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Generative AI in South African Healthcare: Navigating Challenges and Harnessing Opportunities for Industry and Research

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This research seeks to evaluate how Generative Artificial Intelligence (GAI) can be used to disrupt and revolutionise the South African healthcare sector in addressing anomalies and utilising opportunities. This study employed a qualitative approach using secondary data analysis, drawing on policies formulated from the years 2015-2024, the study combines findings from published literature, institutional reports, and reputable databases to explore the potential opportunities, applications, and challenges of integrating generative artificial intelligence (AI) in South Africa's healthcare system. Thematic analysis and trend mapping were used to investigate GAI in diagnostics, drug discovery, personal medicine, data clerking, and medical training. The results make clear the ability of GAI to improve healthcare availability, quality, and organisation. Some critical opportunities, scientific developments, and technological advances present include better diagnostic tests, individualised therapy, rationalisation of work procedures, and an enhanced drug discovery process. However, the study brings out emerging problems like ethical issues, data sources and types, privacy issues, infrastructural constraints, and policy hindrances. These challenges call for multisectoral approaches that involve policymakers, healthcare players, researchers, tech firms, and the South African government in designing and implementing AI programs suitable for the South African setting. This research provides novel knowledge because these advancements are positioned in the South African context from a global perspective. This paper gives specific solutions on how the resulting ethical, technical, and infrastructural issues of GAI implementation may be mitigated. Lastly, this research is the roadmap for stakeholders to leverage the opportunity presented by GAI and place South Africa well ahead in the usage of AI for healthcare development.

Keywords

AI in Healthcare, Generative AI, Healthcare Innovation, Digital Health, Healthcare Challenges

Generative AI in South African Healthcare: Navigating Challenges and Harnessing Opportunities for Industry and Research

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Abstract

This research seeks to evaluate how Generative Artificial Intelligence (GAI) can be used to disrupt and revolutionise the South African healthcare sector in addressing anomalies and utilising opportunities. This study employed a qualitative approach using secondary data analysis, drawing on policies formulated from the years 2015-2024, the study combines findings from published literature, institutional reports, and reputable databases to explore the potential opportunities, applications, and challenges of integrating generative artificial intelligence (AI) in South Africa's healthcare system. Thematic analysis and trend mapping were used to investigate GAI in diagnostics, drug discovery, personal medicine, data clerking, and medical training. The results make clear the ability of GAI to improve healthcare availability, quality, and organisation. Some critical opportunities, scientific developments, and technological advances present include better diagnostic tests, individualised therapy, rationalisation of work procedures, and an enhanced drug discovery process.

However, the study brings out emerging problems like ethical issues, data sources and types, privacy issues, infrastructural constraints, and policy hindrances. These challenges call for multisectoral approaches that involve policy-makers, healthcare players, researchers, tech firms, and the South African government in designing and implementing AI programs suitable for the South African setting. This research provides novel knowledge because these advancements are positioned in the South African context from a global perspective. This paper gives specific solutions on how the resulting ethical, technical, and infrastructural issues of GAI implementation may be mitigated. Lastly, this research is the roadmap for stakeholders to leverage the opportunity presented by GAI and place South Africa well ahead in the usage of AI for healthcare development.

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1. Introduction

Generative Artificial Intelligence (GAI) is one of the most promising technological breakthroughs that may redefine several industries, including the medical field. Always generating texts, images, and data analysis, generative AI presents almost endless possibilities for improving medical diagnostics, tailoring treatments, optimising clerical work, and increasing the availability of high-quality healthcare services. In the context of South Africa, a nation characterized by a dual healthcare system and significant disparities in healthcare

access and quality, the integration of generative AI could serve as a catalyst for addressing systemic challenges and improving health outcomes. This research is focused on the nature of the healthcare system in South Africa and foresees external factors that are likely to affect healthcare practices in the future based on some projections (HSRC, 2024; Philips, 2024).

Generative AI is a branch of artificial intelligence that is used to generate text, images, or even synthetic data sets from an existing dataset. The mechanisms of the current approach are based on more complex neural networks, including GANs

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and transformer models, to generate high-quality outputs across the domains. In the field of healthcare, generative AI is particularly beneficial in its capacity to act as a case replay to assist in the training process, in the creation of customised interfaces for communication, and in filling data gaps by using synthetic data. The adoption of AI in healthcare is part of a broader digital transformation seen across industries, including finance and economic innovation. Blockchain, for instance, has revolutionised financial transparency and security (Paul and Rena, 2024b), and similar principles could be leveraged to enhance the security and trustworthiness of AI-driven healthcare solutions. These capabilities are especially useful in the South African context, where issues of scarcity of resources, disparity in access to health care, and a high disease profile continue to prevail (Ataguba, 2020; Gestaltdt, 2024).

Some recent studies show that the South African health sector has shown increasing interest in using AI technologies. For example, the Philips Future Health Index 2024 indicates that South Africa is the most advanced in using AI for clinical decision-making, including diagnosis, treatment planning, and patient surveillance, with more than 60 % readiness (Philips, 2024). Further, research based on the HSRC (2024) makes a study on how generative AI is a probable cause for employment, equality, and ethical issues within the country. Thus, despite the recent increase in interest in AI implementation, contemporary research still lacks information on numerous AI applications and their advantages and challenges, especially regarding generative AI in the context of the SA socio-economic and infrastructural environment. Previous work tends to investigate AI in a general sense while remaining within the specific bounds of generative models and their implications for healthcare.

This research seeks to understand how generative AI could disrupt the South African health sector to assess the benefits of the approach. Issues relating to data diversity, privacy, constraints, and regulations are also evaluated to determine how generative AI can be used to improve diagnostics, individualised treatments, administrative work, and training for doctors and other medical workers. Further, it offers guidance and solutions for policymakers, healthcare organisations, academicians, and industries on how they can address the challenges regarding the establishment of generative AI within the framework of the healthcare delivery model. The main aim of the research is thus to fill this existing gap and present a thorough understanding of the topic by situating global developments in generative

AI against the background of the South African healthcare landscape.

This is why the structure of this paper is conceived to give adequate scope to the topic under discussion. The scope and background provide an overview of generative AI and how it may be disruptive for the South African healthcare industry. The subsequent section reviews some of the challenges that shape the South African healthcare system today and explores where generative AI could make the most difference. After that, the paper discusses how generative AI is being applied in the healthcare sector, in the spheres of diagnostics, individualised treatment, optimisation of working processes, preparation of medical staff, and search for new medications. The issues that South African healthcare might face when trying to implement generative AI, such as data complexity, privacy, budget constraints, and legal restrictions, are described. The focus is on new options for industry and research based on the positive impact and identification of the transformative effect of generative AI. Some examples of successful implementations of generative AI are then discussed in the South African healthcare context based on case studies. A summary of the recommendations to address the presented challenges and practice pointers for the successful deployment of generative AI is discussed in the final section of the paper. Therefore, it emphasizes the roles to be played by different stakeholders, which supports the need for solutions that are relevant to the South African healthcare system only.

2. Literature review

2.1. The South African healthcare landscape

Healthcare provision in South Africa is divided into the private and public sectors, serving different groups of society. The publicly financed, mostly through taxes, provide services to about 84 percent of the population, especially those with lower income, and the uninsured. Nonetheless, this sector faces many challenges, including poor funding, a shortage of staff, most centres are outdated, and most centres receive many patients, hence the long waiting list, and poor-quality services (Ataguba, 2020).

On the other hand, there is an independent healthcare sector where about 16 % of the population of the country receives hospitalised treatment and other healthcare services that are of higher quality, and more equipped, and there is no long waiting list. While the private sector provides a

fewer jobs in this region, it is mainly populated by those with medical aid or the money to pay for services on their own, thereby compounding serious inequalities in terms of access to and quality of health care services (Mayosi & Benatar, 2014). These differences made it clear that there are diverse systems at play and that such a gap needs creative thinking to be closed.

South Africa has a large number of diseases including a high incidence of communicable diseases, including HIV/AIDS and Tuberculosis, which has gradually been increasing in non-communicable diseases, including diabetes and hypertension. The former is aggravated by the fact that these dual burdens cause substantial pressure on the healthcare system, negating improvements in resource access and, more specifically, exacerbating an already strained and struggling system (Pillay-van Wyk et al., 2016).

It is pertinent to note that the incorporation of appropriate technologies, especially AI, has been perceived to resolve most of these systematic problems. In terms of diagnosis, treatment planning, and assessment, the AI approach has greater potential. For instance, the use of AI in clinical decision support is more advanced in South Africa than seen across the world, in the use of AI in treatment planning and hospital management (Philips, 2024). Future Society (2024), characterised Generative AI as one of the subcategories of AI, which is applicable in the South African healthcare context. Its functionality includes the generation of synthetic data for situations where there is a lack of

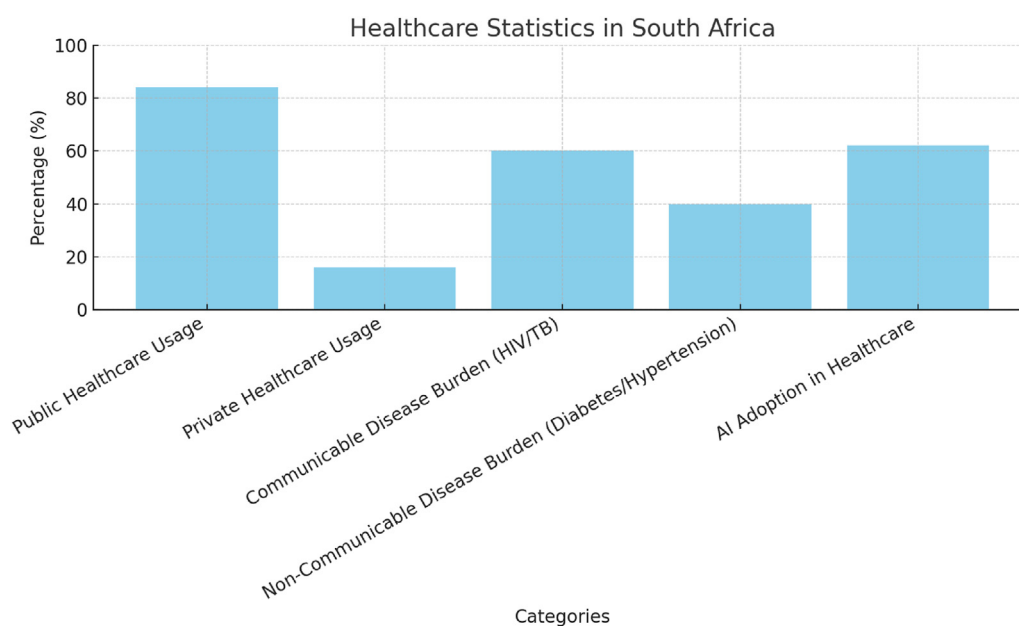
data, the development of individualised patient communication solutions to overcome issues of illiteracy and language, and applications for healthcare forecasting and strategic planning (see Graph 1).

2.2. Healthcare statistics and implications

The bar chart below presents important statistics related to South Africa's healthcare system, offering a visual overview of the disparities, disease burden, and technological advancements within the sector. Each category reveals specific challenges and opportunities that South Africa's dual healthcare system faces.

2.3. Public vs. private healthcare usage

According to the chart, 84 % of South Africans depend on the public healthcare sector, which is financed through taxes and primarily serves uninsured or low-income individuals. In contrast, only 16 % of the population accesses the private healthcare sector, which is available to those who can afford medical aid or pay out-of-pocket. This significant difference highlights the inequality in access to quality healthcare, as the public sector often struggles with overcrowded facilities, staff shortages, and outdated infrastructure (Ataguba, 2020). The heavy reliance on public healthcare puts tremendous pressure on government resources, leaving little opportunity for innovation and development.



Graph 1. Healthcare statistics in South Africa (Ataguba, 2020; Pillay-van Wyk, V. et al., 2016; Philips, 2024; Statistics South Africa, 2022; Qure.ai., 2024).

2.4. Communicable and non-communicable disease burden

The chart further indicates that 60 % of South Africa's disease burden is attributed to communicable diseases, such as HIV/AIDS and tuberculosis (TB). These illnesses continue to dominate healthcare resource allocation due to their widespread occurrence, especially in rural and disadvantaged areas. However, the 40 % burden from non-communicable diseases (NCDs), including diabetes and hypertension, is rapidly increasing, illustrating the dual burden of disease in South Africa. This combined challenge intensifies the strain on the healthcare system and emphasizes the necessity for targeted interventions to effectively address both types of diseases (Pillay-van Wyk et al., 2016).

2.5. Strengthening theoretical grounding: the role of sociotechnical systems (STS) theory

South Africa's healthcare AI adoption discussion lacks an established theoretical basis that explains how society perceives technology changes and shows resistance. The Sociotechnical Systems (STS) Theory functions as an advanced organisational model to connect human resources with technological assets in complex systems (Knox, 2024). The Sociotechnical Systems theory shows that when organisations reach maximum productivity along with sustainable integration, it requires joint alignment between social elements (healthcare workers, policymakers, patients) and technical elements (AI tools, digital infrastructure) (Mumford, 2006). The correct alignment is essential for South Africa because AI adoption suffers from low digital literacy levels and scarcity of resources, together with widespread apprehension toward algorithms used for decision-making.

When this research merges STS theory, it would increase both its methodological robustness and weaken theoretical limitations by recognising various boundaries to AI implementation. The methodology acknowledges both technical feasibility, together with factors such as trust and ethical concerns, and organisational shifts which affect technology acceptance (Baxter & Sommerville, 2011). STS theory acts as an operational framework to develop practical guidelines that help organisations co-construct AI solutions with their end-users and avoid forced implementation, leading to resistance and better long-term sustainability (Pasmore et al., 2019).

This paper requires an embedded STS theory to create both coherent theoretical concepts and

practical usage. The approach provides a transformation of healthcare AI adoption in South African healthcare because it integrates human processes with technological solutions to create an inclusive systems-based framework that fits within stakeholder capabilities.

2.6. AI adoption in healthcare

The fact that 62 % of healthcare leaders in South Africa embrace AI technologies for clinical decision-making and treatment planning is an encouraging sign. This rate is higher than the global average in certain areas, such as in-hospital monitoring and diagnostics (Philips, 2024). Generative AI, in particular, has the potential to enhance diagnostic accuracy, lighten workloads, and improve access to healthcare in rural areas. Nevertheless, for successful implementation, it is essential to tackle infrastructure, skill shortages, and public trust challenges.

2.7. Implications for South Africa

2.7.1. Addressing inequality in access to healthcare

The heavy reliance on the public healthcare sector by most people highlights the urgent need for systemic improvements, including better resource distribution, updated infrastructure, and workforce development. Collaborations between the private and public sectors can be crucial in closing this gap (South African Government, 2024).

2.7.2. Targeted strategies for disease management

Given the significant burden of both communicable and non-communicable diseases, South Africa needs to implement dual strategies. Utilising AI technologies for early diagnosis and personalised treatment can greatly enhance outcomes for both types of diseases (Savant, 2023; Qure.ai, 2024).

2.7.3. Scaling AI adoption

The increasing use of AI signifies a move towards innovation in healthcare. Expanding these technologies throughout the public sector can improve service delivery and alleviate the impact of resource limitations. However, this will necessitate focused investments in infrastructure, training programs for healthcare professionals, and campaigns to raise public awareness (CSIR, 2023; Philips, 2024).

2.8. Critical analysis and perspective on generative AI in South African healthcare

While the literature presents a compelling case for AI-driven healthcare transformation, South Africa's

unique socioeconomic and infrastructural constraints demand a localised and pragmatic approach to AI adoption. The table below contrasts key literature findings with the author's perspective, emphasizing potential gaps and the need for context-sensitive implementation strategies.

In other words, whereas generative AI in the micro context of AI applications can be used to fine-tune diagnostics for the precision of tuberculosis or improve the delivery of rural healthcare, generative AI presents a novel chance for the South African (HSRC, 2024). Advertising research is also enabled by

Key Literature Findings	Author's Critical Perspective
AI enhances diagnostics, operational efficiency, and evidence synthesis (Paul and Rena, 2024b; IT-Online, 2024; Obermeyer et al., 2016; Topol, 2019).	While AI can optimize diagnostics, the lack of digital infrastructure, skilled personnel, and regulatory frameworks in South Africa may slow adoption (Rena, 2006; Moodley and Naidoo, 2021). A phased, region-specific deployment is necessary.
Public-Private Partnerships (PPPs) can fund AI implementation (Paul and Rena, 2024a; World Health Organization, 2021).	PPPs are crucial, but alternative funding models—such as government subsidies, AI-driven digital crowdfunding, and non-profit sector involvement—should also be explored (Paul and Rena, 2024c; Ogbuoji and Yamey, 2019).
AI in healthcare can improve patient engagement and treatment outcomes (Paul and Rena, 2024d; Davenport and Kalakota, 2019).	Without policies ensuring equitable AI deployment, there is a risk that AI will primarily benefit urban, private healthcare sectors while leaving public hospitals under-resourced (Ataguba, 2020; Mahomed and Asmall, 2021).
AI-driven automation can mitigate workforce shortages (Paul and Rena, 2024e; IBM, 2023).	AI cannot replace human expertise in healthcare. Upskilling, reskilling, and AI literacy programmes are necessary to prevent resistance from healthcare workers (Rena & Kidane, 2009; Mesko, 2020).
Ethical AI adoption requires strong regulatory frameworks (Paul and Rena, 2024c; Jobin et al., 2019).	South Africa's current regulatory framework lacks specificity for AI in healthcare. The government must establish clear guidelines on patient data protection, bias mitigation, and AI accountability (Knox, 2024; Naudé, 2020).

Source: Authors' construct

The authors assert that a phased, context-sensitive approach—beginning with AI-assisted diagnostics in rural and under-resourced hospitals, alongside comprehensive AI training programmes for healthcare workers—is the most pragmatic path forward. AI's ethical deployment, equitable access, and long-term sustainability must be critically interrogated and strategically implemented to ensure it bridges, rather than widens, South Africa's healthcare divide (Paul and Rena, 2024d; Rena & Kidane, 2009).

2.9. Opportunities of generative AI in South African healthcare

2.9.1. Evidence synthesis

One of the new features of generative AI is that literature reviews and meta-analyses can be formatted automatically by the AI. The following AI systems help healthcare professionals get access to better quality evidence by suggesting search terms, screening the abstracts, and extracting relevant information. This capability shortens the time needed to synthesise the evidence, leading to improved support for decisions at both individual patient and health system levels that are based on evidence in clinical and policy practice (Fleurence et al., 2024).

Generative AI, which it can arrange literature reviews of an organisation's research and synthesise findings from significant online databases. For example, technologies, such as AI, can analyse ten thousand articles from different journals, identify their main findings, and synthesise them in briefings, saving researchers time for data collection (Philips, 2024). In addition, meta-analysis processes can also be improved by AI since this approach can enhance their thoroughness and the absence of prejudices as a result of automation restrictions (Chetty et al., 2023).

2.9.2. Real-world data analysis

Some widely used I/O sources are clinical notes and medical imaging, which discrete healthcare systems produce in great volumes. Generative AI can process such data types at scale and turn them into useable information. As such, generative AI leads to the optimisation of real-world evidence generation and the advancement of clinical decision-making and patient health trends understanding (Fleurence et al., 2024).

2.9.3. Clinical trial optimisation

Thus, Generative AI also has the potential to enhance clinical trials by satisfying needs for

simulation and optimising patient matching as well as the management of trial data. Such changes are beneficial because they facilitate the testing and approval of new treatments when a conventional methodology would take a longer time and costly. Moreover, generative AI can learn the pattern that will lead to the trial and thereby facilitate the identification of beneficial patterns, and improve efficiency (Fleurence et al., 2024).

2.9.4. Economic modelling

Self-constructed cost-benefit analyses of medical treatments can be supported by generative artificial intelligence. This technology helps policymakers to enhance the process of constructing and testing economic models, thereby allocating strategic resources and planning in the sphere of healthcare. While detailing the effects of interventions on healthcare funding, generative AI offers directions to truly maximise the spending on them (Fleurence et al., 2024).

2.9.5. Other related improvements

The positive impact of generative AI includes enhancement of diagnostics, individualised outcomes, and outcomes of operations. It advances artificial intelligence-based telemedicine and mobile health and helps expand access to health care in rural and poorly provided areas. For instance, in South Africa, where there are still existing inequalities in health provision, such innovations can fill gaps and improve service provision (Philips, 2024).

3. Methodology

Research relies on secondary resources to investigate the capacity of generative AI technology for South Africa's healthcare sector. The systematic evaluation, together with the synthesis of currently available data. The study examines AI applications for healthcare by analysing peer-reviewed journals and government reports and healthcare policy documents in addition to case studies of AI implementations in other regions as they pertain to the South African context.

The chosen data sources satisfied the criteria of credibility along with relevance of content and recent publications to achieve an up-to-date and comprehensive analysis (Boell & Cecez-Kecmanovic, 2015). The research draws on four main sources, including World Health Organisation (WHO) guidelines, South African Department of Health reports, academic studies about AI in healthcare, and global case examples of diagnostic

and treatment interventions powered by AI. The research review focuses on evaluating literary content about ethical challenges alongside policy structures and infrastructure limitations, as well as AI applications for health equality improvement.

This research paper used systematic literature review methods for grouping data into key themes, which included AI-driven diagnostics together with patient data security and healthcare accessibility, and workforce preparedness (Tranfield et al., 2003). A comparative assessment evaluated the medical AI readiness levels of South Africa about leading international approaches. Content analysis enabled researchers to extract important trends and assessment of challenges and suggested solutions from all reviewed literature according to Krippendorff (2018).

The secondary study delivers comprehensive theoretical and evidence-based knowledge about South African artificial intelligence applications within healthcare. The study merges current understandings and proven methods from multiple sources to create a foundation that supports governmental choices related to AI technologies and organisation frameworks, and long-term research plans.

The applicability of generative AI systems requires the use of a large and diverse dataset to produce fair results. South Africa may be contributing to the collection of bad data due to the divide and twofold access to healthcare services. This limitation posits the risk of Algorithmic bias, therefore, the A2i exacerbates health inequities rather than modifying them. To this end, for generative AI to work effectively in South African healthcare, the synthetic data generated needs to depict the ethnic and health diversities present in the country. The inclusion of AI cannot be achieved unless policymakers, data scientists, as well as healthcare providers join forces to develop AI models. Furthermore, focusing on the type of data collection that reflects the downtrodden will lessen bias and improve the fairness of AI models for such populations (Chetty et al., 2023).

4. Results and analysis

4.1. Challenges of generative AI in South African healthcare

4.1.1. Security and privacy

The use of generative AI presents several risks that revolve around values such as data privacy and the protection of patients. South Africa legalised data protection through its Protection of Personal Information Act (POPIA), recently appointed;

however, given the high AI adoption rate, strict ethical codification is crucial to avoiding illicit data use. Traditional AI systems, which can be generative, might lead to privacy violations of sensitive health information if such a system is not secured properly. For instance, any healthcare organisation that is deploying AI solutions needs to embrace full encryption within the entire AI network and incorporate a multi-level authorisation system. Also, further development of definite principles of data management can provide broader acceptance and ethical utilisation of generative AI in healthcare, when stakeholders know that their data is safe and not misused in any way.

4.1.2. Resource limitations

The high attrition costs of integrating generative AI and the tools and system constraints are expensive, especially in South Africa's under-resourced public health facilities. Moreover, there is a scarcity of skilled human resources and knowledge of AI specialising in its application, and the availability of powerful computational facilities limits its progress. Generative AI that need specific investments in education, capacity, and infrastructure to power parity. For example, collaborations between public departments and private technology companies can share risks and reduce expenses on one hand and promote training sessions to build human capital on the other (Boston Consulting Group, 2023).

4.1.3. Restriction through regulation and policies

Lack of AI-friendly policies, legal misfits in adopting AI-friendly legislation or policies, and slow implementation pose a challenge in the integration of generative AI in the South African health sector. Achieving this will require aligning AI implementation with POPIA and other relevant regulations to create an environment conducive to innovation. These challenges can be well managed by timely policies that account for the ethical, legal, and technical implications to provide for technological solutions. In addition, the creation of national AI policies in the healthcare sector that should harmonise innovation with ethical rules should play an essential role in the proportionalisation of the development of AI inside this sector and the solution of potential risks. Many of these issues will need to be solved by the coordinated action of the various stakeholders, such as government agencies, healthcare organisations, and private technology firms, to construct a long-term and ethical approach to generative AI in South African healthcare. Such cooperation should focus on diverse, covered, safe,

fair, and adequately governed access to generative AI capabilities.

4.1.4. Infrastructure and resource constraints

One of the main challenges of integrating AI into South Africa's healthcare system is the insufficient infrastructure and resources. A significant challenge to AI implementation in South Africa's healthcare system is financial constraints. While public-private partnerships are a primary source of funding, alternative methods such as digital crowdfunding platforms are emerging as a viable solution (Paul and Rena, 2024a). These platforms democratise access to resources, allowing hospitals, research institutions, and startups to seek decentralised funding for AI-driven innovations. Public hospitals, in particular, face issues with outdated equipment and unreliable internet connectivity, both of which are crucial for AI-powered systems. Collaborative efforts to upgrade infrastructure are vital to fully harness the potential of generative AI (South African Government, 2024).

4.1.5. Skills gap and workforce development

A major obstacle to AI adoption in South Africa is the lack of trained healthcare professionals who are proficient in using AI technologies. Initiatives such as the Council for Scientific and Industrial Research's (CSIR) AI training programs are designed to address this issue by providing healthcare workers with the essential technical skills needed to effectively implement and manage AI systems (CSIR, 2023).

4.2. Using generative AI in the healthcare sector

4.2.1. Diagnostics

Due to the increasing use of generative AI in the diagnostic process, doctors are now capable of analysing extended datasets within a short time and with high accuracy. South Africa, for instance, continues to experience diseases like tuberculosis, HIV, and cancer among others; therefore, AI diagnostics can be a useful solution. These tools include analysing imaging data to pick signs of early diseases, which helps in early diagnosis and getting improved patient results (News24, 2024). For example, there is an increased use of AI to support chest X-ray screening for tuberculosis in rural clinics, reducing the pressure on overworked professionals and shortening the time for treatment (Intersystems, 2024). Diagnostic tools in the field of AI, for instance, tuberculosis detection devices, use a set of rules to analyse chest X-ray images and look for the first symptoms of the illness. In South Africa, these tools have greatly improved the accuracy of diagnosis,

and they have been more helpful in those regions where access to radiological support is rare. For instance, AI-based mobile diagnostic centres supported by a computerised detection system have shortened diagnosis times and enhanced first-time disease detection proportions (Qure.ai, 2024; Savant, 2023). However, one of the main hurdles that must be overcome before AI can be properly implemented in South Africa's healthcare industry.

4.2.2. Personalised medicine

Personalised medicine directs generative AI in the formation of precise health plans that suit unique patients. It is also important to understand different genetic and environmental factors that may explain at least one of them, as lifestyle factors, AI systems increase the effectiveness of treatments and minimise side effects. Namely, South Africa, where the patient population differs significantly from other countries due to existing healthcare disparities, and where a generative AI-based approach to personalised medicine seems to be a viable solution. For instance, newly developing models of artificial intelligence are applied to enhance optimal drug prescriptions and personalise the therapy depending on one's genetic makeup (The Trade Adviser, 2024).

4.2.3. Operational efficiency

Generative AI is already changing the ways that outline operations for healthcare organisations as it brings efficiency to technical tasks, including patient registration, appointment scheduling, and record keeping. These systems assist in lightning the workload of the healthcare staff by taking much of the real work to the electronic platform. AI solutions have started to permeate South African hospitals, especially so in the use of artificial intelligence-based resource planning in a manner such as bed planning, supply chain, etc (Boston Consulting Group, 2023). These changes have increasingly helped cut costs tremendously while at the same time increasing patients' satisfaction.

4.2.4. Medical and schooling

The use of AI-generated simulation and self-directed as well as educative materials is improving the training of black healthcare workers in South Africa. Simulated scenarios provide medical students with safe, controlled environments to practice comprehensive care planning without the risk of real-world consequences. Moreover, the above-mentioned AI-based platforms create ongoing training for healthcare employees, making them aware of the recent developments in healthcare science and technologies (ITWeb, 2024). In doing

so, these tools also aid in narrowing gaps in training resources to create better healthcare workers.

4.2.5. Drug discovery

Generative AI fast-tracks other drug discovery procedures by identifying molecular behaviours and mimicking compound functions. This capability is most important for diseases that affect our society in South Africa. AI tools help to limit the development time and costs of new drugs, with the new diseases being treated faster and more effectively. For example, AI systems are being proposed to design cheap treatments for various diseases, and treatment plans that incorporate the local healthcare system facilities (Intersystems, 2024).

4.3. Chances for the industry and science

4.3.1. Fostering the development of AI-driven new generation startups and healthcare innovations

The increased market for the utilisation of AI in the healthcare sector of South Africa is encouraging the development of new founder-centric AI startup businesses. These companies are putting their efforts into creating diagnostic and telemedicine as well as patient care solutions through Artificial Intelligence that not only benefit the local economy but also enhance healthcare services (Bizcommunity, 2024).

4.3.2. Technology tenets for scaling telemedicine and enhancing access to care for Jennie and others in rural areas

Telemedicine Platforms integrate generative AI to provide the needed connection to bridge the gap between the urban and rural health services in South Africa. They facilitate remote consultations, virtual monitoring, and health advice, and the delivery of quality medical care to the intended vulnerable populations. Other applications of AI chatbots and virtual assistants are in the administration of primary health care in remote regions (IT-Online, 2024).

4.3.3. Sustainable approaches to the development of generative AI in South Africa

By having the right investments and policies in place, South Africa has the right ingredients for being a world-class hub for generative AI research. I value localised AI models focused on prevailing health issues that can generate international cooperation and funding and place the country as an innovator in AI healthcare advancement (Gestaldt, 2024).

4.3.4. AI models for the different demographic types among the South African population

Developing products that fit each group of people that exists in South Africa is an efficient way of ensuring that correct solutions are delivered. These models help to reconsider the existing gaps concerning diagnostics and treatment results concerning all the population categories mentioned ([The Trade Adviser, 2024](#)).

4.3.5. Promoting interaction of disciplines and international participation

Technologists, healthcare workers, as well policymakers, are now involved in the creation of robust and effective AI systems.

4.4. Cross-disciplinary research

The practicality and ethics of applying artificial intelligence in healthcare are made possible through an interdisciplinary approach. These partnerships have helped South Africa contribute to the advancement of AI around the world ([The Future Society, 2024](#)).

4.4.1. Pilot projects and implementation strategies

Pilot projects serve as a valuable method for testing AI systems in controlled settings before they are implemented on a larger scale in the healthcare sector. For example, using generative AI in select clinics for personalised diagnostics or resource allocation can help uncover implementation challenges and improve processes. Successful pilot projects not only demonstrate the potential of AI but also offer evidence-based strategies for wider adoption ([Gestaldt, 2024](#)).

Looking ahead, advancements in generative AI for South African healthcare should prioritise the development of localised AI models that reflect the country's diverse population and specific health challenges. It is crucial to invest in research, foster cross-sector collaborations, and launch public awareness campaigns to build trust and acceptance of AI technologies. Additionally, establishing regulatory frameworks that balance innovation with ethical considerations will be vital for sustainable adoption ([IT-Online, 2024](#); [Philips, 2024](#)).

5. Case studies

5.1. Automated Tuberculosis (TB) diagnosis in rural clinics with the potential intervention of artificial intelligence

South Africa struggles with a severe TB epidemic, 280,000 cases and 54,000 deaths per year. These

conditions are due to factors like the high prevalence of HIV infection, poor healthcare facilities, and an inadequate number of medical personnel. To overcome these challenges, mobile X-ray units installed in rural health delivery institutions were provided with CAD systems. It identifies TB immediately and gives instructions to practitioners; the Pulmonary Tuberculosis negative (PTB-negative) patients are excluded from further test processes, so it cuts the costly and time-consuming lab expenses from unnecessary tests. Council of this approach can result in saving up to R300 million annually in terms of laboratory expenses and is capable of early identification of forty percent of the patients that the conventional procedure of symptom could not detect.

5.2. A forensic review of cancer detection using machine learning models

Breast cancer is still one of the biggest killers of South African women, especially those in rural areas, because most of the screenings are difficult to access. Currently, we have Kathryn Malherbe, the CEO and the founder of Medsol, working on deep machine learning (DML) and artificial intelligence (AI) software to solve this problem. While using the current prototype, the accuracy has been estimated at 97.6 % for the detection of breast cancer, aiding health care staff and increasing the accuracy of diagnoses ([Malherbe, 2024](#)).

5.3. The outcomes and lessons learned

The implementation of AI-driven diagnostic tools in South Africa has led to several positive outcomes:

1. *Improved Diagnostic Accuracy:* Modern AI-based techniques have surpassed conventional approaches in the diagnosis of diseases such as TB and breast cancer.
2. *Cost Reduction:* Due to the ability of its systems to exclude TB-negative patients and therefore decrease the number of unnecessary laboratory tests, AI implementations will ultimately result in large cuts to healthcare expenses.
3. *Enhanced Accessibility:* Mobile AI-powered units are capable of reaching population segments in remote and underserved areas, increasing healthcare accessibility.

However, considerations include infrastructure development and training of the healthcare workforce. This paper argues that it is important to

address these problems for the sustainable integration of artificial intelligence in healthcare.

6. Methods of managing challenges

6.1. *Ethical policy recommendations for the integration of artificial intelligence*

A key element in fostering responsible AI innovation is ensuring that academic institutions have the freedom to conduct unbiased, ethical research. Studies indicate that academic freedom plays a crucial role in addressing economic inequalities and industrialisation in developing nations (Paul and Rena, 2024e). In the South African context, robust academic research is vital to ensure that AI is implemented ethically and inclusively in healthcare (Paul and Rena, 2024c). Based on that, we need to establish a robust policy framework that will cover issues like data protection, approaches to algorithmising, and the consent of patients. Due to the World Health Organisation (WHO) pipeline for Computer-Aided Design (CAD) for Chest X-ray interpretation for TB and silicosis screening and diagnosis, the Department of Health is exploring the adoption of AI tools for these purposes (South African Government, 2024).

6.2. *Enabling PPP in funding infrastructure and research*

Co-achievement of governmental organisations, private organisations, and universities can help assemble resources for the AI framework and advancement. Such partnerships may help establish the development and implementation of AI solutions suitable to the South African environment of the healthcare system (Gestaldt, 2024).

6.3. *AI training programs for capacity enhancement of healthcare workers*

Building AI capacity in healthcare requires a fundamental shift in higher education and training programmes. Studies show that strategic financing and policy reforms are crucial in ensuring the sustainability of educational advancements (Rena, 2002). Additionally, historical perspectives on educational reforms suggest that institutional support and infrastructure investment play pivotal roles in shaping workforce development (Rena, 2006; Rena & Kidane, 2009). South Africa must leverage these insights to develop AI-centred curricula for medical training. The right training programmes that can enlighten Healthcare workers through AI literacy and AI

technical characteristics should be integrated and launched. The SC/CSIR is in the process of designing diagnostic systems using machine learning to enhance diagnostic facilities for doctors, whereby rural patients are often referred to with poor or a lack of diagnostic facilities (CSIR, 2023).

6.4. *Towards an AI-friendly environment for patients and providers*

The inception of trust in AI solutions is a process that should be facilitated by such information. The sensitivity of consumers and healthcare providers to AI can be reduced through an informational campaign, training sessions, and seminars (Human Sciences Research Council, 2024). Through the execution of these strategies, South Africa can unleash generative AI to its full potential in the health sector, enhancing the lives of patients and the health department of the nation.

6.5. *Future directions and recommendations*

Future advancements in generative AI for South African healthcare should focus on developing localised AI models that account for the country's diverse population and unique health challenges. Investments in research, cross-sector collaborations, and public awareness campaigns are critical for fostering trust and acceptance of AI technologies. Moreover, creating regulatory frameworks that balance innovation with ethical considerations will be essential for sustainable adoption (IT-Online, 2024; Philips, 2024).

6.6. *Comprehensive contributions of the study*

This study offers a thorough and insightful contribution by investigating how generative AI can tackle systemic challenges in South Africa's healthcare system. By looking at practical applications, obstacles, and potential benefits, the research lays out a framework for using generative AI to promote fair and effective healthcare results.

6.7. *Advancing healthcare accessibility and equity*

A key aspect of this study is its emphasis on generative AI as a means to close the healthcare accessibility gap between the public and private sectors in South Africa. The public healthcare system, which caters to the majority of the population, often faces issues like resource shortages, long wait times, and overcrowded facilities (Ataguba, 2020). This research illustrates how generative AI can help

ease these challenges by providing mobile diagnostic solutions and virtual consultations for rural and underserved communities (Savant, 2023; Qure.ai, 2024). For instance, AI-driven mobile X-ray units have already shown effectiveness in early tuberculosis (TB) detection in rural clinics, presenting a scalable model that could be adapted for other diseases.

6.8. Enhancing clinical decision-making and diagnostics

The study also highlights how generative AI can improve diagnostic accuracy and clinical decision-making, especially in a country grappling with a high prevalence of communicable diseases like TB and HIV, alongside increasing non-communicable diseases such as diabetes and hypertension (Pillay-van Wyk et al., 2016). Generative AI systems, trained on varied datasets, can recognise disease patterns and forecast treatment outcomes with greater precision than conventional diagnostic techniques. For example, the research points out that machine learning algorithms in cancer diagnostics have reached up to 97 % accuracy, transforming early detection and treatment in South Africa (SAB Foundation, 2020). These advancements not only enhance patient outcomes but also improve resource management in overburdened healthcare facilities.

6.9. Supporting workforce development and retention

This study makes a significant contribution by tackling the workforce challenges faced by South Africa's healthcare system. With a public healthcare sector that is both overburdened and under-resourced, generative AI presents tools that can automate routine administrative tasks and enhance operational efficiency. This allows healthcare professionals to dedicate more time to patient care (Philips, 2024). The South African healthcare sector significantly depends on migrant workers, particularly in rural areas where healthcare worker shortages are acute. However, these workers often face barriers in accessing digital training opportunities. Similar to the challenges faced by migrant entrepreneurs in economic inclusion (Paul and Rena, 2024d), targeted AI training initiatives are essential to empower migrant healthcare professionals, ensuring they are not left behind in the digital transformation. Additionally, AI-driven training programmes and simulations for medical practitioners promote ongoing professional development, helping to bridge the skills gap and equip

healthcare workers with essential technological competencies (CSIR, 2023).

6.10. Mitigating data scarcity through synthetic data generation

Another important aspect of this study is its focus on generative AI's capability to produce synthetic data, which helps to alleviate the problem of data scarcity in healthcare research. Given South Africa's distinct demographics and health challenges, there is a need for localised data; however, gathering such data is often complicated by privacy issues and logistical obstacles. Generative AI can create anonymised datasets that accurately represent population diversity, allowing researchers to train and validate models without risking patient confidentiality (Chetty et al., 2023).

6.11. Informing policy and strategic implementation

Lastly, this study offers valuable insights for policymakers, healthcare providers, and industry stakeholders. By emphasizing regulatory and ethical considerations, such as compliance with the Protection of Personal Information Act (POPIA) and ensuring transparency in algorithms, it provides a framework for the ethical integration of generative AI into the healthcare system (South African Government, 2024). Moreover, the study encourages collaborative pilot projects and public-private partnerships to develop and test scalable AI solutions that meet the specific needs of South Africa's healthcare sector. In essence, this study presents a comprehensive perspective on the transformative potential of generative AI in South African healthcare. It not only identifies the challenges but also explores the opportunities for improvement.

7. Conclusion

Generative Artificial Intelligence (AI) holds significant potential to address the complex challenges facing South Africa's healthcare system, including diagnostic bottlenecks, resource constraints, and service delivery inefficiencies. They range from using it for better diagnostic and individualised therapeutic management, and administrative purposes, to accelerating the process of drug development. It is these advancements that can create better outcomes for the patients and bring better accessibility to highly qualified healthcare services and better usage of resources. Nevertheless, the effective implementation of generative AI in healthcare

requires work from several actors, such as policy-makers, doctors, scientists, as well as technology creators. All these constitute key themes that would require collective effort to address issues on data diversity and heterogeneity, data security and privacy, data scarcity, and conflicting data regulations. Drawing public-private collaborations helps to outline the principles of AI use and build the essential infrastructure for AI operations.

It is recommended that future studies build computational models specific to the demographics of South Africa and the corresponding prevalence of diseases. This is due to the current limitations of AI, which have to build localised datasets to deal with the current population of the country, to remove bias, and improve the relevance of AI. Furthermore, realistic operational plans should include the development of educational courses that will introduce healthcare personnel to AI and the establishment of measures that will help to gain patient and healthcare worker acceptance of the technologies. Thus, it can be concluded that, despite a great number of opportunities generative AI provides for South African healthcare advancement, the creation of such opportunities requires an elaborate, ethically grounded, and culturally sensitive strategy. In this way, applying generative AI in South Africa as a combination of new collaborative strategies and localised solutions will let the country build an effective, fair, and customer-oriented healthcare system.

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