



UNIVERSITY OF ALGARVE
FACULTY OF ECONOMICS

**ARTIFICIAL INTELLIGENCE AND HEALTHCARE: THE OPPORTUNITIES,
RISKS AND BARRIERS OF AI ADOPTION IN HEALTHCARE IN SUB-SAHARAN
AFRICA**

CHELEOLISA VITALIS EZECHUKWU

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AFRICA**

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ABSTRACT

Technology revolutionizing healthcare service delivery is evident globally. It is frequently cited as the primary driver of lower service delivery costs and improved clinical results. Healthcare systems are already overworked, and are also facing additional pressures from growing expenses, pandemics, infectious disease outbreaks, and chronic illnesses. That is why this study investigated the opportunities, risks and barriers of artificial intelligence adoption in healthcare in Sub-Saharan Africa through Systematic Literature Review.

The study scope was first established, and the inclusion/exclusion criteria defined to include specific publication timeline between 2018 and 2024, relevance to the topic, and accuracy of the selected literature. Databases like PubMed, Medline, Science Direct and Google Scholar were used to extract necessary literature by searching for defined keywords and phrases. Using PRISMA flowchart, fourteen journals were adopted for the study, having met the necessary criteria set.

This study revealed that the use of artificial intelligence technology has incredible potential to develop more dependable healthcare systems, enhance patient outcomes per the work of Anthony et al. (2023), enhance healthcare safety (Macrae,2019). Artificial intelligence finds tremendous opportunities for use in diagnoses, patient screening and in surgeries. It also shows that there are risks and concerns including data privacy, management of artificial intelligence safety, bias in algorithms and regulatory concerns. Moreover, in Sub-Saharan Africa, artificial intelligence adoption in healthcare faces barriers ranging from ethical, legal, and social barriers in the form of inadequate infrastructure, paucity of legislative framework. This study recommends that there should be the creation and execution of customized regulatory frameworks for artificial intelligence in healthcare specifically targeting the unique regional intricacies, resource allocation for research and training in artificial intelligence, as well as investment in necessary support infrastructure, guidelines for safeguarding data privacy, addressing ethical concerns, and establishing criteria for the use of artificial intelligence in medical environments.

Keywords: Artificial Intelligence, Health, Healthcare, Opportunities, Risks, Barriers, Sub-Saharan Africa

RESUMO

É evidente a forma como a tecnologia está a revolucionar a prestação de serviços de saúde nas economias desenvolvidas. Graças a ela, o custo de bens e serviços tem vindo a diminuir, enquanto a produtividade tem vindo a aumentar. A tecnologia é frequentemente apontada como a principal responsável pela redução dos custos de prestação de serviços e pela melhoria da qualidade do serviço, nomeadamente em termos de resultados clínicos. Nos últimos anos, tem havido um aumento do interesse e dos avanços em aplicações de inteligência artificial médica devido à substancial melhoria na capacidade de processamento dos computadores modernos e à disponibilidade de grandes quantidades de dados digitais. A utilização de aplicações de inteligência artificial pode trazer vantagens para o sector da saúde, nomeadamente na prática clínica, no diagnóstico, e nas cirurgias. Além disso, áreas ligadas à saúde, mas não diretamente ligadas à parte clínica, como a gestão e a administração, também podem beneficiar destas aplicações. Sunarti et al. (2023) destacaram vários benefícios, incluindo melhoria dos resultados para os doentes, redução de custos, melhor acesso aos cuidados de saúde em áreas rurais e aumento na contratação e retenção de pessoal. Estas vantagens também promovem confiança ao fomentar a responsabilidade e a transparência. No entanto, a implementação da inteligência artificial no setor da saúde apresenta perspectivas ainda mais animadoras para aumentar o acesso aos serviços em todos os níveis de atendimento no continente africano.

Os sistemas de saúde africanos já se encontram sobrecarregados e enfrentam pressões adicionais decorrentes do aumento dos gastos, da pandemia, de surtos de doenças infecciosas e do crescimento do número de doentes com doenças crónicas. É por isso que este estudo se dedica à análise das oportunidades, riscos e barreiras da adoção da inteligência artificial no sector da saúde na África Subsaariana através de uma revisão sistemática da literatura. Inicialmente, foi estabelecido o âmbito do estudo e foram definidos os critérios de inclusão/exclusão para abranger um horizonte temporal entre 2018 e 2024, a relevância para o tema e a precisão da literatura selecionada. Foram utilizadas bases de dados como a PubMed, a Medline, a Science Direct e o Google Scholar para extrair a literatura necessária, através da pesquisa por palavras-chave e frases definidas. Utilizou-se um fluxograma PRISMA para mostrar a literatura selecionada para análise. A análise descritiva do fluxograma PRISMA revela que foram analisados 528 artigos para estudar as oportunidades, riscos e barreiras da adoção da inteligência artificial no sector da saúde na África Subsaariana. Durante o processo de revisão sistemática, foram identificados 120 artigos duplicados e, conseqüentemente, excluídos do conjunto inicial. Posteriormente, foi aplicado um processo de seleção a 407 artigos. Nomeadamente, 23 artigos foram removidos por não cumprirem os critérios de elegibilidade do estudo. Isto envolveu casos em que os artigos estudavam outros países para além da África Subsaariana, ou quando havia detalhes que indicavam a inclusão de outro sector, como a educação ou a política, em vez do foco pretendido no sector da saúde. Deste modo, foram selecionados para o estudo final, quatorze artigos publicados entre 2018 e 2024 que, cumpriam todos os critérios previamente estabelecidos.

O estudo revelou que o uso da tecnologia de inteligência artificial tem um potencial incrível no desenvolvimento de sistemas de saúde mais robustos e na melhoria dos resultados dos pacientes, conforme demonstrado no trabalho de Anthony et al. (2023). O estudo também evidencia que as tecnologias de inteligência artificial estão a melhorar significativamente a eficácia de enfermagem e da gestão dos hospitais (Lee e Yoon, 2021). Além disso, ficou patente que a inteligência artificial pode melhorar a segurança da saúde, embora traga consigo novos riscos (Macrae, 2019).

Ainda de acordo com este estudo, existem enormes oportunidades de utilização da inteligência artificial nos diagnósticos das doenças, nas análises de risco, na triagem dos doentes e como auxílio nas cirurgias. Owoyemi et al. (2020) fornecem mais perspectivas sobre a utilização da inteligência artificial nos cuidados de saúde, lançando luz sobre as potenciais vantagens e dificuldades encontradas pelo sector dos cuidados de saúde, como a utilização da inteligência artificial para identificar medicamentos falsificados, melhorar a eficácia da enfermagem, o diagnóstico e a gestão hospitalar. No entanto, também foram identificados riscos e preocupações relacionados com a privacidade de dados, gestão da segurança da inteligência artificial, enviesamento nos algoritmos e questões ligadas à regulação da ação da inteligência artificial.

Mais especificamente, a adoção da inteligência artificial na saúde na África Subsaariana enfrenta barreiras que vão desde questões éticas, legais e sociais, que podem manifestar-se na forma de infraestruturas deficientes, imprecisão na deteção e tratamento de doenças, preocupações com a privacidade de dados e a necessidade de um quadro legislativo específico.

Este estudo recomenda a criação e implementação de marcos regulatórios personalizados para a inteligência artificial na saúde, que visem especificamente as questões e complexidades únicas da África Subsaariana. Adicionalmente, é recomendada a alocação de recursos para pesquisa e formação de técnicos, pessoal médico e reguladores de políticas de saúde em inteligência artificial. É igualmente crucial o investimento em infraestruturas necessárias para apoiar o desenvolvimento e adoção da inteligência artificial. Este documento deve fornecer instruções para salvaguardar a privacidade de dados, abordar questões éticas e estabelecer critérios para o uso da inteligência artificial em ambientes médicos. De acordo com Assadullah (2019), estes obstáculos têm implicações ao nível da gestão, da investigação e da regulamentação, que vão desde a elaboração de políticas, o teste e a classificação dos sistemas de inteligência artificial para utilização nos cuidados de saúde, o tratamento seguro dos dados relativos aos cuidados de saúde e os preconceitos.

Para além do exposto, é importante ressaltar a necessidade de envolver a comunidade em geral no processo de adoção da inteligência artificial na saúde. A sensibilização para os benefícios e riscos potenciais é fundamental para garantir a aceitação e confiança do público. A colaboração com empresas tecnológicas também é crucial para o desenvolvimento e implementação de soluções de inteligência artificial adaptadas ao contexto africano.

Além disso, é importante considerar o potencial da inteligência artificial para melhorar a educação e a formação dos profissionais de saúde em toda a África. A inteligência artificial pode ser utilizada para criar programas de aprendizagem personalizados e fornecer acesso a recursos educativos de qualidade, independentemente da localização geográfica.

Em conclusão, a inteligência artificial tem o potencial de transformar a prestação de serviços de saúde na África Subsaariana. No entanto, para que esse potencial seja plenamente realizado, é necessário abordar as barreiras existentes e desenvolver um ecossistema de inteligência artificial robusto e sustentável. Através de um investimento estratégico em infraestrutura, recursos humanos e um quadro legislativo adequado, a África Subsaariana pode tirar partido dos benefícios da inteligência artificial e melhorar significativamente a saúde e o bem-estar das suas populações.

Palavras-chave: Inteligência Artificial, Saúde, Oportunidades, Riscos, Barreiras, Assistência Médica, África Subsaariana

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List of Abbreviations

AI- Artificial Intelligence

TAM- Technology Acceptance Model

TAM 2 – Technology Acceptance Model 2

MRI- Magnetic Resonance Imaging

CT- Computed Tomography

RCTs- Random Control Trials

MAI- Medical Artificial Intelligence

IT- Information Technology

RISE - Regulatory aspects, Interpretability, Interoperability, Structured Data and Evidence

HTA - Health Technology Assessment

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Artificial intelligence (AI) is believed to be the next "general-purpose" technology, following the steam engine, electricity, and the internal combustion engine (Brynjolfsson and McAfee, 2017; Russell, 2021). This is a consensus among researchers and practitioners of emerging technologies. A fundamental breakthrough in the development of numerous businesses and societies should be based on the development (Chatterjee et al., 2021; Upadhyay et al., 2022; Woschank et al., 2020; Yeo et al., 2022) and the application of new technologies, including leading to advancements in design, logistics, manufacturing, and other areas. According to Kulkov (2023), the healthcare business is increasingly concentrating on the application of diagnosis, therapy, healthcare administration, and medication development.

Evidence of how technology is revolutionizing healthcare service delivery is evident in developed economies. The cost of goods and services has generally decreased, while productivity has increased thanks to technology. Technology is frequently cited as the primary driver of lower service delivery costs and higher service quality, namely in terms of realized clinical results. This is especially true when discussing the healthcare industry. As the world continues to urbanize, sustainable development is still seen as contingent upon sustainable urbanization; this is especially true in low- and lower-middle-income nations such as Ghana, where effective management of urban growth is crucial (KPMG, 2012). To ensure that everyone has access to infrastructure and services like healthcare, the United Nations (2017) points out that policies aimed at improving the lives of both urban and rural residents are essential.

A high-performing healthcare system must make use of all available data to enhance service delivery and offer evidence-based medicine (Batani and Maharaj, 2022; Mbunge, Muchemwa, and Batani, 2021). It must also make the required adjustments to enhance the system's quality, accessibility, and effectiveness (Wagenaar et al., 2017). All healthcare facilities must strive for three things to succeed: quality (providing efficient care and enhancing the patient experience); access (providing proactive care and facilitating admission into the healthcare system upon recognition of a need); and efficiency (streamlining healthcare processes and practices and minimizing costs while guaranteeing quality and access to care) (Batani and Maharaj, 2022).

The regulatory compliance burden is particularly great for new digital health technology. As such, the collection, processing, and management of health data in many healthcare systems, particularly in developing nations, is primarily dependent on paper-based procedures. Large volumes of health data kept in paper-based health systems are getting harder to access, store, process, and analyze—especially in times of pandemics like the coronavirus disease 2019 (COVID-19) (Mbunge, 2020).

AI is a "general purpose technology" that can alleviate problems and provide access to high-quality healthcare by utilizing digital data. AI applications in the medical field, such as contact tracking algorithms and access control systems for places, have been accelerated by the COVID-19 outbreak. Telemedicine and digital platforms were, in some cases, triggered by the pandemic. Nonetheless, data in some instances suggests that the pandemic has widened the digital divide and exacerbated historical divisions (Mothobi and Gillwald, 2021).

As per Russell and Norvig (2016), AI is a word that encompasses a vast and expanding array of computer technology functions, classifications, terminologies, and types. It is not a single technological component. A commonly acknowledged definition of AI in health has not yet been developed because it can have a broad or specific definition depending on how well it performs and uses data (House of Lords, 2018; Russell and Norvig, 2016). Russell and Norvig (2016) have identified several prominent instances of AI advancement, including deep learning, machine learning, and natural language processing.

Recent years have seen a significant increase in interest in and progress towards medical AI applications because of the significantly increased processing capacity of current computers as well as the abundance of digital data that can be gathered and used (Meskó, 2017). The use of AI in medicine is evolving gradually. Medical sectors, including clinical, diagnostic, rehabilitative, surgical, and prognostic practices, can all benefit from the deployment of various AI applications. Diagnosing diseases and making clinical decisions is another crucial area of medicine where AI is having an influence. To identify illness and inform clinical judgments, AI tools can ingest, analyze, and report vast amounts of data from several modalities (Hamid, 2016; Cho et al., 2020).

Improvements in patient outcomes, lower costs, more equitable healthcare distribution through support for rural areas and the recruitment and retention of staff there, and enhanced accountability and transparency—all of which contribute to the development of trust—were among the advantages outlined by Sunarti et al. (2021). Additionally, Siala and Wang (2022) highlight the enormous opportunities presented by integrating AI-powered or AI-embedded technologies for overcoming a variety of difficulties faced by health systems in Sub-Saharan Africa.

1.2 Statement of the Problem

The implementation of AI in the healthcare industry presents prospects for increasing access to services at all care levels throughout the African continent. Healthcare systems are already overworked, and they face additional pressures from growing expenses, pandemics, infectious disease outbreaks, and the growth of chronic illnesses. The intersection of pre-existing structural disparities, a lack of qualified healthcare workers or supplies, accessibility and cost issues, and the divisions between rural and urban areas create critical barriers (Banifatemi et al, 2021).

The work of Owoyemi et al. (2020) suggests that incorporating AI into healthcare has the potential to revolutionise the industry and overcome the challenges that Sub-Saharan African healthcare systems confront. This revolutionary potential encompasses lowering inequities, increasing access to high-quality healthcare, and improving patient outcomes. Significant progress in digital technology and AI in recent years has created many opportunities for the African health sector. Owoyemi et al. (2020) have claimed that digital technology and AI can be extremely helpful in tackling issues related to maternal and child health, infectious diseases, and non-communicable diseases that are common in Sub-Saharan Africa.

In 2022, Sharma and associates carried out research that demonstrated artificial intelligence's enormous potential in Sub-Saharan Africa's healthcare industry. The focus of their research was to enhance communication between patients and healthcare professionals, an area in dire need of improvement.

In their recent research, Sahni and colleagues (2023) investigated how the US healthcare system may save costs significantly by implementing AI utilising current technologies. Their research

revealed that a broader use of AI might result in savings of five to ten percent on US healthcare costs, or \$200 billion to \$360 billion, based on US healthcare expenditure statistics for 2019. This demonstrates one of the most hotly debated advantages of using AI in healthcare: cost savings, which are especially valuable in the health sector of Sub-Saharan Africa.

However, Sinde et al. (2023) contend that Anglophone African nations are not yet completely equipped to take advantage of artificial intelligence's potential for sustainable development in several fields, including healthcare. Equal weight must be given to identifying the current obstacles and limitations as well as the prospective benefits of implementing AI in Sub-Saharan Africa's healthcare systems.

Based on the backdrop, this study intends to investigate the opportunities, risks and barriers to AI adoption in healthcare in Sub-Saharan Africa. The rationale for stating that there is no systematic literature on this area and there is no similar bibliographic review on the topic with respect to Sub-Saharan Africa. In light of this, the study will demonstrate the substantial potential AI to enhance decision-making processes, identify patterns, predict outcomes, and automate and increase the effectiveness and efficiency of healthcare services in the aforementioned area through systematic review. The result of the study aims to assist hospital administrators and policymakers in more effectively distributing resources, optimising patient throughput, and improving the overall delivery of healthcare.

Although AI offers opportunities for enhanced patient outcomes and personalised therapy. The research aims to showcase the ability of AI systems to detect certain risk factors, enhance the accuracy of diagnoses, and provide personalised treatment plans. This would empower health

ministries and policymakers to develop targeted treatments and policies that address specific health requirements.

However, it is important to comprehend the dangers and challenges associated with using artificial intelligence in the healthcare sector. Concerns arise with data security, privacy, and potential bias in algorithmic decision-making. The study's results will compel governments and health ministries to establish stringent regulations and legislation to ensure the ethical implementation of AI and protect the rights of patients.

Ultimately, this study will enhance the existing knowledge on the intersection of AI and healthcare, and it will serve as a valuable resource for future academic inquiries. Since there is no bibliographic overview, this study hopes to synthesize as much information as possible within the given timeframe and resources, concluding related works in the field in the context of the Sub-Saharan African region.”

1.3 Objectives of the Study

The purpose of the study is to investigate the opportunities, risks and barriers of AI adoption in healthcare in Sub-Saharan Africa through Systematic Literature Review. The study specifically seeks;

1. To identify and analyse the existing opportunities for the use of AI technology in the healthcare system in Sub-Saharan Africa.
2. To enumerate the risks involved.
3. To examine and highlight the barriers to the adoption of AI in healthcare in the region.

1.4 Research Questions

1. What are the existing opportunities for the use of AI technology in the healthcare system in Sub-Saharan Africa?
2. What are the risks involved?
3. What are the barriers to the adoption of AI in healthcare in the region?

1.5 Significance of the Study

First, the study's outcomes will show how AI may significantly enhance decision-making processes, uncover trends, forecast outcomes, and automate and improve the efficacy and efficiency of healthcare services. The result will help hospital administration and policymakers better allocate resources, maximise patient flow, and enhance the delivery of healthcare as a whole.

AI also presents chances for improved patient outcomes and tailored treatment. The project will demonstrate how AI algorithms can identify specific risk factors, increase the precision of diagnoses, and offer individualised treatment regimens. This would enable ministries of health and decision-makers to create focused interventions and policies that cater to particular health needs.

But it's critical to understand the dangers and difficulties that come with using AI in healthcare. Data security, privacy, and the possibility of bias in algorithmic decision-making are issues. The study's findings will force governments and health ministries to create strict rules and laws to guarantee the ethical application of AI and safeguard patient rights.

In conclusion, the research will contribute to the body of knowledge regarding AI and healthcare, and it can serve as a point of reference for scholarly investigations.

1.6 Organisation of the Study

The study is organized into five chapters:

- Chapter 1: This introductory chapter provides the background of the study, statement of the problem, objective of the study, research questions, significance of the study, and organization of the study.
- Chapter 2 presents a literature review of the study topic, that is, artificial intelligence and healthcare in Sub-Saharan Africa.
- Chapter 3 presents the methods to be used for the study, it will entail the research approach, research design, sampling, data collection and data analysis.
- Chapter 4 presents the findings of the study which is the results.
- Chapter 5 presents the discussion of the results, conclusions of the study and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews past literature about the study topic. The study first looked at the concept of artificial intelligence, artificial intelligence in healthcare, technology acceptance theory representing the theoretical framework that align with the topic and the required objectives, and finally the opportunities, risks and barriers of AI in healthcare with the view of conducting a systematic literature review.

2.2 Concept of Artificial Intelligence

Artificial intelligence encompasses a variety of technologies that collaborate to empower machines with the ability to see, understand, take action, and acquire knowledge at a level comparable to humans. Perhaps this is the reason why there appears to be a divergence in the understanding of artificial intelligence among individuals: AI is not a singular entity. Machine learning and natural language processing are key components of the artificial intelligence domain. Each component is progressing along its unique trajectory and, when utilised in conjunction with data, analytics, and automation, has the potential to assist businesses in attaining their objectives, whether it be enhancing customer service or optimising the supply chain (www.accenture.com).

AI systems function by assimilating substantial quantities of labelled training data, scrutinising the data for correlations and patterns, and employing these patterns to formulate predictions regarding forthcoming conditions. By providing a chatbot with a dataset of text samples, it can acquire the

ability to generate realistic conversations with individuals. Similarly, an image recognition tool can develop the capability to recognise and describe things in photographs by analysing millions of examples. State-of-the-art generative AI methods are capable of producing highly realistic text, images, music, and other forms of media, with significant advancements being made at a quick pace (Laskowski and Tucci, 2023).

The field of AI has been a persistent pursuit of scientists and engineers for more than six and a half decades. The fundamental argument posits that machines developed by humans possess the capacity to not only do arduous tasks but also acquire intelligence akin to that of humans. Whether conscious of it or not, AI has been deeply integrated into our everyday lives, assuming innovative functions in industries, healthcare, transportation, education, and various other domains that directly impact the public. AI is widely recognised as a significant catalyst for transforming socio-economic livelihoods. AI plays a significant role in advancing cutting-edge technology across several disciplines of study, serving as valuable instruments for pioneering research. Nevertheless, the current success of AI did not come about without obstacles. Over the past few decades, AI has faced significant challenges and setbacks known as "winters" (Jiang et al., 2022).

The time preceding the year 1956 is considered to be the incubation phase of AI. Before that period, scientists and engineers endeavoured to substitute a portion of their cognitive labour with robots. In 1936, mathematician Alan Turing introduced a mathematical framework for an optimal computer, establishing the theoretical basis for future electrical computers. In 1943, neurophysiologists W. McCulloch and W. Pitts constructed the initial neural network model, known as the M-P model (Zhang and Zhang, 1999). The M-P model is the initial mathematical model designed to replicate the structure and operational mechanism of organic neurons. It can be

considered the oldest artificial neural network. In 1949, Hebb introduced a learning mechanism rooted in neuropsychology (Kuriscak, Marsalek, Stroffek, & Toth, 2015).

The "Hebb learning rule" is an unsupervised learning rule that extracts statistical features from training sets and classifies data based on their similarity. This represents the most primitive concept of machine learning (ML), and it closely resembles the cognitive process of humans. In 1952, Arthur Samuel, a scientist at IBM, created a checkers programme that was capable of acquiring implicit models from the present position and providing instructions for future moves (Samuel, 2000). Chess programs were one of the early examples of evolutionary computing in this particular application. The method conducts a comparison between a modified replica and the optimal version and designates the victor as the new benchmark. John McCarthy is credited with coining the term "AI" at the 1956 Dartmouth Summer Research Project on Artificial Intelligence, together with McCarthy, Minsky, Rochester, and Shannon (1955). John McCarthy is widely regarded as the progenitor of artificial intelligence. Following this event, the investigation into artificial intelligence has yielded numerous notable accomplishments, such as machine learning, theorem proving, pattern recognition, problem-solving, expert systems, and natural language processing.

The emergence of AI is linked to a substantial augmentation in computational capacity (Yin and Kaynak, 2015; Yin, Li, Gao, and Kaynak, 2014). The increased dimensions of AI-based devices allow them to effectively handle complex jobs. During this period, there will unavoidably be a decrease in the speed of transmitting and processing information, resulting in a significant amount of energy being consumed (Shen, Harris, Skirlo S., et al., 2017). Anticipated advancements in photon computing are projected to address the current limitations of electron-based computing methods, perhaps resolving the bottleneck issue (Shen, Harris, Skirlo S., et al., 2017).

Aside from the limitations imposed by physical laws on achieving the highest attainable speed, many obstacles in the implementation process might result in substantial delays. By employing advanced methods of speeding up processes in both hardware architecture (Zaman, Reaz, Ali, et al., 2021) and software algorithms, the duration of training tasks, which typically span several months, can be significantly reduced to a matter of days or even hours (Li et al., 2021; Meidan, Lerner, Rabinowitz, and Hassoun, 2011; Sun et al., 2019). It is feasible because diverse deep neural networks can be broken down into multiple blocks where numerous necessary operations are the same. As an illustration, a standard CNN (Convolutional Neural Network) block typically encompasses the steps of convolution, pooling, normalisation, activation, and a fully linked layer (Bau et al., 2020).

Recently, there have been promising results documented about AI chips. Specialised NPUs (Neural Network Processing Units) have been created and implemented on Kirin 970 chips and A11-A14 Bionic CPUs for iPhones. This enables the execution of tasks in real-time on portable devices, such as video processing for live broadcasts, rapid biometric identification, and 3D rendering in games (Jones et al., 2020; Yeh, Lin, Chung, and Wang, 2012; Krizhevsky, Sutskever, and Hinton, 2012). The public was impressed and regained faith in AI due to the superior performance of several AI systems in contests and competitions, surpassing even the top human players (Moravcik, Schmid et al., 2017; Johnson N. et al., 2013).

In 2011, IBM's artificial intelligence system Watson emerged as the victor of the highly regarded quiz television show "Jeopardy!" in the United States. Despite not having an internet connection, the device possessed a storage capacity of four terabytes, capable of accommodating 200 million pages of data, including the whole edition of Wikipedia. This is an impressive accomplishment in

creating a machine that possesses a wide range of capabilities, including information retrieval, knowledge organisation, logical thinking, and natural language understanding. Between 2016 and 2017, AlphaGo engaged in matches against professional go players and emerged victorious against more than 60 esteemed human go masters, such as the world champion Lee Sedol and the highest-ranked player in the world, Ke Jie. The team at Google's DeepMind, which previously developed AlphaGo, went on to create a new artificial intelligence system called AlphaGo Zero. This system is unique in that it is completely self-taught, starting from the beginning without any input from human game records. The system achieved a level of knowledge that exceeded thousands of years of human understanding using reinforcement learning. Remarkably, it was able to uncover new and unexpected tactics within a matter of days (Silver, Schrittwieser, Simonyan, et al., 2017).

2.3 Artificial Intelligence in Healthcare

Researchers and health professionals are currently focusing on the application of AI in the healthcare sector. Prior research on this subject has been limited in its exploration of a multi-disciplinary approach, encompassing fields such as accounting, business and management, decision sciences, and health professions (Secinaro, Calandra, Secinaro, et al., 2021).

Prior to the COVID-19 pandemic, with telemedicine, various contactless healthcare solutions were being utilised. A notable example of a contactless healthcare system involved the monitoring of vital indicators, such as blood pressure, heart rate, and temperature, using radio frequency identification technology (Hui and Kan, 2017). Although this automated method is efficient in monitoring patients' vital signs, it necessitates a reader device and the ability to link with other systems. Therefore, this method has not been extensively implemented (Ukkonen and Sydanheimo, 2017). Furthermore, AI-enabled robots have been utilised in various capacities

within the healthcare sector. These include aiding in inpatient rounds, organising medical records, managing reception and payment, as well as providing treatment information such as the number of patients waiting and estimated examination times (Yoon et al., 2020). As previously mentioned, the development of smart healthcare during the Fourth Industrial Revolution involved combining cutting-edge information technology like AI and integrated circuit board modules. This period is now known as the pre-COVID-19 era (Lee and Lee, 2020, 2020b).

The growing emphasis on technology in the field of healthcare has created a pressing necessity to examine how organisations successfully execute and oversee change in their development procedures. Hence, it is vital to comprehend the pertinent facets of technology management, specifically in the context of using AI in healthcare (Kulkov et al., 2023d). The AI programme "Watson for Oncology," created by IBM, has been widely used due to its ability to offer cancer diagnoses that align with 90% of diagnoses made by oncology specialists (Liang et al., 2019). AI enhances both the effectiveness of hospital operations management and the provision of patient-centred healthcare services (Yoon and Lee, 2018; Yoon et al., 2020).

In addition, the healthcare industry is currently spearheading innovation through the implementation of modern information technology, such as artificial intelligence and integrated circuit board manufacturing combined with healthcare. Many hospitals have implemented intelligent healthcare systems, enabling medical personnel to deliver treatment and diagnosis services to patients through both online and offline channels. In addition, wearable scanners or medical gadgets are employed for post-treatment patient health care, while hospital-specific apps provide continuous monitoring of patients' status around the clock. The Cleveland Clinic in the United States collaborated with Siemens Healthineers, a prominent medical technology business,

to conduct advanced artificial intelligence research aimed at providing precise guidance for the treatment of cancer patients (Cleveland Clinic Newsroom, 2019). The Mayo Clinic and Google have revolutionised healthcare service delivery by implementing AI-powered solutions for secure storage and protection of patient data. This collaboration has paved the way for digital advancements in disease detection and treatment (Anastasijevic, 2019).

Healthcare expenses are rapidly increasing worldwide. The increasing life expectancy, rising incidence of chronic diseases, and ongoing developments in pricey medicines are the driving forces behind this trend. Therefore, it is unsurprising that researchers anticipate a bleak outlook for the long-term viability of healthcare systems worldwide. AI offers the potential to mitigate the effects of these advancements by enhancing healthcare and increasing its cost-effectiveness (Higgins and Madai, 2020). In the field of medicine, AI is commonly utilised through clinical decision support systems (CDSS), which aid healthcare professionals in the process of diagnosing diseases and making treatment decisions. Conventional clinical decision support systems (CDSS) compare the traits of individual patients to a pre-existing database of knowledge. In contrast, AI-based CDSSs utilise artificial intelligence models that have been trained on data from patients who are similar to the specific situation being addressed. However, despite its unquestionable capacity, AI is not a universally applicable answer. In the past, significant challenges and new questions have frequently accompanied technical advancements.

Certain issues stem from the technological aspects of AI, while others are associated with legal, medical, and patient viewpoints, necessitating the adoption of a multidisciplinary approach.

GE Healthcare Partners has implemented the "Clinical Command Centre," a cutting-edge healthcare system, in seven hospitals spanning the USA, the United Kingdom, and Canada,

utilising AI. The purpose of this centre is to enhance the effectiveness of hospital administration and deliver healthcare services that prioritise the needs of patients. This is achieved using artificial intelligence, which enables real-time analysis of information. The centre employs various advanced technologies, including predictive prescription, machine learning, natural language processing with complex algorithms, and predictive analytics (GE Healthcare Partners website).

In their study, Kulkov et al. (2023d) investigated the impact of AI on the healthcare industry, specifically exploring its role in fostering entrepreneurship and generating value. The results demonstrate that the integration of several technologies can confer a competitive edge on technology entrepreneurs and facilitate the shift from basic consumer products to practical healthcare applications. Kulkov et al. (2023d) categorised three primary domains of entrepreneurship: 1. Analytics encompassing staff downsizing, patient forecasting, and decision-making assistance; 2. Security measures encompassing defence against cyberattacks and identification of unusual cases; 3. Performance enhancement involving streamlining medical procedures, staff training, minimising capital expenses, and exploring new markets.

Rong, Mendez, Assi, et al. (2020) undertook a review to monitor recent scientific achievements, assess the accessibility of technologies, recognise the significant potential of AI in biomedicine, and offer inspiration to researchers in related disciplines. It might be argued that similar to AI itself, the implementation of AI in biomedicine is still in its nascent phase. Continual advancements and discoveries will further expand the boundaries and broaden the range of AI implementation, with rapid progress anticipated in the foreseeable future.

A significant category of illness diagnosis relies on the utilisation of medical imaging (two-dimensional) and signal (one-dimensional) processing. These methods have been utilised in the

identification, treatment, and forecasting of diseases. AI has been utilised in one-dimensional signal processing for biomedical signal feature extraction. This includes applications in electroencephalography, electromyography, and electrocardiography. Electrocardiography has a significant role in predicting epileptic seizures. Predicting seizures is crucial to mitigate their impact on patients (Cook, O'Brien, Berkovic, et al., 2013).

Tran et al. (2019) specifically examine the worldwide progression of AI research in the field of medicine. Their bibliometric study focuses on identifying trends and issues specifically connected to the applications and techniques of AI. According to a study by Connelly et al. (2020), there has been a significant increase in the number of robot-assisted surgeries in recent years. Their bibliometric research illustrates the increasing adoption of robotic-assisted surgery across several medical disciplines, including urology, colorectal surgery, cardiothoracic surgery, orthopaedics, maxillofacial surgery, and neurosurgery. Secinaro, Calandra, Secinaro, et al. (2021) conducted a study that uncovers several AI applications in health care as well as a significant amount of research that remains unexplored. For example, AI projects necessitate expertise and a keen understanding of data quality for in-depth research and knowledge-driven administration. Insights can facilitate academics and health professionals in comprehending and tackling forthcoming studies on artificial intelligence in the healthcare domain.

2.4 Theoretical Framework

2.4.1 Technology Acceptance Theory

Technology adoption has emerged as a highly important topic in the world of software engineering. Many theories and models have been suggested throughout the years to explain individuals' usage behaviour towards technologies (Momani & Jamous, 2017). Since the 1970s, it has been

acknowledged that studying the adoption, acceptability, and usage of information technologies and information systems is necessary for effectively using and implementing technology. For organisations, this implies the need to further augment their financial allocation towards information technology (Hong, Thong, and Tam, 2006). Davis, Bagozzi, and Warshaw (1989) defined technology adoption as the process of incorporating software and hardware technology into an organisation with the aim of enhancing productivity, gaining a competitive edge, accelerating processing speed, and facilitating easy access to information.

The Technology Acceptance Model (TAM) is a modification of the Theory of Reasoned Action (TRA) developed by Davis (1986). The technology acceptance measures of perceived usefulness and perceived ease of use were substituted for TRA's attitude towards behaviour. TAM did not incorporate the subjective norms of the TRA into its framework. It was created after the implementation of information systems within organisations. The development of the mentioned concept is specific to the information technology industry, whereas TRA and the Theory of Planned Behaviour (TPB) were formed in the psychology field. Consequently, it is more specific and focused compared to TRA and TPB (Davis et al., 1989). The development of TAM proceeds through three phases: adoption, validation, and extension. During the adoption phase, the information system applications underwent extensive testing and were subsequently implemented. During the validation phase, researchers observed that TAM effectively measures users' acceptance behaviour towards various technologies with precision. In the extension phase, numerous studies have been conducted to include new variables and explore the links between the elements of the Technology Acceptance Model (TAM).

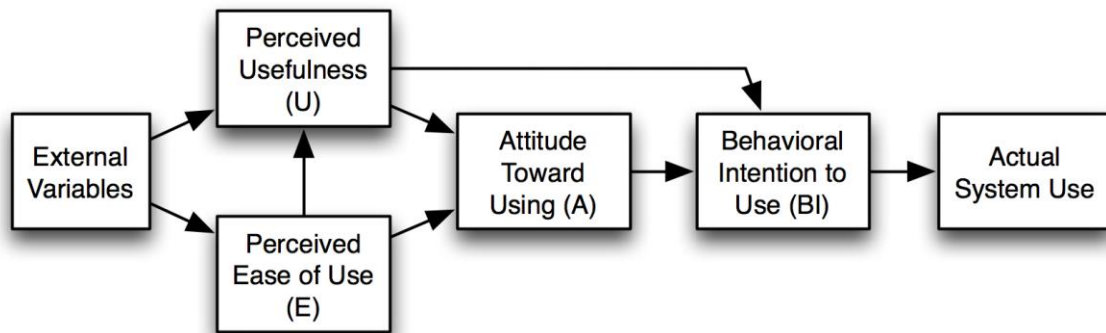


Figure 1: Technology Acceptance Model (TAM). (EconPosts, 2024).

TAM2 was developed in the realm of information technology. Venkatesh and Davis (2000) expanded upon TAM to elucidate the concepts of perceived utility and perceived ease of use, taking into account the perspectives of social impact and cognitive instrumental processes. Social influence mechanisms encompass subjective norms, voluntariness, and image, whereas cognitive instrumental processes encompass job relevance, output quality, outcome demonstrability, and perceived simplicity of use. In contrast to TAM, Venkatesh and Davis incorporated subjective norms as an additional component by drawing from the TRA and TPB models. The subjective norm is directly related to both the perceived usefulness and the intention to utilize it. The association between perceived usefulness and it is influenced by the user experience, whereas the association between intention of use and it is influenced by both the user experience and the voluntariness of usage. Enhancing the performance of the TAM model can be achieved by including additional constructs from older theories, along with certain moderators, into the perceived utility and perceived ease of use in TAM2.

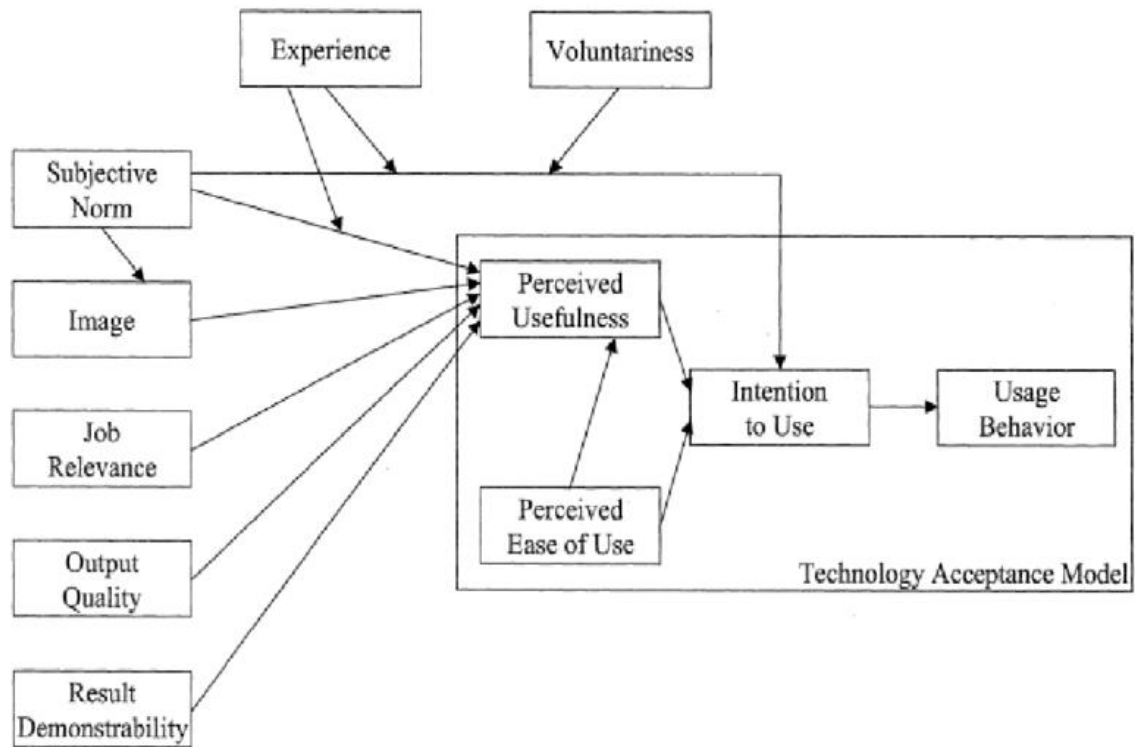


Figure 2: Technology Acceptance Model II (TAM 2) (Venkatesh and Davis, 2000).

From a theoretical perspective, most studies on AI’s role in health care are devoted to successful cases in diagnostics, therapy and other areas (Hee Lee and Yoon, 2021; Yu et al., 2018), the role of technology business in industry transformation (Kulkov et al., 2023a, b, c), ethics (Bartoletti, 2019) and trust (Omran et al., 2022). Many authors combine different technologies and emphasize the importance of their implementation for healthcare needs (Aceto et al., 2018; Syeed et al., 2022). Conversely, researchers state that AI enables literature technology to empower society and processes (Secinaro et al., 2021). Some health studies mention that AI’s primary use is in health care but leave this area open for other researchers (Giuggioli and Pellegrini, 2023; Panch et al., 2019).

2.5 Opportunities, Risks and Barriers of AI in Healthcare

Iliashenko, Bikkulova, and Dubgorn (2019) determined that AI is predominantly utilised in healthcare for the execution of the following tasks: 1) providing aid in diagnosing medical conditions; 2) overseeing the operations of healthcare organisations; 3) maintaining a healthy way of living. As stated by Iliashenko et al. (2019), the primary obstacles to the implementation of AI in healthcare include 1) the requirement for specialised infrastructure within organisations; 2) societal bias against AI; 3) the need to ensure privacy and data security; 4) the need to deliver highly reliable and high-quality services.

In their 2021 study, Sunarti, Rahman, Naufal, et al. explored the potential of AI and its associated risks in the field of health services. A thorough literature search was conducted across three databases (Web of Science, Google Scholar, and EBSCOhost) to locate relevant papers. Utilising AI to enhance health care. The quality of the studies was evaluated by two reviewers using the Joanna Briggs Institute. The application's potential to enhance diagnoses, prevention, and treatment of patients has been established, leading to improved cost efficiency and equality in health services. In the dilemma at hand, the lack of AI implementation in the public sector gives rise to issues about patients' privacy and their rights to autonomy in AI applications.

Racine, Boehlen, and Sample (2019) assert that various forms of AI, such as deep learning algorithms and neural networks, are currently undergoing extensive investigation for innovative healthcare applications. These applications encompass areas such as imaging and diagnosis, risk analysis, lifestyle management and monitoring, health information management, and virtual health assistance. The anticipated advantages in these domains are extensive and encompass enhanced imaging speed, a deeper understanding of predictive screening, and reduced healthcare expenses

and inefficiencies. Nevertheless, AI-driven healthcare technologies can give rise to numerous scenarios that may question widely accepted values and ethical norms. This brief article focuses on three potentially troublesome elements of utilising artificial intelligence in the field of healthcare: The three key aspects are: (1) the management of dynamic information and permission; (2) the clear visibility and control over data ownership; and (3) the protection of privacy and prevention of prejudice.

A review was undertaken by Aung, Wong, and Ting (2021) using the search terms 'AI' or 'ML' or 'deep learning' and 'healthcare' or 'medical' on PubMed and Google Scholar, covering the period from 2000 to 2021. The applications of AI have the potential to revolutionise the workflow of physicians and enhance patient care by supporting doctors, automating administrative duties, and enhancing medical knowledge. The deployment of AI is fraught with problems, ranging from training ML systems to a lack of clear accountability. It is a complex and gradual process at best. Physicians also have a limited comprehension of the potential implications of AI applications. The implementation of AI in healthcare can have significant advantages, but it necessitates careful regulation comparable to the regulation of medical practitioners. There is a requirement for regulatory rules to be established to ensure the safe implementation and evaluation of AI technology. Additionally, more study is necessary to understand the precise capabilities and limitations of AI in the field of medicine.

Hazarika (2020) conducted a study to discover prospective AI opportunities that could significantly change the role of healthcare providers. This was done by evaluating the existing literature. The study determined that AI is revolutionising the healthcare industry by enhancing operational effectiveness and elevating the standard of service. It can aid healthcare providers in

making well-informed clinical decisions and motivate individuals to actively participate in managing their health. Artificial intelligence can mechanise monotonous duties, enabling professionals to concentrate on more advanced cognitive responsibilities and the provision of care to patients. Nevertheless, it also poses difficulties such as ethical and medico-legal consequences, labour market ramifications, and inherent data prejudices. To maximise the advantages of AI, it is necessary to adopt a well-rounded strategy that focuses on improving accountability, transparency, innovation, responsible data access, and trust. Artificial intelligence is unlikely to supplant people, but it will change their responsibilities.

Zhang and Kamel Boulos (2023) showcased a range of illustrative instances of generative AI applications in the fields of medicine and healthcare. They also examined several related concerns, including trust, accuracy, clinical safety, dependability, privacy, copyrights, ownership, and prospects, such as AI-powered conversational user interfaces to enhance human-computer interaction. Zhang and Kamel Boulos (2023) concluded that as generative AI continues to advance and become more customised for the medical field, it will have a growing significance in medicine and healthcare. This will be facilitated by the development of laws, policies, and regulatory frameworks that govern its use.

According to Hamid (2016), AI technologies are improving medical diagnosis and decision-making by rapidly and reliably detecting disease indicators in medical imaging, surpassing human capabilities. Enlitic's deep learning algorithm, known as Picture Archiving and Communications (PAC), can identify diseases in MRI, CT scans, ultrasound, and X-rays at a significantly accelerated rate of 50–70%. The promise of AI to enhance healthcare is promising, although it also poses hazards. Trust is contingent upon the essential factors of accuracy, reliability, security, and

privacy. AI systems in clinical environments may come across untrained data, which can jeopardise patient safety. It is imperative to protect the data collected by smart wearables, such as Fitbit PurePulse Trackers. Transparency in outcomes is essential for building trust in AI systems. It is essential to tackle these dangers as technology advances and becomes more widely used (Hamid, 2016).

AI-enabled devices can provide valuable insights into various areas of healthcare. These insights can help identify both positive and negative health-seeking behaviours, facilitate point-of-care diagnostics, determine target indications for existing therapies, explore the epigenetics of diseases, develop new care pathways, establish standards of care, evaluate programme quality, and even contribute to accreditation standards. The integration of artificial intelligence into decision-support apps has the potential to enable patients to assume responsibility for their healthcare plans (Eysenbach, 2000) and enhance compliance with medicine and therapy (Bohlmann, Mostafa, & Kumar, 2021). AI can enhance the speed and accuracy of disease diagnosis for physicians, particularly in the critical care unit. It can also identify emergent dangers and facilitate smooth transitions of care. Deep learning is being used more and more in radiology to identify possibly cancerous lesions in radiological images that may not be detectable by expert radiologists (Vial, Stirling, Field, et al., 2018).

When artificial intelligence is integrated into machines that carry out tasks dependent on context, they can react to user prompts, environmental circumstances, and alterations in task priorities as determined by the user. The advancement of self-governing social robots that interpret facial expressions as indicators of emotion depends on AI technology and the collection of real-time sensory data (Campa, 2016). AI in robots can offer social assistance to patients, gather novel forms

of data for clinical trials, and enhance rehabilitation results by facilitating adaptive routines according to patient feedback (Campa, 2016).

Translating AI advances into practical applications in healthcare is a formidable obstacle to overcome. Initially, extensive and inclusive training data sets are not easily accessible to all researchers or are scattered in separate data repositories that necessitate numerous layers of authorization to get. Furthermore, the algorithms employed to derive information from the data can rapidly become outdated as novel methodologies are developed. These problems pose two inquiries to potential users and regulators: 'What level of accuracy is considered satisfactory?' and 'When should adoption take place?' Clinicians are typically cautious about being early adopters of innovations due to the possible safety hazards. AI may inject technical limits and potential biases into the therapeutic decision-making process, which physicians may be less familiar with (Lachman, 2020).

The use of AI-based apps raises apprehensions over the confidentiality and protection of data. Health data is highly confidential and often a prime target for data breaches. Ensuring the security of patient data is of utmost importance (Dilsizian and Siegel, 2014). The advancement of AI raises issues about data privacy since consumers may mistakenly see artificial systems as humans and unknowingly contribute to future data collection (Luxton, 2014). Hence, patient consent plays a vital role in addressing data privacy issues, as healthcare organisations may authorise the extensive use of patient data for AI training without obtaining adequate individual patient agreement. In 2018, Google bought DeepMind Health (Powles and Hodson, 2017).

An impediment for patients adopting this technology is their confidence in the safety and security of data collection. Patients may harbour skepticism towards "impersonal" data collection software,

such as AI, for storing diagnosis and treatment information. According to a recent survey conducted in the United States, data privacy is regarded as the foremost concern when contemplating artificial intelligence technologies (Zhang and Dafoe, 2020).

Mathur and Geerts (2023) examined the notable obstacles that can impede the integration of technology, such as AI, in the provision of medical treatment. In order for AI to be embraced, clinicians must possess comprehension and confidence in AI systems. Education and comprehension of AI models are crucial components in this process. The interface design of the AI is a crucial factor in establishing confidence with clinicians. Additional obstacles are to the verification of the efficacy, specifically the economic and medical worth of the AI system.

High-quality datasets are necessary for clinicians to validate AI models both clinically and technically. Nevertheless, the collection of patient information and photographs for the purpose of testing AI algorithms becomes hard as a result of the dispersion of medical data across multiple electronic health record systems (EHRs) and software platforms. An additional hindrance arises from the incompatibility of medical data between organisations, resulting from interoperability issues with other platforms. To enhance the quantity of data accessible for testing artificial intelligence systems, the healthcare industry should focus on developing methods for standardising medical data (Emeritus, 2023).

Tachkov, Zemlenyi, Kamusheva et al. (2022) divided the potential hurdles into categories such as data-related, methodological, technological, regulatory and policy-related, and human factor-related. Several barriers exhibit significant similarities, particularly in relation to the technologies involved. There is a limited amount of research that specifically examines the utilisation of artificial intelligence in the context of health technology assessment and decision-making. The

field of AI and augmented decision-making tools is a relatively new discipline, and we are now working on customising it to meet specific requirements. The process of HTA involves several sequential processes and several evaluations that depend on diverse data sources. Hence, the predictable spectrum of obstacles necessitates input from field specialists to identify the most significant hurdles. This will enable the formulation of recommendations to surmount these barriers and facilitate the widespread implementation of these technologies.

Chapter Three

Methodology

3.1 Introduction

This chapter emphasised and implemented the systematic review analytical approach employed for carrying out important evidence that is significant to meet the requirement for the objectives of the study. According to Pollock and Berge, (2018), a systematic review has to do with the rigorous process of identifying, appraising, and synthesizing relevant studies to address a specific research question/objective. The rationale for opting for this method is that systematic review is based on its transparency, predefined protocol and its ability to minimize bias. This method also enables comprehensive exploration of existing literature and secondary sources of data, providing a robust evidence base. The sequential steps involved in the systematic review are outlined as follows:

3.2 Systematic Review Stages

Stage 1: Study Scope

The "Study Scope" in the systematic review process entails precisely defining the limits and restrictions of the research questions/objectives. This explains how the researcher established the connection between the variables selected in the topic and as well relating them to the Sub-Saharan African context. Based on this, it is important to determine the review of the inclusion and exclusion criteria of the study.

The rationale for the aforementioned statement is to clearly define the research scope that directly affects the manageability, relevance and accuracy of the study (Snyder, 2019). To maintain an

emphasis on specific features, it is important to establish a clear scope while reviewing the extensive and different fields of AI in healthcare, particularly considering the distinct problems encountered in Sub-Saharan Africa. For example, it includes identifying the categories of AI applications (such as diagnosis, therapy, and data management) or the particular healthcare environments in Sub-Saharan Africa (urban, rural, primary care).

This precision in defining the study scope has several implications. Firstly, it aids researchers in handling the vast amount of material accessible, so ensuring a more streamlined and focused review process. Furthermore, a well-defined scope improves the internal validity of the review by ensuring consistency in the criteria used to include or exclude information (Paré et al. 2016). This implies that it ensures that the chosen studies are exactly in line with the problem of the research, hence minimising the possibility of introducing bias. Furthermore, a meticulously structured research scope is essential for ensuring the applicability of the results. In light of this, the researcher gets significant insights into the prospects, hazards, and obstacles of AI implementation in healthcare in Sub-Saharan Africa by clearly defining the inclusion criteria and then analysing the journals selected for the study.

Stage 2: Database and Keyword Search

Databases: At this phase, the selection of research databases plays a pivotal role in enhancing the ability to access pertinent data. To conduct a systematic review in the specified research domain, various databases are under evaluation. Specifically, the chosen research topic focuses on Artificial intelligence and Health care in the quest to examine the risks, barriers and opportunities in sub-Saharan Africa. In light of this, the following databases will be considered, and these include PubMed, Medline and Science Direct. These databases are preferred due to their extensive collection of peer-reviewed research journals and articles on the research.

Additionally, Google Scholar is employed to access openly available secondary materials, serving as a comprehensive search engine offering academic books and peer-reviewed journals. Leveraging these databases involves retrieving peer-reviewed journal articles that encompass diverse research approaches, data collection methods, and focal points. The selection of these articles aligns with meticulously defined inclusion and exclusion criteria. The utilization of academic databases, including the retrieval of secondary research material, is instrumental as it provides relevant information that is important for analysing the risks, barriers and opportunities in the Sub-Saharan countries regarding Artificial Intelligence and Healthcare services.

Keyword search: After determining the most appropriate databases for the systematic review, it becomes critical to seek accurate keywords that align with the research objectives from these databases. The acquisition of precise information that aligns with the research objectives/question and contributes to solving the research problem is imperative. These keywords serve as substantial evidence, essential for conducting a highly valid systematic review and deriving effective research outcomes. The keyword selection process plays a pivotal role in this context. The rationale behind selecting the right keywords is to facilitate an efficient exploration of databases and establish key research variables. Consequently, a brainstorming session is conducted to identify and employ effective keywords, addressing the research problem as outlined below. Also, the Boolean operators include the use of “AND, OR”, used to join the keywords and to ensure that the words are relevant before applying them where necessary.

Table 1: The Keyword search and connectors selected for the systematic review process.

Connectors	Keywords used to search for the journals selected	Expected outcome of the keywords search
AND	<ol style="list-style-type: none"> 1. Artificial Intelligence AND Machine Learning 2. Opportunities AND Benefits Risk AND Dangers 	The researcher retrieved all the keyword search if they had all the records and counted the articles/journals as those relevant to the study.
OR	<ol style="list-style-type: none"> 1. Healthcare OR Hospital 2. Barriers OR Challenges 3. Barriers OR Problems 	ANY of the keyword search terms could be included or used interchangeably while searching for the papers suitable for this study.

Stage 3: Inclusion and Exclusion Criteria

Quality Criteria: Maintaining quality is necessary to obtain authentic and reliable research outcomes to address the planned research challenge. Within this framework, the quality of research publications is determined by adhering to certain guidelines that include both important inclusions and exclusions as discussed below:

- **Peer-Review Process:** Journals that pass through a peer-review and single-review procedure are important for this study. The reason is that peer-reviewed papers are more exposed to meeting rigorous academic criteria and offering reliable information (Tenopir et al. 2016). The examination by professionals in the field of the journal selected could guarantee the methodological and conceptual integrity of the main research. On the other hand, journals that have not passed through peer review, such as conference proceedings or non-academic publications, will not be included so that high quality and scholarly integrity of the review would be maintained. Such sources may lack the thorough evaluation necessary for academic credibility. This also includes the diligent and careful skimming of the eligible journals through reading the abstracts, sampling techniques, and results and considering if the topics of the journals could meet the requirements of the current research objectives.
- **Publication Source:** Papers and publications from publishers or journals that are credible, well-established, and have a solid academic standing are included. Esteemed publishers often maintain elevated editorial standards, so enhancing the general credibility of the material. Also, to ensure the exclusion of possibly biased or incorrect material, predatory publications or sources without a defined editorial review procedure are excluded at the point of selecting the journals for the current study. The reason is that journals from sources of dubious reputation may undermine the integrity of the systematic review.

- **Methodological Rigor:** Journals with robust research methodologies and clear study designs are considered for this study. The idea behind this is that research studies that use rigorous and well-defined strategies enhance the trustworthiness of systematic reviews by ensuring the accuracy and capacity to reproduce the results (Kolaski et al. 2023). Meanwhile, studies that exhibit methodological faults or lack adequate information regarding the study design are not included to maintain the overall quality and validity of the review. Rigorous methodologies enhance the strength of the evidence base.
- **Relevancy Criteria:** In this study, relevant research papers are chosen by using the most appropriate research keywords. This ensures that there are sufficient secondary data sources available to match the objectives of the research. Considering this, the following criteria for relevance are also established to include and exclude the appropriate research sources:
- **Alignment with Research Objectives:** Articles directly addressing the opportunities, risks, and barriers of AI adoption in healthcare in Sub-Saharan Africa are included. It could be said that alignment with the research question and objectives is crucial for the relevance of the selected literature and the fulfilment of research objectives. In contrast to this, studies unrelated to the specific focus of the review, such as those focused solely on global trends in AI healthcare adoption, are excluded to maintain topical relevance. Ensuring a direct connection to the research objectives enhances the review's coherence and applicability.
- **Geographical Relevance:** Journals featuring studies conducted specifically in Sub-Saharan Africa are prioritised. The focus is on the unique healthcare landscape of the region, ensuring the applicability of findings to the targeted geographical area. Meanwhile, studies conducted in other regions aside from Sub-Saharan Africa or those lacking clear geographical identification are excluded to maintain the regional specificity of the review. This could be

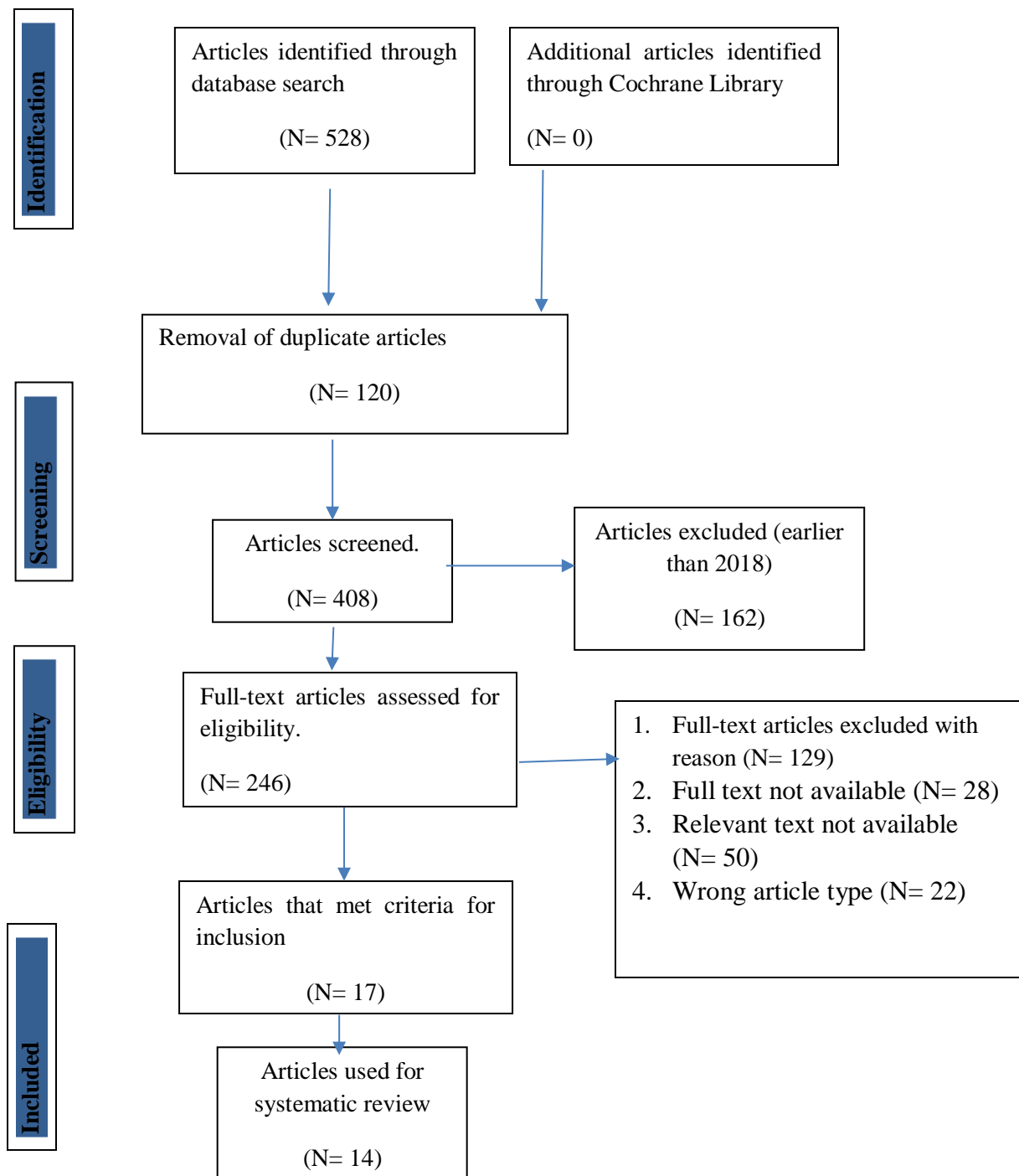
drawn from the study of Kumar et al. (2023), who arguably stated that geographical relevance is critical for understanding the context-specific challenges and opportunities related to AI adoption in healthcare.

- **Publication Timeline:** Current and timely papers are regarded as capturing the most recent advancements in AI use in healthcare in Sub-Saharan Africa. Considering this, journals between 2018 and 2024 are included in this study. This guarantees that the assessment accurately represents the current condition of the area and offers valuable insights into modern issues and progress. To ensure the current relevance of the systematic review, outdated research or those that do not apply to the current state of AI in healthcare are excluded. A focus on recent publications helps uncover the most relevant and current perspectives on the topic.
- **Comprehensive Approach:** To achieve an ideal balance between the standard of excellence and the pertinence of information, it is essential to use an all-encompassing methodology. The approach entails meticulously evaluating the significance of each factor and making well-informed choices when selecting journals, especially as it relates to this study. It is crucial to acknowledge that an excessively strict approach might lead to the elimination of relevant viewpoints, even with a lenient approach may undermine the trustworthiness of the systematic review.

The criteria mentioned above, which are peculiar to the relevance of the study, helped select fourteen journals out of the numerous secondary data sources that were rigorously assessed. These fourteen journal sources are the most reputable and significant in terms of providing highly relevant and genuine material to address the research topic and objectives. The PRISMA flowchart below effectively illustrates the important factors that are used to determine the relevant evidence

at each step of article selection. In addition, the table illustrates the conclusive set of evidence and secondary data used in conducting the systematic review.

Figure 3: PRISMA Flow Diagram Showing Search Results



Risk Bias Consideration Methods

Evaluating and mitigating the potential for bias is an essential aspect of a systematic review, particularly when examining a subject as intricate and diverse as "Artificial Intelligence and Healthcare: The Opportunities, Risks, and Barriers of AI Adoption in Healthcare in Sub-Saharan Africa." An exacting methodology for assessing bias is needed to ensure the reliability and precision of the review's results as discussed below:

1. **Quality Assessment Tools:** Through the utilization of established methods, for assessing quality like the Cochrane Collaborations Risk of Bias Tool it becomes feasible to evaluate components of research quality (Higgins et al. 2011). This evaluation helps identify biases in processes such as randomization, allocation concealment, blinding and other significant factors. However, it is crucial to recognize that these tools have limitations and may not perfectly align with every study design or research question (Sterne et al. 2019).
2. **Study Design Considerations:** Different study designs carry distinct risks of bias. Randomized controlled trials (RCTs) which are commonly considered the approach could potentially have certain biases related to blinding and allocation concealment. On the other hand, observational studies might be influenced by confounding factors. It is important to acknowledge and carefully evaluate these biases associated with research designs to gain a nuanced understanding of the data (Bero et al. 2013).
3. **Selection Bias:** Rigorous attention to selection bias is crucial. The inclusion of a selection of research participants could lead to findings that are not accurate, in representing the target population. As a result, the generalizability of the conclusions may be affected (Page et al. 2018). It is essential to evaluate the methods employed for recruiting and selecting participants to understand how applicable the research included in the review is to situations.

4. **Publication Bias:** Acknowledging the existence of publication bias is critical. Research studies that show results or have statistical findings are more likely to get published which could introduce bias and affect the overall conclusions. To identify and address this publication bias the researcher can use techniques, like funnel plots or statistical tests such, as the Eggers test (Egger et al. 1997). However, it is important to note that these methods have their limitations and require interpretation.
5. **Heterogeneity Assessment:** Systematic reviews often encounter heterogeneity across studies. While statistical methods, such as the I^2 statistic, quantify the extent of heterogeneity, critical interpretation is required. Heterogeneity may suggest variations in the characteristics of the research participants, the treatments used, or the results observed. Comprehending and dealing with these disparities are necessary for deriving significant inferences from the review (Higgins et al. 2003).

Implications and Critical Considerations

- **Cautious Interpretation of Findings:** Identifying and acknowledging bias in research does not automatically render its conclusions insignificant, but it does need a more careful interpretation. Having a clear understanding of the constraints of the available data helps determine the level of certainty that may be attributed to the derived conclusions.
- **Transparent Reporting:** Ensuring clear and comprehensive disclosure of the evaluation of bias is of the utmost importance for the ability to replicate and trust the findings of the systematic review. Providing a clear and detailed explanation of the techniques used to determine bias enables readers to thoroughly examine the strength and reliability of the review.
- **Ongoing Monitoring:** The evaluation of potential bias should not be limited to a single instance, but rather should be taken into account continuously throughout the review process.

Continual surveillance and possible revisions to the evaluation may be required if further evidence surfaces or our understanding of biases increases.

Chapter 4

Results

4.1 Characteristics of the study

This chapter exhibited the practicality of what was discussed in chapter three to meet the set objectives stated in chapter one. After a thorough and rigorous search of the articles in the databases mentioned in Chapter Three, the selected articles were independently assessed to ensure their quality and relevance match up with the three objectives stated in chapter one. These will be further explained in chapter five (see the discussion section). Considering this, the PRISMA flowchart in Chapter Three was utilized to assess the credibility and characteristics of the study.

The table's descriptive analysis reveals that 528 articles were searched to explore Artificial Intelligence and Healthcare: The Opportunities, Risks and Barriers of AI Adoption in Healthcare Sub-Saharan Africa. During the systematic review process, 120 duplicated articles were identified and consequently excluded from the initial pool. Subsequently, a screening process was applied to 408 articles. Notably, 162 articles were removed due to their failure to meet the study's eligibility criteria outlined in chapter three. This involved instances where articles featured other countries beyond Sub-Saharan Africa, or when there were details that indicated the inclusion of another sector like education or politics rather than the intended focus on the healthcare sector.

Additionally, some articles were excluded because their publication dates did not align with the specified eligibility criteria for 2018-2024. Further scrutiny involved a detailed assessment of 50 full-text articles because the relevant text was not available and 22 wrong articles (i.e. articles like conferences or seminar write-ups), resulting in 17 articles meeting the inclusion criteria.

Significantly, fourteen (14) articles were chosen for systematic review, forming the central focus of the results presented in this chapter.

4.2 Critical Appraisal of the studies in terms of their quality and relevance

Since this study aims to understand aspects of AI adoption in healthcare in Sub-Saharan Africa in terms of opportunities, risks and barriers through the eyes of other researchers and then draw independent conclusions, parameters were set to ensure quality and relevance of the literature to be used in this review. The evaluation of these research articles revolves around the study's design, the size of the sample, the quality of the data, the coherence within the scholar(s)' field of study, potential biases, and the conclusions derived from each article (to be comprehensively addressed in chapter five). Additionally, the assessment considered the articulation of objectives and the methodologies employed by the scholars in recruiting their study samples. These will be done with respect to each of the study objectives defined in section 1.3 and are included in the tables below. As stated earlier in section 4.1, the PRISMA flowchart in Chapter Three was used to filter out the irrelevant literature based on the defined parameters, ensuring that only literature that met the set parameters are used.

Table 2 presents five studies exploring the first objective of this study – opportunities for AI adoption and use in healthcare in Sub-Saharan Africa.

The study count column in the tables below represents the frequency of citations obtained from Google Scholar and other databases indicated in Chapter Three. It also represents the number of times the journals were reviewed to further prove the reliability of the materials selected.

Table 2 – Main characteristics of selected articles in relation to objective: Existing opportunities for the use of AI technology in the healthcare system in Sub-Saharan Africa

Scholars	Study Insights	Study design	Main research findings	Intervention	Study count
Anthony et al. (2023).	The study aimed at exposing the fact that AI in healthcare is important to save patients' time at healthcare facilities.	Retrospective, prospective, and case-control studies.	The study revealed that the use of AI technology has incredible potential in the development of more reliable healthcare systems which enhances patients' health outcomes.	The research participants were provided with AI technology in healthcare settings to minimise waiting times.	23
Yin et al. (2021)	AI has been integrated into clinical treatment.	The study design comprises a total of 20 observational studies, 17 prospective studies and 3 retrospective studies. Additionally, there are 13 RCTs, 8 experimental studies, 4 before-and-after studies, 3 surveys, 1 randomised crossover trial, 1 nonrandomized trial, and 1 structured interview.	The most important findings revolve around the initial phase of investigating the practical use of AI applications in clinical settings, the requirement for a more rigorous methodology to evaluate the advantages and difficulties linked to clinical AI applications, and the immense potential of AI applications to enhance patient outcomes.	-	-

Scholars	Study Insights	Study design	Main research findings	Intervention	Study count
Lee and Yoon, (2021).	AI technologies are significantly improving the efficiency of nursing and management tasks in hospitals.	-	<ul style="list-style-type: none"> - The study shows that AI technologies are greatly enhancing the effectiveness of nursing and management tasks in hospitals. - AI-powered technologies have effective impact on enhancing physicians' decision-making processes for diagnoses and treatment. - They assist in diagnosing illnesses and enhancing the overall effectiveness of patient outcomes. 	-	-
Owoyemi et al. (2020)	The study summarised that by 2026, the integration of AI in healthcare has the potential to generate savings of \$150 billion.	-	The paper's primary results include the past and present utilisation of medical artificial intelligence (MAI) in Africa, the anticipated worldwide investment in MAI, and the restricted but encouraging healthcare applications of AI in Africa.	AI is employed for the detection of diabetic retinopathy. Also, an artificial intelligence-based hyperspectral platform designed to verify the authenticity of pharmaceuticals.	-

Scholars	Study Insights	Study design	Main research findings	Intervention	Study count
Kitsios et al. (2023)	The scholars summarised that AI could enhance the overall quality of services offered in the healthcare sector.	-	<ul style="list-style-type: none"> - The scholars found out that Artificial intelligence provides benefits to people, corporations, and the medical sector. - However, additional investigation is required to scrutinise the potential uses and advantages of artificial intelligence in the field of healthcare. <p>The use of AI in the medical domain remains restricted, despite its vast potential for many applications and benefits.</p>	<ul style="list-style-type: none"> - AI healthcare systems were designed for early detection and diagnosis. - Furthermore, utilisation of AI applications and IT solutions were discovered to save expenses, to identify fraudulent activities, enhance performance, and provide support in managing workflows. <p>Utilising AI to reduce the expenses associated with clinical trials by minimising the reliance on human labour in the process of drug development.</p>	132

AI-Artificial Intelligence, IT- Information Technology, RCT- Randomised Control Trial, MAI- Medical Artificial Intelligence

Anthony et al. (2023) conducted a systematic study on the use and opportunities of AI in healthcare, focusing on Sub-Saharan Africa. The research provides insights into the potential opportunities and challenges of AI in the healthcare sector, particularly in Africa. Yin et al. (2021) and Owoyemi et al. (2020) provide more perspectives on the use of AI in healthcare, shedding light on the potential advantages and difficulties encountered by the sector.

Kitsios et al. (2023) conducted a comprehensive analysis of the latest developments in AI in the field of healthcare, offering a global overview of the subject. The research highlights the potential of AI to augment healthcare results through enhanced diagnoses, personalized treatment strategies, and increased efficiency. However, challenges such as data privacy, ethical concerns, and the digital divide are also highlighted.

Anthony et al.'s (2023) research stands out due to its regional emphasis, providing a more precise knowledge of the issues and opportunities in Sub-Saharan Africa that are peculiar to the area. Owoyemi et al. (2020) also discuss the African setting, highlighting the significance of customizing AI solutions to meet the particular requirements of the people. However, Anthony et al.'s (2023) research is potentially limited by the absence of a comparable examination including other locations.

Table 3 shows a summary of the main characteristics of three articles in relation to objective - Risks involved the use of AI in the healthcare system in Sub-Saharan Africa.

Table 3 – Main characteristics of selected articles in relation to objective: Risks involved the use of AI in the healthcare system in Sub-Saharan Africa

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Macrae, (2019)	The integration of AI technology in healthcare delivery is expected to pose a variety of new potential risks and enhance current ones.	The research aims to examine the technical hazards linked to machine learning in clinical environments, evaluate the potential threats to patient safety in the nearest future, and initiate a new dialogue around the regulation of artificial intelligence safety in healthcare.	-	The scholars realised that AI could enhance healthcare safety, but it also brings about new risks. Machine learning poses risks to patient safety in the short, medium, and long term. To address these risks, - It is necessary to develop safety governance systems for emerging AI technologies, which requires interdisciplinary research and a comprehensive understanding of human and organisational vulnerabilities.	-	-
Arora, (2020)	AI has the potential to enhance and amplify previous innovations.	- The objective of this study is to examine the use of artificial intelligence in healthcare as a digital innovation, drawing on existing management literature. - Additionally, the study aims to identify and analyse potential risks and opportunities related to the use of AI in healthcare.	-	- AI is acknowledged as a revolutionary advancement that can surpass human doctors in some medical problems, particularly in the interpretation of images in the fields of dermatology and radiology. - AI can improve medical technologies and facilitate interdisciplinary innovation in the healthcare industry.	-	

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Goodman et al. (2020)	AI-driven dialogue agents or chatbots that provide health advice have the potential to enhance public health.	-		<ul style="list-style-type: none"> - The paper's primary findings involve the pragmatic application of artificial intelligence in healthcare, driven by improved computational capabilities and the abundance of extensive data. - Additionally, it highlights the ethical issues surrounding artificial intelligence in public health, arising from the interplay between risks, concerns, potentials, and opportunities. - It emphasises the pivotal role of trust in the realm of digital health. <p>Furthermore, the World Health Organization's dedication to tackling the ethical, governance, and regulatory aspects of artificial intelligence in the field of health is emphasised.</p>	<ul style="list-style-type: none"> - The study discusses the use of machine learning algorithms to facilitate diagnosis, treatment identification, and analysis of public health risks. <p>Additionally, it explores the possible utilisation of artificial intelligence-driven conversational robots or chatbots to provide health advice.</p>	

The three studies reviewed in table 3 revealed their focus on the ethical, safety, and equity aspects associated with the utilization of AI in healthcare. Macrae's (2019) emphasis on governance aligns with Goodman et al.'s (2020) focus on the equilibrium between risks and rewards, while Arora's (2020) conception provides more insight into the revolutionary capacity of AI.

To adopt a critical viewpoint, it is necessary to acknowledge and tackle certain deficiencies or shortcomings. Macrae, (2019) and Goodman et al. (2020) discuss biases in AI systems, but Arora, (2020) presented a more positive outlook on the advantages without thoroughly analyzing the disadvantages. A thorough examination would be enhanced by a more intricate examination of the moral ramifications, unforeseen repercussions, and any adverse effects on patient results. Furthermore, the studies together emphasize the worldwide scope of these risks, underscoring the need for international norms in the development and use of AI in healthcare. Nevertheless, the distinct risks and possibilities in Sub-Saharan Africa are rarely directly acknowledged.

A key finding in the work of Goodman et al. (2020) is that if AI is not deployed with fairness as a priority, it has the potential to worsen health inequities. This is consistent with Macrae's (2019) apprehension of partiality in AI systems. The academics emphasize the need to consider the socioeconomic determinants of health to prevent AI applications from perpetuating pre-existing inequities.

Table 4 shows six articles and describes their main characteristics in relation to objective - Barriers to the adoption of AI in healthcare in Sub-Saharan Africa.

Table 4 – Main characteristics of selected articles in relation to objective: Barriers to the adoption of AI in healthcare in Sub-Saharan Africa.

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Assadullah, (2019)	The field of healthcare benefits from several uses of artificial intelligence.	The research aims to examine the challenges hindering the use of artificial intelligence in the healthcare sector.	The study design is a systematic review of qualitative and quantitative research, configurative analysis, and thematic synthesis of mixed methods case studies.	The primary results include the many implementations of AI in the healthcare sector, the consequences for researchers and healthcare administration, and the objectives for guiding AI research in healthcare.		-

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Jung et al (2019)	AI is mostly regarded as a trendy term in the context of illness detection and treatment.	<ul style="list-style-type: none"> - The study aims to address the uncertainty surrounding the use of AI in disease diagnosis and treatment. - It seeks to identify the algorithmic challenges that AI faces when dealing with unpredictable healthcare data. - Additionally, it aims to expose the limitations of using genetic mutations as a tool for personalised medicine based on genome analysis. - Finally, it provides insights into the potential future applications of AI in healthcare. 	-	<ul style="list-style-type: none"> - The use of AI in illness diagnosis and therapy is currently hindered by algorithmic challenges in handling unpredictable and non-patterned healthcare data. - The identification of genetic variants as a technique for genome-based personalised therapy has an inherent fallacy. <p>The study provides a comprehensive analysis of the potential use of AI in the healthcare sector.</p>		-

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Magrabi et al. (2019)	Ensuring the safe and successful use of AI-enabled clinical decision assistance in complex sociotechnical contexts will need a strong commitment to extensive and continuous assessment.	<ul style="list-style-type: none"> - The paper underscores the significance of thorough and continuous assessment for the secure and efficient incorporation of AI in intricate sociotechnical environments. - It proposes that the necessary improvements for the next wave of AI-powered clinical decision support will be identified through practical implementation. 	-	-		-

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Matheny et al. (2020)	AI is expected to have a significant and supplementary role in human cognition to enhance the provision of personalised healthcare.	-	-	<ul style="list-style-type: none"> - AI is expected to play a significant and additional role in enhancing human cognition to facilitate the provision of personalised healthcare. - AI advancements have shown exceptional precision in jobs related to image and signal recognition, establishing them as highly developed tools in this field. - Present challenges in the field of AI in healthcare which include the use of biased data for model creation, the extension of AI applications to underrepresented communities - The study also presented the neglect of potential unintended implications, and the scarcity of data detailing the real impact on patient outcomes and healthcare expenses. 	-	-

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Gwagwa et al. (2020)	Artificial intelligence has the potential to foster socioeconomic inclusion in African contexts.	<p>The study does not explicitly state its objectives, but based on the content, it aims to provide an overview of AI deployment in Africa.</p> <p>It discussed the core benefits and challenges of AI in African settings, highlighted key policy dimensions for the continent, review literature on AI's manifestations and policy dimensions.</p> <p>It discusses current sites of AI policymaking at various levels, emphasise the importance of developing AI skills and fostering African AI policymaking capacity, and highlight the potential impact of AI on Africa.</p>		<ul style="list-style-type: none"> - The paper's key findings involve the widespread adoption of AI technologies in Africa, the necessity for well-founded policy strategies to foster inclusive AI ecosystems. - The potential benefits and challenges of AI in present-day African contexts, the early stage of the African AI policy discussion, and the examination of literature and on-the-ground situational analyses that inform the analysis. 	-	

Scholars	Study Insights	Study aim	Study design	Main research findings	Intervention	Study Count
Varghese, (2020)	The use of artificial intelligence in clinical research is increasing.	<ul style="list-style-type: none"> - The research aims to analyse the typical barriers to widespread implementation of AI technologies in hospital-based settings, focusing on the use of Structured Data. - The study provides a detailed explanation of the criteria for broader clinical implementation, based on research related to Clinical Data Systems (CDSS). - The RISE criteria, which include Regulatory aspects, Interpretability, Interoperability, Structured Data and Evidence, provide a comprehensive framework for understanding the challenges and drawbacks of medical AI applications. 	-	<ul style="list-style-type: none"> - The primary results encompass the identification of crucial obstacles in the widespread integration of AI applications in clinical settings, acknowledgement of the limited extent of large-scale implementation and adoption of AI applications in clinical settings. - The findings also revealed the provision of a comprehensive examination of key challenges and potential solutions pertaining to regulatory aspects, interpretability, interoperability, structured data, data quality, and evidence, which are independent of specific use cases. 		

AI- Artificial Intelligence, RISE- Regulatory aspects, Interpretability, Interoperability, Structured Data and Evidence

Table 4 includes six articles. Jung (2019) highlights the potential risks of AI in healthcare, particularly in the accuracy of illness detection and treatment. Magrabi et al. (2019) highlight the challenges in assessing the effectiveness of AI in clinical decision assistance. Matheny et al. (2020) highlight the need for cooperation among stakeholders, ethical deliberations, and regulatory systems for the effective implementation of AI.

Gwagwa et al. (2020) analyze the implementation of AI in Africa, highlighting the advantages, difficulties, and policy aspects. The report acknowledges the potential benefits of AI in enhancing healthcare in Sub-Saharan Africa but also highlights obstacles such as inadequate infrastructure, data privacy concerns, and the need for customized legislative frameworks. Varghese's (2020) research examined the opportunities and barriers associated with the widespread integration of AI in medicine. The potential of AI to augment diagnostic capacities and improve patient outcomes is acknowledged, but barriers such as data security, ethical considerations, and regulatory benchmarks are addressed. Generally, these studies highlight the need for a holistic strategy to tackle the challenges related to AI adoption in healthcare.

Chapter 5

Discussion, Conclusion and Recommendations

5.1 Introduction

This study chapter focuses on evaluating the research results in line with the objectives of the study. The findings obtained from the systematic review conducted in Chapter Three are thoroughly scrutinised for the specified study objectives and questions. This chapter provides a thorough analysis of the obtained data via careful interpretation, as well as comparisons with relevant previous research. This strategy seeks to efficiently assess and deal with the research issue.

5.2 Discussion of Key Findings

Objective 1: Opportunities for the Use of AI Technology in the Healthcare System in Sub-Saharan Africa

The systematic study conducted by Anthony et al. (2023) investigates the use and opportunities of AI techniques in healthcare. The review provides a thorough analysis of the present status of this topic. This research provides significant insights into the potential opportunities and challenges of AI in the healthcare sector, specifically in Sub-Saharan Africa. To thoroughly analyze the outcomes and conclusions, it is crucial to juxtapose and evaluate this study with other pertinent studies in the area. That is why Yin et al. (2021) performed a comprehensive analysis to examine the impact of AI applications in actual clinical settings. While the report does not specifically concentrate on Sub-Saharan Africa, it offers a more comprehensive perspective on the worldwide overview of AI in healthcare. For instance, the scholars posited that the exposure of the healthcare sector to the use of AI is still at a premature level even though it has great potential. Meanwhile,

they suggested that there is always a need to examine more opportunities and challenges connected with clinical AI applications through a more rigorous methodology. Regardless, Yin et al. (2021) pointed out that the healthcare sector has been exposed to opportunities such as diagnosing diseases, analyzing risks, performing surgical operations, and patient screening among many others. This could be linked to the study of Iliashenko et al. (2019), who explained the predominance and opportunities of AI in healthcare for operational performance like the diagnosis of medical conditions, overseeing the operations of healthcare organisations, and maintaining a healthy way of life.

Lee and Yoon (2021) and Owoyemi et al. (2020) provide more perspectives on the use of AI in healthcare, shedding light on the potential advantages and difficulties encountered by the healthcare sector such as using AI to identify fake drugs, improving nursing effectiveness, diagnosis and hospital management. While Owoyemi et al. (2020) encompasses the entire African region, Anthony et al. (2023) concentrated on Sub-Saharan Africa. However, the research conducted by Owoyemi et al. (2020) is primarily focused on finding prospects in Africa rather than carrying out a comprehensive evaluation.

Kitsios et al. (2023) conducted a comprehensive analysis of the latest developments in AI in the field of healthcare via a systematic evaluation of existing literature. Although the report does not primarily focus on Sub-Saharan Africa, it offers a comprehensive analysis of the most recent advancements in the subject on a worldwide scale. By looking at Kitsios et al.'s (2023) research along with Anthony et al.'s study, it might be easier to find the shared patterns and discrepancies in the integration and use of AI in the healthcare sector.

An analysis of this research uncovers several shared patterns and points of difference. An overarching discovery in several studies is the capacity of AI to augment healthcare results using enhanced diagnoses, personalized treatment strategies, and elevated efficiency. Nevertheless, studies repeatedly emphasize difficulties such as data privacy, ethical concerns, and the digital divide.

Anthony et al.'s (2023) research stands out from others due to its regional emphasis, which offers a more precise knowledge of the issues and opportunities in Sub-Saharan Africa that are peculiar to the area. The regional emphasis is essential due to the distinctive healthcare environment, infrastructural constraints, and socioeconomic issues that are widespread in the area. Owoyemi et al. (2020) also discuss the African setting, highlighting the significance of customizing AI solutions to meet the particular requirements of the people. Nevertheless, Anthony et al.'s (2023) research is potentially limited by the absence of a comparable examination including other locations. Although it is important to concentrate on Sub-Saharan Africa to tackle challenges particular to the area, making a wider comparison might improve the applicability of results and promote cross-regional knowledge exchange. Considering this, it was also noticed from the literature search that the opportunities and challenges of using AI in the healthcare sector go together.

Objective 2: Enumerating the risks involved in the use of AI technology in the healthcare system in Sub-Saharan Africa

The three studies conducted by Macrae (2019), Arora (2020), and Goodman et al. (2020) provide significant insights into the governance, conceptualization, and risks linked to the utilization of AI in the healthcare sector. Through a rigorous analysis of this research, the researcher can investigate

the interrelatedness of their results and pinpoint significant patterns in the changing field of AI in healthcare, specifically in Sub-Saharan Africa.

It was observed that Macrae (2019), focuses on the management of AI safety in the healthcare sector, highlighting the need for well-functioning regulatory structures. The author emphasizes the significance of addressing ethical considerations, transparency, accountability, and patient safety in the development and use of AI systems. Macrae, (2019), argues that the fast progress of AI in healthcare necessitates a thorough and flexible system of governance. The scholar also highlights the significant concern of bias in AI algorithms, which might result in inequalities in healthcare results. This could be stated as an extension to the analysis of Sunarti et al. (2021), who argue the lack of AI implementation in the public sector gives rise to issues about patients' privacy and their rights to autonomy in AI applications. This could suffice, as some of the risks associated with the use of AI are consistent with the wider discussion on equity and responsibility in AI systems. Hence, the reason why the research emphasized the need to continuously monitor, evaluate, and modify AI systems is to guarantee their safety and efficacy.

Arora (2020), on the other hand, offers a preliminary examination that defines AI as a digital advancement in healthcare. The author examines the capacity of AI to bring about significant changes in healthcare and examines its many uses, such as diagnostics, treatment planning, and personalized medicine. Arora highlights the need to understand the precise role of AI in healthcare innovation and its consequences for patient outcomes.

Arora's idea enhances the wider discussion on the beneficial elements of artificial intelligence in the healthcare sector. Nevertheless, the research may not thoroughly explore the possible hazards

linked to the extensive use of AI technology. It is crucial to acknowledge that while AI offers prospects for advancement, it also raises difficulties that need thoughtful deliberation.

The research conducted by Goodman et al. (2020) examines the intricate equilibrium between the potential risks and advantages linked to artificial intelligence in the field of healthcare. The scholars recognize the possibility of enhanced diagnosis, therapy, and efficacy, but stress the need to tackle ethical considerations, data privacy problems, and unforeseen repercussions. The report advocates for a comprehensive strategy for evaluating and controlling risks when using AI technology in the healthcare sector.

Objective 3: The barriers to the adoption of AI in healthcare

The studies conducted by Jung (2019), Magrabi et al. (2019), Matheny et al. (2020), Gwagwa et al. (2020), and Varghese (2020) provide valuable insights into the complex field of AI implementation in healthcare. Also, the study of Assadullah, (2019) delved into how AI is implemented in the healthcare sector, the consequences for researchers and healthcare administration, and the objectives for guiding AI research in healthcare. These studies specifically examine the use of AI in disease diagnosis and treatment, clinical decision support, and the hindrances and advantages of integrating AI into the healthcare system. Although each study offers useful insights, a thorough examination uncovers both shared patterns and differences in their results and views.

Assadullah (2019) looks at the thematic barriers to the adoption of AI into healthcare. His work identified ethical, legal and social barriers. These barriers have management, research and regulatory implications ranging from policymaking, testing and rating of AI systems for healthcare use, safe handling of healthcare data to biases. In the author's view, these social, ethical and legal

barriers are intertwined, making them complex. However, the study emphasizes on healthcare management engaging both AI technologists and social scientists in finding a common ground to deal with such social issues as cost and inequality, since these social issues are not detached from scientific issues. This supports both Magrabi et al. (2019) and Matheny et al (2020) viewpoints of collaboration in dealing with barriers.

The research of Jung (2019) explores the dangers of AI in the field of healthcare, with a particular emphasis on the accuracy of illness detection and treatment. The paper recognizes the potential advantages of AI but highlights the corresponding hazards. The scholar emphasizes the issues surrounding the precision and dependability of AI algorithms, ethical deliberations, and the need to maintain a harmonious equilibrium between technical progress and the human element in healthcare. This viewpoint is consistent with the prudence stated by other researchers, such as Magrabi et al. (2019), who emphasize the difficulties in assessing the effectiveness of AI in clinical decision assistance.

Furthermore, Magrabi et al. (2019) focus on the difficulties associated with assessing the effectiveness of artificial intelligence in providing help for clinical decision-making. The research highlights the intricate nature of evaluating AI systems in healthcare, which is influenced by elements such as the transparency and interpretability of the systems as well as the changing nature of medical knowledge. The authors contend that existing assessment frameworks may not be appropriate for AI applications, thereby requiring the creation of new approaches. This is consistent with Jung's (2019) apprehensions over the dependability of AI systems, underscoring the need for meticulous assessment procedures.

Matheny et al. (2020), on the other hand, provide a report from the National Academy of Medicine on the use of AI in healthcare, adding to the ongoing discussion on this topic. The report recognizes the potential of AI to revolutionize healthcare delivery but underscores the need for appropriate incorporation. They emphasize the need for cooperation among those involved, ethical deliberations, and the function of regulatory systems. This supports Magrabi et al.'s (2019) focus on the difficulties in assessing AI, underscoring the notion that thoughtful deliberation and cooperation are crucial for the effective implementation of AI.

Gwagwa et al. (2020) provide a distinct viewpoint by analyzing the implementation of AI in Africa, with a specific emphasis on the advantages, difficulties, and policy aspects. The report acknowledges the potential advantages of AI in enhancing healthcare in Sub-Saharan Africa while emphasizing obstacles such as inadequate infrastructure, apprehensions over data privacy, and the need for customized legislative frameworks. The inclusion of a regional viewpoint introduces further intricacy to the worldwide discussion on artificial intelligence in healthcare, underscoring the need to consider context-specific factors.

Varghese's (2020) research especially examines the opportunities and barriers associated with the widespread integration of artificial intelligence in the field of medicine. The research acknowledges the potential of AI to augment diagnostic capacities and boost patient outcomes. Additionally, Varghese (2020) addresses barriers such as data security, ethical considerations, and the need for regulatory benchmarks. This is consistent with the overarching trend seen in the research, which highlights the need to implement a holistic strategy to tackle the difficulties related to the adoption of AI in healthcare.

These studies together emphasize shared obstacles to the use of AI in healthcare, such as concerns over the dependability of algorithms, the need for strong assessment systems, ethical issues, and the need for legislation tailored to particular contexts. Nevertheless, Gwagwa et al.'s (2020) regional viewpoint brings forward a vital aspect by highlighting the distinctive difficulties encountered in Sub-Saharan Africa. While the studies provide valuable insights, there is a need for ongoing research and collaboration to address these challenges systematically.

5.3 Conclusion

Conclusively, this study deals with the summary of the discussion of findings with respect to the research objectives and their consistency with other relevant literature. The objectives, as stated, include:

4. Identifying and analyzing the existing opportunities for the use of AI technology in the healthcare system in Sub-Saharan Africa.
5. Enumerating the risks involved in the use of AI technology in the healthcare system in Sub-Saharan Africa.
6. Examining and highlighting the barriers to the adoption of AI in healthcare in the region.

In the subsequent sections of Chapter Two, the concept of Artificial intelligence was revealed as an AI system that functions by assimilating substantial quantities of labelled training data, scrutinizing the data for correlations and patterns, and employing these patterns to formulate predictions regarding forthcoming conditions. By providing a chatbot with a dataset of text samples, it can acquire the ability to generate realistic conversations with individuals. Similarly, an image recognition tool can develop the capability to recognize and describe things in photographs by analyzing millions of examples. Furthermore, this study revealed the models for

AI and the healthcare sector which include HospitalQual, HEALTHQUAL, PubHosQual, SERVQUAL, and Donabedian's models.

Also, Chapter Three of this study introduced the suitable methodology meant for this study using systematic review and the process involved. The current study systematically reviewed thirteen (13) journals to answer the research questions, accordingly, as shown in Chapter Four.

The systematic study conducted by Anthony et al. (2023) investigates the use and opportunities of AI techniques in healthcare. The review provides a thorough analysis of the present status of this topic. This research provides significant insights into the potential opportunities and challenges of AI in the healthcare sector, specifically in Sub-Saharan Africa. To thoroughly analyze the outcomes and conclusions, it is crucial to juxtapose and evaluate this study with other pertinent studies in the area. That is why Yin et al. (2021) performed a comprehensive analysis to examine the impact of artificial intelligence (AI) applications in actual clinical settings. While the report does not specifically concentrate on Sub-Saharan Africa, it offers a more comprehensive perspective on the worldwide overview of AI in healthcare. For instance, the scholars posited that the exposure of the healthcare sector to the use of AI is still at a premature level, although it has great potential. Meanwhile, they suggested that there is always a need to examine more opportunities and challenges connected with clinical AI applications through a more rigorous methodology.

The three studies of Macrae (2019), Goodman et al. (2020), and Arora (2020) are interrelated because of their focus on the ethical, safety, and equity aspects associated with the utilization of AI in healthcare. Macrae's (2019) emphasis on governance aligns with Goodman et al.'s (2020)

focus on the equilibrium between risks and rewards, while Arora's (2020) conception provides more insight into the revolutionary capacity of AI.

These studies by Jung (2019), Magrabi et al. (2019), Matheny et al. (2020), Gwagwa et al. (2020), and Varghese (2020) altogether emphasize shared obstacles and barriers to the use of AI in healthcare, such as concerns over the dependability of algorithms, the need for strong assessment systems, ethical issues, and the need for legislation tailored to contexts. Nevertheless, Gwagwa et al.'s (2020) regional viewpoint brings forward a vital aspect by highlighting the distinctive difficulties encountered in Sub-Saharan Africa. While the studies provide valuable insights, there is a need for ongoing research and collaboration to address these challenges systematically.

5.4 Recommendations

Based on the research papers made for each of the objectives of this study, the following recommendations should be considered:

1. There should be the creation and execution of customized regulatory frameworks for AI in healthcare that specifically target the unique issues and intricacies of Sub-Saharan Africa. This document should provide instructions for safeguarding data privacy, addressing ethical concerns, and establishing criteria for the use of artificial intelligence in medical environments.
2. There should be an allocation of resources towards implementing extensive training programmes for healthcare professionals, policymakers, and technicians to augment their comprehension of AI technology. This entails developing the ability to efficiently oversee and execute AI solutions while also ensuring that the workforce is adequately prepared to handle the intricacies of these technologies.

3. Also, there should be an allocation of resources and strategic investments in the essential infrastructure required to facilitate the incorporation of artificial intelligence (AI) into the healthcare sector. This entails enhancing internet connections, developing resilient data storage and processing capacities, and guaranteeing dependable power sources, especially in distant regions, to facilitate the smooth operation of AI systems.
4. Initiating awareness efforts to enlighten the public on the advantages and possible hazards of AI in the healthcare sector. Promote open and clear communication to establish trust, rectify misunderstandings, and engage communities in decision-making processes around the use of AI technology in healthcare.
5. Fostering collaborative research endeavours among academics, healthcare institutions, and technological professionals. Promote the creation of AI solutions that apply to local contexts by forming partnerships that use the knowledge and skills of many stakeholders. This cooperation may assist in tackling certain healthcare concerns that are widespread in Sub-Saharan Africa.
6. Enacting measures that promote innovation in the field of AI healthcare. Offer inducements, such as research grants and tax incentives, to encourage the development of AI solutions that address the distinct healthcare requirements of the area, including preventative measures, illness detection, and patient management.
7. Implementing strong data governance mechanisms to guarantee the appropriate and safe use of health data in AI applications. Highlight the significance of data privacy and enforce rigorous security protocols to protect confidential healthcare data. This entails establishing explicit criteria for the sharing, ownership, and safeguarding of data.

Suggestions for future developments

Future developments should give priority to developing AI technologies that are specifically designed to address the unique healthcare demands and concerns of Sub-Saharan Africa. Tailored solutions may effectively manage regional illnesses, infrastructural constraints, and socioeconomic issues, ensuring the applicability and efficiency of AI technology in local healthcare environments.

Furthermore, future development should promote and enhance cooperation among the healthcare sector, technology industry, government organizations, and research institutes. Facilitating the dismantling of isolated departments and fostering collaborative relationships across different disciplines helps expedite the development and adoption of artificial intelligence technologies. By adopting a collaborative approach, they can harness a wide range of skills to address intricate difficulties and amplify the influence of artificial intelligence in the healthcare sector.

Aside from that, create strong ethical guidelines to govern the development and use of AI technology in the healthcare sector. To address the ethical challenges linked to the use of AI, it is crucial to prioritize concepts such as justice, openness, and accountability. By ensuring that AI applications conform to ethical norms, trust may be established among stakeholders and the public, therefore promoting the sustainable and responsible use of AI.

In conclusion, creating and implementing ways to maintain continuous communication and involvement with stakeholders, such as healthcare professionals, policymakers, patients, and local communities. By engaging these essential stakeholders in the decision-making processes about AI in healthcare, future advancements may be more effectively synchronized with the requirements

and principles of the area. Regular feedback and input from a wide range of perspectives will enhance the inclusivity and effectiveness of AI deployment.

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