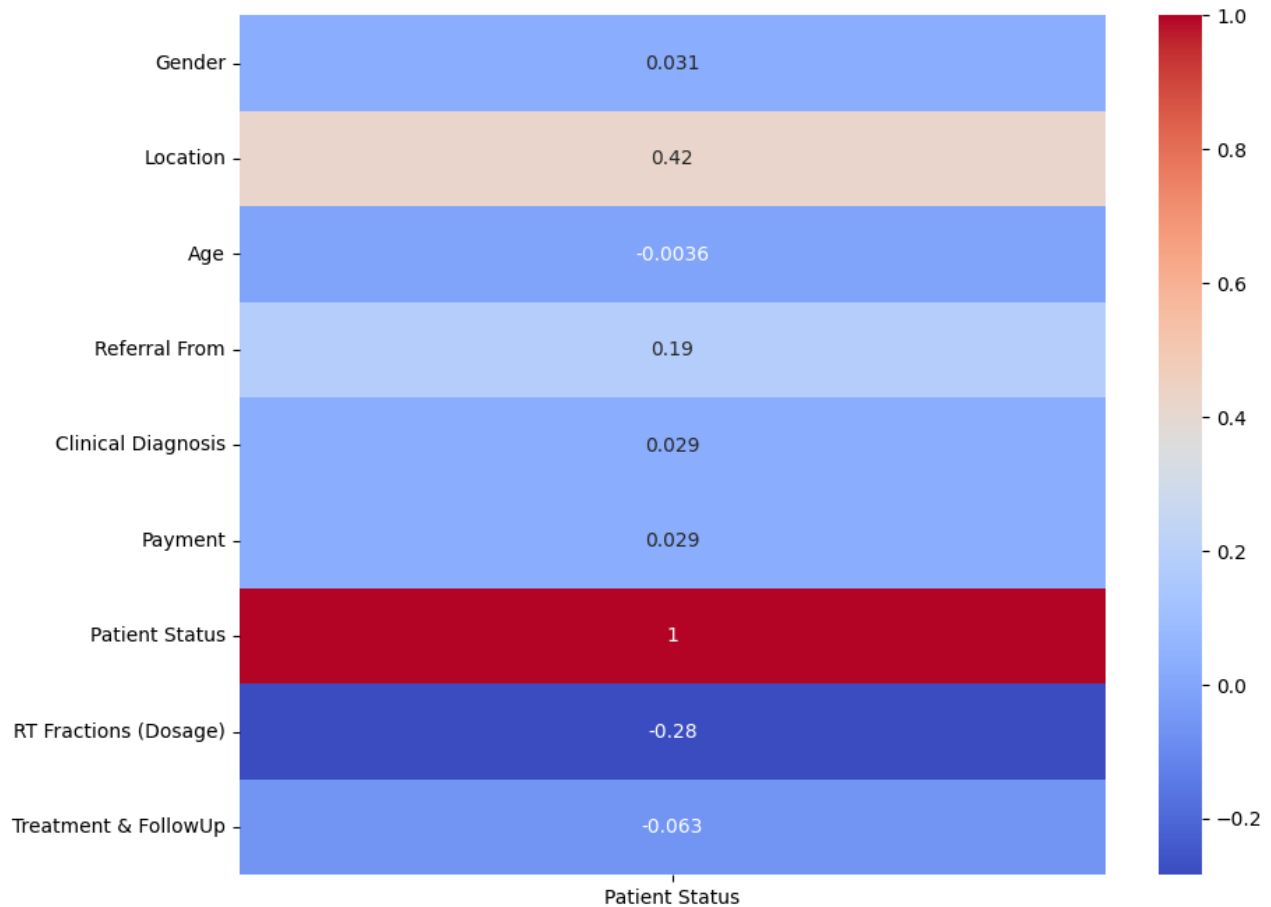


Figure 4.17: Shows the Correlation Analysis of the variables from the Cancer Diagnosis Dataset

(Source: Author, 2023).

The location variable shows a moderate positive correlation (0.419) with the patient status, indicating that patients from certain locations may be more likely to have a better patient status than others. The referral from variable shows a weak positive correlation (0.186), which may suggest that patients referred from certain sources have slightly better patient statuses than others. The gender variable shows a very weak positive correlation (0.031) with the patient status, as shown in *Figure 30*, indicating that gender may not strongly predict patient status. Finally, the clinical diagnosis and payment variables show almost no correlation (0.029) with the patient status. This suggests that a patient's clinical diagnosis and payment may not significantly impact their patient status. The age variable shows a very weak negative correlation (-0.004) with the patient's status, as shown in *Figure 28*, which suggests that age may not be a strong predictor of patient status. Finally, the treatment and follow-up variable show a weak negative correlation (-0.063), indicating that patients who receive more treatment and follow-up may have slightly worse patient statuses. Finally, the RT fractions

(dosage) variable shows a moderate negative correlation (-0.285), suggesting that patients who receive higher doses of RT fractions may have worse patient status, as shown in *Figure 30*.

4.5.3 Multiple Regression Analysis

Multiple regression analysis is a statistical method used to analyze the relationship between a dependent variable and two or more independent variables allowing us to investigate how multiple independent variables affect a single dependent variable. In this case, the patient status is the dependent variable, while location, referral source, gender, clinical diagnosis, payment method, age, treatment and follow-up, and radiation therapy dosages are the independent variables. The importance of multiple regression analysis lies in its ability to identify which independent variables are significant predictors of the dependent variable and to quantify the strength and direction of these relationships. As a result, healthcare professionals can make more informed decisions and develop targeted interventions to improve patient outcomes by understanding how different factors influence patient status.

Variable	Coefficient	Standard Error	T Statistic	P Value
Intercept	-0.34	n/a	n/a	n/a
Location	0.01	0.0003	32.6	0
Reference Source	0.0005	0.00004	11.77	0
Gender	0.07	0.02	3.03	0.002
Clinical Diagnosis	0.0009	0.53	0.002	0.999
Payment method	0.0009	0.53	0.002	0.999
Age	0.0001	0.0006	0.22	0.83
Treatment and follow up	-0.00003	0.00002	-1.34	0.18
RT (Radiation Therapy) Dosage	-0.02	0.001	-16.44	0

Table 4.7: shows the regression analysis on the variables: Patient status, Location, Reference Source, Gender, Clinical Diagnosis, Payment method, Age, Treatment and follow-up, and Radiation Therapy Dosage (Source:Author, 2023).

Table 12 shows the regression analysis on the variables: Patient status, Location, Reference Source, Gender, Clinical Diagnosis, Payment method, Age, Treatment and follow-up, and Radiation Therapy Dosage. The established multiple linear regression equation becomes:

$$Y = -0.34 + 0.01X_1 + 0.0005X_2 + 0.07X_3 + 0.0009X_4 + 0.0009X_5 + 0.0001X_6 - 0.00003X_7 - 0.02X_8$$

Where:

Y – Patient Status

X₁ - Location

X₂ – Reference Source

X₃ - Gender

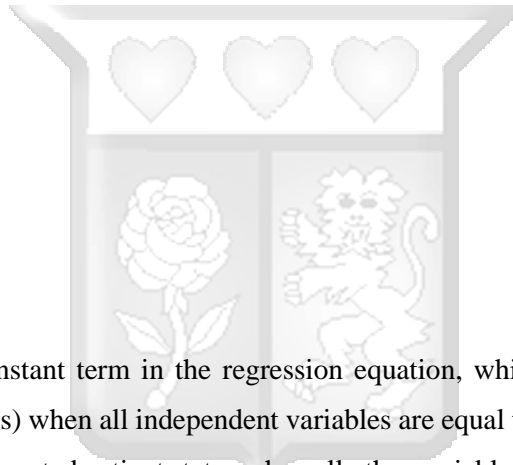
X₄ - Clinical Diagnosis

X₅ - Payment method

X₆ - Age

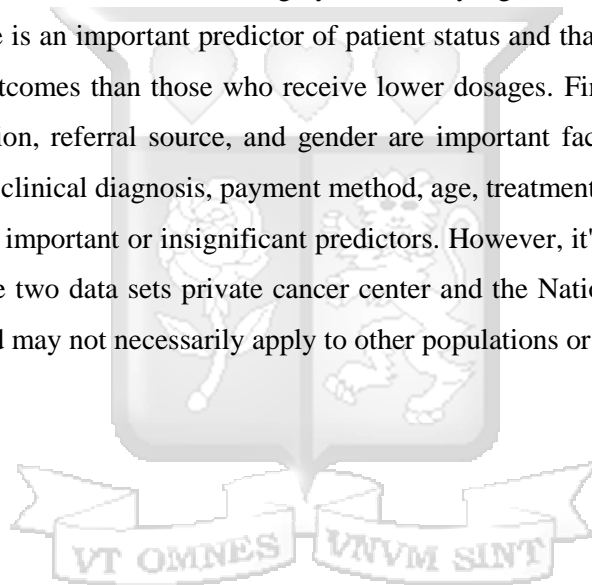
X₇ - Treatment and follow-up

X₈ - RT dosage



The intercept represents the constant term in the regression equation, which is the expected value of the dependent variable (patient status) when all independent variables are equal to zero. In this case, the intercept is -0.34, which means that the expected patient status when all other variables are zero is negative, which may not be meaningful in this context. The location has a coefficient of 0.01, which means that for each unit increase in location (whatever unit that represents in this dataset), patient status is expected to increase by 0.01 units, holding all other variables constant. The standard error of this coefficient is 0.0003, which measures the estimate's precision, and the t-statistic is 32.6, indicating that the coefficient is highly statistically significant (p-value = 0). This suggests that location is an important predictor of patient status and that patients from certain locations may have better outcomes. Referral From has a coefficient of 0.0005, which means that for each unit increase in referral source (whatever unit that represents in this dataset), patient status is expected to increase by 0.0005 units, holding all other variables constant. The standard error of this coefficient is 0.00004, which measures the estimate's precision, and the t-statistic is 11.77, indicating that the coefficient is highly statistically significant (p-value = 0). This suggests that referral source is an important predictor of patient status and that patients referred from certain sources may have better outcomes than others. More need for data to be shared (depending on where they are from etc.) number is small, but the sign is positive, which is an indication.

Gender has a coefficient of 0.07, which means that female patients are expected to have higher patient status than male patients, holding all other variables constant. The standard error of this coefficient is 0.02, which measures the estimate's precision, and the t-statistic is 3.03, indicating that the coefficient is statistically significant (p-value = 0.002). This suggests that gender is an important predictor of patient status and that female patients may have better outcomes than male patients. On the other hand, clinical Diagnosis, Payment, Age Treatment & follow-up all have coefficients that are not statistically significant, as evidenced by their high p-values and very low t-statistics. This suggests that these variables are not important predictors of patient status in this dataset. Finally, RT Fractions (Dosage) have a negative coefficient of -0.02, which means that higher radiation therapy dosages are associated with poorer patient outcomes, holding all other variables constant. The standard error of this coefficient is 0.001, which measures the estimate's precision, and the t-statistic is -16.44, indicating that the coefficient is highly statistically significant (p-value = 0). This suggests that radiation therapy dosage is an important predictor of patient status and that patients who receive higher dosages may have worse outcomes than those who receive lower dosages. Finally, the multiple regression analysis indicates that location, referral source, and gender are important factors when predicting patient outcomes. At the same time, clinical diagnosis, payment method, age, treatment and follow-up, and radiation therapy dosages may be less important or insignificant predictors. However, it's important to note that these conclusions are based on the two data sets private cancer center and the National referral hospital-specific dataset and analysis used and may not necessarily apply to other populations or contexts.



4.5.4 Multiple Regression Analysis on select variables (Location, Reference Source, and Gender)

Variable	Coefficient	Standard Error	T Statistic	P Value
Intercept	-0.57	n/a	n/a	n/a
Location	0.01	0.0003	39.73	0
Reference Source	0.0006	0.00003	16.73	0
Gender	0.06	0.02	2.53	0.01

Table 4.8: shows the regression analysis on the variables: Patient status, Location, Reference Source, and Gender

(Source:Author, 2023)

Table 13 shows the regression analysis on the variables: Patient status, Location, Reference Source, and Gender. The established multiple linear regression equation becomes

$$Y = -0.57 + 0.01X_1 + 0.0006X_2 + 0.06X_3$$

Where:

Y – Patient Status

X₁ - Location

X₂ – Reference Source

X₃ - Gender

The coefficient for the location variable (0.01) indicates that for each unit increase in location, the predicted value of the patient status increases by 0.01 units. The standard error of the coefficient (0.0003) suggests that this effect is statistically significant (t-Statistic=39.73, p-value=0), meaning the location variable has a strong positive association with the patient status variable. Shows that the patient status (for review or a new patient) and location of the health facility matter. The closer and more convenient the location, the better the patient's status in seeking medical treatment/advice. The coefficient for the referral from variable (0.0006) indicates that the dependent variable's predicted value increases by 0.0006 units for each unit increase in referral. The standard error of the coefficient (0.00003) suggests that this effect is also statistically significant (t-Statistic=16.73, p-value=0), meaning it has a moderate positive association with the patient status variable. The coefficient for the gender variable (0.06) indicates that holding all other variables constant, males have a predicted value of the dependent variable that is 0.06 units higher than females. In addition, the standard error of the coefficient (0.02) suggests that this effect is statistically significant (t-Statistic=2.53, p-value=0.01), meaning it has a small positive association with the patient status variable and this effect is statistically

significant. Overall, this regression model appears to fit the data well, as all three independent variables have statistically significant associations with the dependent variable (patient status). Furthermore, the p-values for each variable are very small, indicating that the observed effects are unlikely due to chance. There is a high correlation between patient status and location. A high correlation indicates that when the location changes, there is a corresponding change in the patient's status or vice versa. This suggests that the location may be a significant factor influencing the patient's health condition or outcome.



CHAPTER 5: CONCLUSION, CHALLENGES AND RECOMMENDATION

5.1 Conclusion

Based on the findings from the survey responses and descriptive statistics, the key factors influencing data consolidation and integration from multiple sources in the health sector. The high score from the customer perspective suggests that the oncologists believe the organization is doing well in meeting the needs and expectations of their patients. This indicates a focus on patient-centered care and a commitment to improving the patient experience. To further enhance data consolidation and integration, the organization can leverage patient feedback and preferences to tailor their data management strategies accordingly. The relatively high score in the financial perspective indicates effective financial management and a focus on achieving financial goals. For data consolidation and integration, the organization should consider investing in robust data systems and infrastructure that facilitate seamless data sharing and analysis while optimizing resource allocation and cost-effectiveness. The lower score in the internal process perspective may suggest opportunities for improving the efficiency and effectiveness of internal processes such as patient care delivery, communication, and information management. To enhance data consolidation and integration, the organization should streamline data workflows, implement interoperable systems, and foster a data-driven culture to ensure smooth data exchange and utilization across different processes. The high score in the learning and growth perspective indicates a commitment to employee development and innovation. This could be leveraged to foster a data-literate workforce and promote data-driven decision-making, leading to more effective data consolidation and integration strategies. The public generally perceives trust in hospitals regarding fidelity, trustworthiness, and competency. However, there may be some integrity-related concerns. To address these concerns and improve data consolidation and integration, hospitals should focus on transparency regarding patient data protection. This includes providing clear information about data practices, offering patients meaningful data control options, ensuring easy access to health data, enhancing data security measures, reliable data retention protocols, and robust enforcement of data management policies. In conclusion, to enhance data consolidation and integration in the health sector, organizations should focus on patient-centered care, effective financial management, streamlining internal processes, fostering employee development and innovation, and prioritizing transparency and data protection. By addressing these key factors, the health sector can unlock the full potential of data-driven decision-making and ultimately improve patient outcomes and healthcare delivery.

Secondly based on the regression analysis, the current data does not provide strong evidence to conclude that trust and transparency significantly influence value-based care in the healthcare industry. However, it is essential to acknowledge potential limitations such as sample size, measurement errors, or omitted variables

that may have influenced the results. Given the negative coefficient estimates for trust and transparency, it appears that there might be issues with the current levels of trust and transparency in the healthcare industry, negatively impacting value-based care. To address this, there is a need for strategies to enhance trust and transparency among patients and stakeholders. One potential approach to improve these factors and subsequently value-based care is through the adoption of technologies like Blockchain. Blockchain technology can increase trust and transparency by ensuring secure and tamper-proof data sharing, enhancing data integrity, and promoting patient empowerment through greater control over their health information. Further research and data collection, considering a larger and more diverse sample, could provide more robust insights into the relationship between value-based care, trust, and transparency in the healthcare industry. Additionally, investigating the role of technology, such as Blockchain, in fostering trust and transparency could be beneficial to support value-based care initiatives.

Thirdly based on the survey data and demographic information, we can conclude that there is a gender and age gap in degree attainment among the respondents. Women appear to be well-represented in the 31-40 and 41-50 age brackets, particularly at the post-graduate level, but there are fewer female respondents in the 51 and above age bracket, especially in terms of holding advanced degrees like PhDs. This highlights the importance of promoting greater gender equality and diversity in higher education and the workforce to ensure that both men and women have equal opportunities for education and career advancement. Additionally, the survey respondents are mainly graduating, and the dominant age bracket is the 31-40 group, indicating that the majority of the respondents are from the young to middle-aged category. The data underscores the significance of continuous educational development and training opportunities for healthcare professionals, including oncologists, to keep up with advancements in the field and deliver high-quality care to patients.

Furthermore, the data analysis provides valuable insights into the distribution of cancer cases in Kenya. The maps indicate a high concentration of cancer cases in certain regions, represented by the red areas. These regions, such as Central, Coastal, and Western Kenya, have a higher prevalence of cancer cases. On the other hand, the green areas suggest regions with relatively fewer reported cancer cases and potentially insufficient attention or awareness regarding cancer. One intriguing finding is the lower number of cancer cases in Northern Kenya compared to other regions. This disparity raises important questions that require further investigation to understand the underlying causes. Potential factors contributing to this trend could be the lack of access to health facilities, limited awareness of cancer, or differences in the overall health status of the population in this region. In conclusion, the data analysis highlights the importance of understanding cancer distribution across different regions in Kenya to tailor appropriate healthcare interventions and resource allocation. The disparities in cancer cases observed in Northern Kenya warrant further research and

investigation to identify and address the underlying factors. Additionally, improving the management and transfer of health records between county hospitals and referral hospitals is essential for providing seamless continuity of care and improving patient outcomes. The findings underscore the significance of data-driven decision-making and the need for collaborative efforts among healthcare providers, researchers, and policymakers to develop targeted strategies for cancer prevention, early detection, and treatment across the country. By addressing these challenges and disparities, Kenya can enhance its healthcare system and improve the overall health and well-being of its population, particularly in the context of cancer care. The impact of the COVID-19 pandemic on healthcare-seeking behaviors and access to healthcare facilities warrants closer examination. Policymakers and stakeholders in the healthcare industry can use this information to make informed decisions and implement targeted strategies to improve cancer care and management in Kenya. By addressing the challenges and disparities in cancer care, Kenya can enhance its healthcare system and provide better support to cancer patients across the country.

The significance of gender and regional factors in cancer diagnosis patterns at the Private Cancer Center and the National Referral Hospital in Kenya. The higher prevalence of cancer cases among females underscores the importance of addressing gender-specific health issues in cancer care and management. Policymakers and healthcare providers should consider these trends while devising strategies for cancer prevention, early detection, and treatment in different regions of Kenya. By implementing targeted interventions and raising awareness, efforts can be made to reduce the burden of cancer and improve healthcare outcomes for both male and female patients across the country. Furthermore the age distribution of cancer cases indicates that cancer affects individuals of all ages, and it is essential to provide comprehensive care tailored to the specific needs of different age groups. Additionally, active data sharing by patients is crucial for optimizing healthcare outcomes and avoiding potential adverse events related to their treatment and care. By promoting data sharing and collaboration between patients and healthcare providers, we can work towards achieving better cancer care and management in Kenya.

Overall, this comprehensive analysis provides valuable insights into the characteristics of cancer patients in Kenya. It highlights the importance of considering age, gender, location, referral sources, and other factors when developing effective prevention and treatment strategies. These findings can guide healthcare providers and policymakers in developing targeted interventions to reduce cancer incidence, improve patient outcomes, and enhance the overall quality of cancer care in Kenya. Additionally, it emphasizes the importance of data sharing and collaboration between patients and healthcare providers to optimize healthcare outcomes and minimize potential risks or adverse events. Further research and data analysis are needed to continue enhancing our understanding of cancer patterns and trends in Kenya and to inform evidence-based cancer care

strategies.

5.2 Challenges

The sample size from the primary data was insufficient to show a statistical significance between value-based care and trust and transparency. Due to the differences in cancer diagnosis standards between the two datasets, it was not feasible to evaluate them together, which limited the ability to compare and analyze the results. The private cancer center dataset contained several important variables that could be used to monitor patients' progress, such as treatment, follow-up care, and scan dates. However, a significant proportion of these variables (88%) had missing values, making it difficult to conduct a thorough analysis. On the other hand, the dataset from the national referral hospital had a limited number of variables, particularly regarding treatment and follow-up care for patients, which posed challenges for conducting a comprehensive analysis.

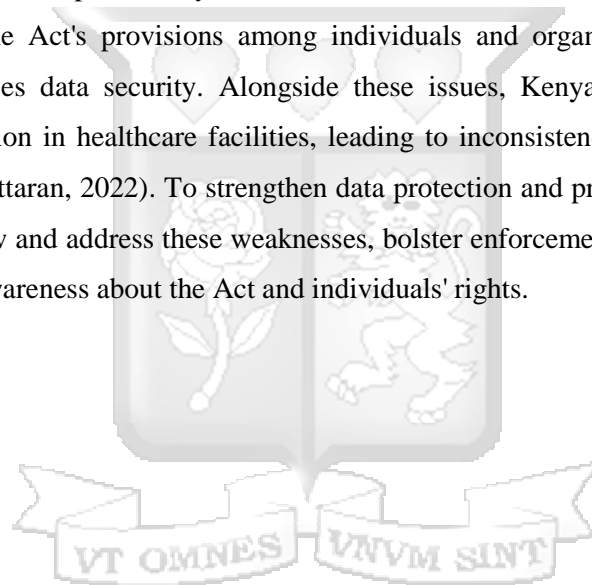
The analysis also reveals challenges related to health records when patients move from county hospitals to the National Referral Hospital. It has been observed that health records are either left behind in the county or transferred with incomplete information. This lack of seamless continuity of care can lead to delays, duplication of tests, and potential errors in treatment decisions. Addressing this issue is crucial for ensuring comprehensive and effective healthcare delivery.

5.3 Recommendations

The first recommendation is for the Ministry of Health (MOH) to implement strategies to improve cancer patients' management in private and public healthcare facilities (Niranjanamurthy, 2019). This could involve improving coordination between different healthcare providers, enhancing the capacity of healthcare professionals to diagnose and treat cancer, and implementing quality control measures to ensure that patients receive the best possible care. The MOH could also consider creating standardized protocols for cancer care to ensure that patients receive consistent and evidence-based treatment. The second recommendation is to develop data security policies to ensure patient information confidentiality (Makokha, 2019). With the increasing use of digital technology in healthcare, it is crucial to safeguard patients' personal and medical information from cyber-attacks and data breaches. The third recommendation is to focus on investments in preventive care and marketing. Preventive care can include early screening and detection, immunizations, and lifestyle changes to reduce cancer risk. (Kessler, 2017) Marketing efforts could include awareness campaigns to educate the public about cancer prevention, screening, and treatment options. Such campaigns can be done through traditional media, social media, or public forums. Finally, the fourth recommendation is to invest in prediction, which involves developing predictive models to identify individuals at high risk of developing cancer. This can help to identify individuals who would benefit from early screening and intervention,

ultimately leading to better outcomes. Prediction models can be developed using advanced analytics and machine learning techniques, data from electronic health records, medical imaging, and other sources (Ramachandran, 2020).

The Kenyan Data Protection Act 2019 is designed to safeguard personal data, including healthcare information, but it exhibits several weaknesses (Mhlanga, 2020). Firstly, its limited scope confines protection to data processing within Kenya, creating complications for international data transfers and healthcare data sharing (Khezr, 2019). Secondly, the Act lacks clarity in certain provisions, leading to confusion and inconsistent interpretation, especially concerning sensitive personal data and health information (Florance, 2010). Thirdly, the limited enforcement mechanism through the Office of the Data Protection Commissioner hampers effective implementation, particularly in the healthcare sector (Makokha, 2019). Moreover, a general lack of awareness about the Act's provisions among individuals and organizations contributes to non-compliance and compromises data security. Alongside these issues, Kenya faces challenges with data uniformity and standardization in healthcare facilities, leading to inconsistencies and inaccuracies in data sharing and management (Attaran, 2022). To strengthen data protection and privacy, it is imperative for the relevant authorities to review and address these weaknesses, bolster enforcement mechanisms, promote data standardization, and raise awareness about the Act and individuals' rights.



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APPENDIX

Appendix I: Introduction letter

Ole Sangale Rd, Madaraka Estate,
P.O Box 59857 00200, Nairobi, Kenya,
Cell: +254 703 414/6/7, Twitter: @585Kenya
Email: info@sbs.ac.ke or visit www.sbs.strathmore.edu



13th October 2022

To Whom It May Concern,

RE: FACILITATION OF RESEARCH – SAINI VINITA BALBIR

We introduce Vinita Saini Balbir, a Master of Business Administration in Healthcare Management (MBA-HCM) student at Strathmore University Business School, student number 138191/21. As part of our MBA-HCM Programme, Vinita will learn through applied research and undertake a project. This is in partial fulfillment of the requirements of the course. To this effect, she would like to request appropriate data from your organization.

Vinita is undertaking a research paper on “**The Impact of Blockchain Technology on Data Sharing in Oncology Treatment and Care**” The information obtained shall be treated confidentially and used for academic purposes only.

Our MBAHCM Programme seeks to establish links with industry, and one of the ways of doing so is by directing our research to areas that would be of direct use to the industry. We would be glad to share our findings with you after the research, and we trust that you will find them of great interest and practical value to your organization.

We appreciate your support and shall be willing to provide any further information if required.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Njoki Kiagiri".

Njoki Kiagiri
Manager – Graduate Programmes.

Association of African
Business Schools



Strathmore Business School is a Proud member of:



Appendix II: Ethical Clearance



21th February 2023

Dr Saini Vinita Balbir,
vinita.balbir@strathmore.edu

Dear Dr Saini,

RE: The Effect of Block-Chain Technology on Data Sharing in Oncology Treatment and Value-Based Care

This is to inform you that SU-ISERC has reviewed and **approved** your above **SU- master's** research proposal. Your application reference number is **SU-ISERC1596/23**. The approval period is from **21th February 2023 to 20th February 2024**.

This approval is subject to compliance with the following requirements:

- i. Only approved documents including (informed consents, study instruments, and MTA) will be used
- ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-ISERC.
- iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-ISERC within 48 hours of notification
- iv. Any changes, anticipated or otherwise, that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-ISERC within 48 hours
- v. Clearance for the export of biological specimens must be obtained from relevant institutions.
- vi. Submission of a request for renewal of approval at least 60 days prior to the expiry of the approval period. Attach a comprehensive progress report to support the renewal.
- vii. Submission of an executive summary report within 90 days of completion of the study to SU-ISERC.

Before commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology, and Innovation (NACOSTI) <https://research-portal.nacosti.go.ke/> and obtain other clearances needed.

Yours sincerely,

for: **Dr Ben Ngoye,**
Secretary; SU-ISERC

Cc: Mr Ambrose Rachier,
Chairperson; SU-ISERC



Appendix IV: Questionnaire

1. Purpose of the interview

The interview aims to collect information from Chief Oncologists; the data collected will partially fulfil the requirements for the award of a degree of Master of business administration in healthcare management (MBA-HCM), Strathmore Business School, Strathmore University. In addition, the survey aims to identify the features determining consolidating and integrating data from multiple sources and **how policy recommendations can be implemented to determine data protection for the health sector.**

2. Confidentiality

Information provided in the Questionnaire by the Oncologists will be treated as confidential and used strictly for the purpose indicated above. The student(s) involved are under oath not to disclose any information to a third party. If you wish to remain anonymous, please indicate

3. Due Date

Information provided in the Questionnaire within 21 days upon receipt. We will collect the filled Questionnaire on the due date or earlier and in the agreed-upon format. Retain the duplicate copy of the Questionnaire for your records.

4. Respondent

The respondents are expected to be the Chief Oncologists and the cancer patients.

5. Queries

The interviews should address queries or assistance regarding the completion of this Questionnaire.

For more information, contact the following:

Vinita Saini – 0701182015

Vinita.balbir@strathmore.edu

MBA-HCM- 2021

Graduate Student

Strathmore University

PS: Please answer all questions.

Section 1: Background Information

1. Please tick your age bracket

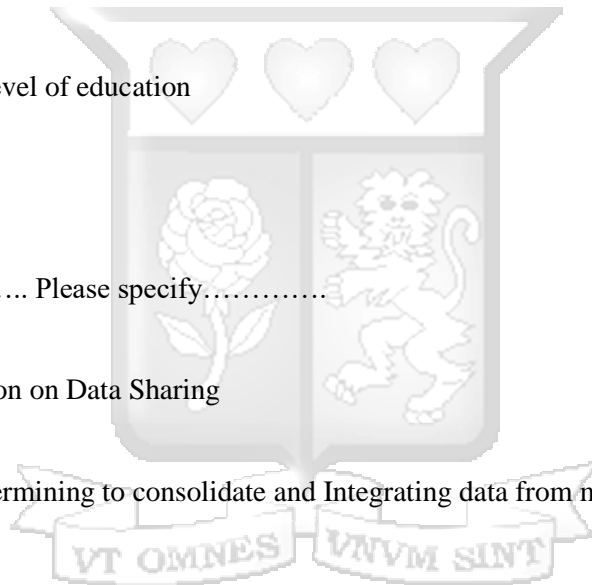
- a) 21-30
- b) 31-40
- c) 41-50
- d) 51-above

2. Please tick your gender

- a) Male
- b) Female

3. Please tick your level of education

- a) Primary
- b) Secondary
- c) Univerisity
- d) Others..... Please specify.....



Section 2: Information on Data Sharing

Part A. Features determining to consolidate and Integrating data from multiple sources.

TRUST

1. This section contains questions on your general understanding of **fideliity**.

Fidelity captures benevolence; a trustee prioritizes the trustor's needs and interests. At the system level, this means that the organizations that share health information value and prioritize the needs of the public whose health information they have.

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1- Not at all; 2- Somewhat true; 3- Fairly true; 4-Very true

No	Statement	1	2	3	4
1.	The hospital that has my health information and shares				

	it “does not care about helping people like me.”				
2.	The hospital value my needs				
3.	The hospital would not knowingly do anything to harm me.				
4.	The hospital cares most about research.				
5.	The hospital cares mostly about what is convenient for its healthcare practitioner.				
6.	The hospital cares most about holding costs down.				

2. This section contains questions on your general understanding of **competency**.

Competency: refers to having the ability and expertise to minimize errors and achieve goals

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1- Not at all; 2- Somewhat true; 3- Fairly true; 4-Very true

No	Statement	1	2	3	4
1.	The hospital that has my health information and shares it is very good at conducting research.				
2.	The hospital has a good track record of using health information responsibly.				
3.	The hospital should be more careful than they are in sharing health information.				
4.	The hospital makes more mistakes.				
5.	The hospitals are not good at their jobs.				

3. This section contains questions on your general understanding of **trustworthiness**.

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1- Not at all; 2- Somewhat true; 3- Fairly true; 4-Very true

No	Statement	1	2	3	4
1.	Can the hospital be trusted to keep my health information secured				
2.	Can the hospital be trusted to use my health information responsibly?				
3.	The hospital thinks about what is best for me.				
4.	The hospital acts in an ethical manner				

4. This section contains questions on your general understanding of **integrity**.

Integrity: Is defined as honesty or following the principles of non-deception by not hiding mistakes or being fair in their treatment of people.

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1- Not at all; 2- Somewhat true; 3- Fairly true; 4-Very true

No	Statement	1	2	3	4
1.	The hospital tries hard to be fair in dealing with others.				
2.	The hospital tries to hide severe mistakes.				
3.	The hospital will tell me how my health information is used.				

Part B: Data Protection in the health sector

1. Notice

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	The Health Information Exchange					

	(HIE) has a notice clearly stating the type of health data collected and shared.					
2.	The HIE has a notice that clearly states the purpose for which the health data is to be exchanged.					
3.	The HIE has a notice that identifies any potential recipients of the data.					
4.	The HIE has a notice explaining how the shared personal information will be used.					
5.	The HIE has a notice stating whether the requested data exchange is voluntary or required.					

2. Choice

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	The privacy statement provides an individual's choice of limiting personal information sharing.					
2.	Privacy statement clearly explains an individual's consent on personal information discharge.					
3.	The privacy statement provides the choice given to an individual to opt					

	in or opt out.					
4.	Privacy statement offers users a clear choice by asking permission before disclosing personal information to a third party.					
5.	The privacy statement provides an individual choice of sharing health information under specific conditions (such as the case of an emergency)					

3. Access

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

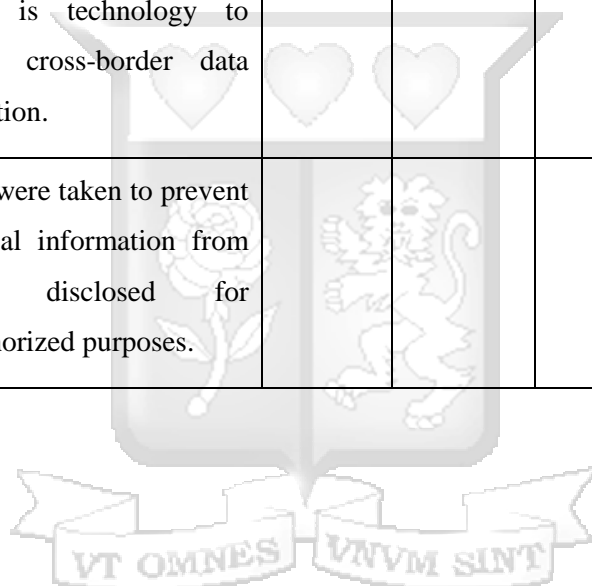
No	Statement	1	2	3	4	5
1.	Individuals can access their personal information.					
2.	Individuals can correct inaccuracies in their personal information.					
3.	Individuals have the right to delete their personal information from the HIE record.					
4.	Individuals are allowed to review their shared personal information.					

4. Security

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	There are actions to ensure personal data security during information sharing.					
2.	There is technology to ensure cross-border data protection.					
3.	Steps were taken to prevent personal information from being disclosed for unauthorized purposes.					



5. Retention

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	Privacy policy clearly states the duration of keeping personal data.					
2.	Privacy policy clearly					

	explains when providers will access shared health information.					
3.	Privacy policy clearly states the steps to delete personal data if it is no longer required for the consented purpose.					
4.	Privacy policy clearly explains the reasonable approaches to ensure private health data is not kept longer than is necessary.					

6. Enforcement

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	The privacy statement discloses a law sanctioning those who violate the privacy policy.					
2.	The privacy statement explains actions that will be taken according to the law against those violating privacy principles.					

3.	The privacy statement provides guidelines and enforcement mechanisms to assure that online information sharing will abide by privacy laws.					
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Appendix V: Questionnaire

1. Purpose of the survey

This key Informant Guide aims to collect information from public and private healthcare providers, organizations already using blockchain-driven healthcare platforms and research institutions.

The data collected will partially fulfil the requirements for the award of a degree of Masters in Business Administration – Health Care Management, Strathmore Business School, Strathmore University. In addition, the survey **aims to identify the features determining to consolidate and integrate data from multiple sources and how policy recommendations can be implemented to determine data protection for the health sector.**

2. Confidentiality

Information provided in the Questionnaire by the participants will be treated as confidential and used strictly for the above purpose. The students are under oath not to disclose information to a third party. If you wish to remain anonymous, please indicate in the text box below:

3. Duration and Modalities of the Interview

This key Informant Guide will take approximately 20-30 minutes. Upon completion of the survey, I shall allow you ten minutes to raise any questions which we shall respond to:

4. Queries

Queries or assistance regarding the completion of this Questionnaire should be addressed by the interviewer, whose contact details are below:

Vinita Saini - +254701182015

Vinita.balbir@strathmore.edu

MBA-HCM 2021

Graduate student

Strathmore University

PS: This Questionnaire has been designed to complement the use of secondary data to identify **features determining to consolidate and integrate data from multiple sources and how policy recommendations can be implemented to determine data protection for the health sector.**

Please answer all questions

Section 1: **Background Information**

1. Please tick your age bracket

- a) 21-30
- b) 31-40
- c) 41-50
- d) 51-above

2. Please tick your gender

- a) Male
- b) Female

3. Please tick your level of education

- a) O-level
- b) Diploma
- c) Graduate
- d) Post-Graduate

4. Organization

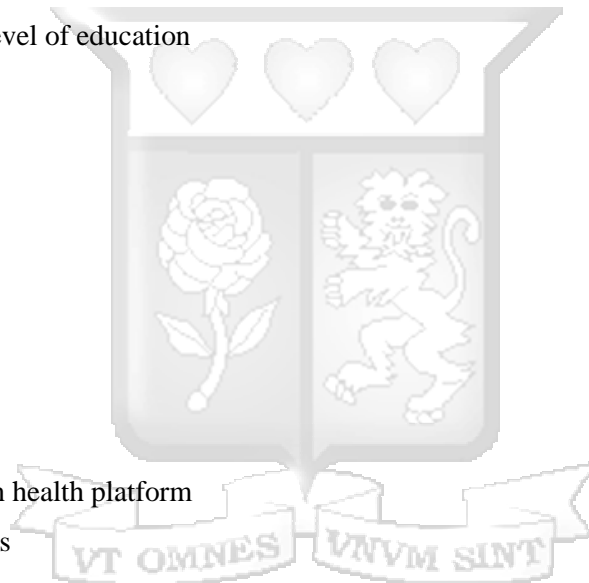
- a) Public-Hospital
- b) Private-Hospital
- c) Blockchain-driven health platform
- d) Research Institutes

5. Position

- a) Executive/Vice executive
- b) IT manager
- c) Other managers
- d) Staff

6. Work Experience

- a) 1-4 years
- b) 5-10 years
- c) >10 years



The balanced scorecard (BSC) approach is used to understand in depth how Blockchain Technology can be used to evaluate the performance of an organization.

1. Customer Perspective

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	Can the use of Blockchain Technology in Healthcare help improve the availability of medical services?					
2.	Can the use of Blockchain Technology in Healthcare help improve the accessibility of medical services?					
3.	Can the use of Blockchain Technology in Healthcare help improve the quality of medical service?					
4.	Can the use of Blockchain Technology in Healthcare help improve patient satisfaction?					
5.	Can the use of Blockchain Technology in Healthcare help improve medical staff satisfaction?					
6	Can the use of Blockchain Technology in Healthcare help Improve administrative staff					

	satisfaction?					
7	Can the use of Blockchain Technology in Healthcare help improve payer satisfaction?					
8	Can using Blockchain Technology in Healthcare help promote hospital image and reputation?					
9	Can Blockchain Technology in Healthcare help promote hospital recognition of medical services?					

2. Financial Perspective

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	Can the use of Blockchain Technology in Healthcare help improve the utilization of medical equipment and facilities?					
2.	Can the use of Blockchain Technology in Healthcare help increase the occupancy rate of beds?					
3.	Can the use of Blockchain technology in Healthcare help increase the turnover rate of beds?					
4.	Can the use of Blockchain Technology in Healthcare help					

	increase new revenue from self-payment medical services?					
5.	Can the use of Blockchain Technology in Healthcare help increase new revenue from new customer markets?					
6	Can the use of Blockchain Technology in Healthcare help increase return on investment?					
7	Can the use of Blockchain Technology in Healthcare help increase sale revenue?					
8	Can the use of Blockchain Technology in Healthcare help increase profit margins?					
9	Can the use of Blockchain Technology in Healthcare help increase market share?					

3. Internal Process Perspective

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	Can use Blockchain Technology in Healthcare help improve the administrative service processes?					
2.	Can using Blockchain Technology in					

	Healthcare help improve the healthcare service process?					
3.	Can the use of Blockchain Technology in Healthcare help improve the after-medical-care service process?					
4.	Can using Blockchain Technology in Healthcare help avoid medical errors or incidents?					
5.	Can using Blockchain Technology in Healthcare help identify more innovative opportunities for hospitals?					
6	Can the use of Blockchain Technology in Healthcare help design innovative administrative services?					

4. Learning Growth Perspective

Kindly indicate your level of agreement with the statements provided. The scale to use is as follows:

1-Strongly disagree; 2 disagree; 3 Neither agree nor disagree; 4-agree; 5-Strongly agree

No	Statement	1	2	3	4	5
1.	Can the use of Blockchain Technology in Healthcare help improve the skills and talent of employees?					
2.	Can the use of Blockchain Technology in Healthcare help					

	provide more opportunities for the training of employees?					
3.	Can the use of Blockchain Technology in Healthcare help improve employee knowledge sharing?					
4.	Can Blockchain Technology in Healthcare help improve awareness of the shared vision, objectives, and values?					
5.	Can the use of Blockchain Technology in Healthcare help improve the alignment of goals and incentives with strategy?					
6	Can the use of Blockchain Technology in Healthcare help improve the quality of information?					
7	Can the use of Blockchain Technology in Healthcare help improve knowledge management capabilities?					
8	Can using Blockchain Technology in Healthcare help improve the accessibility of various information among healthcare providers?					