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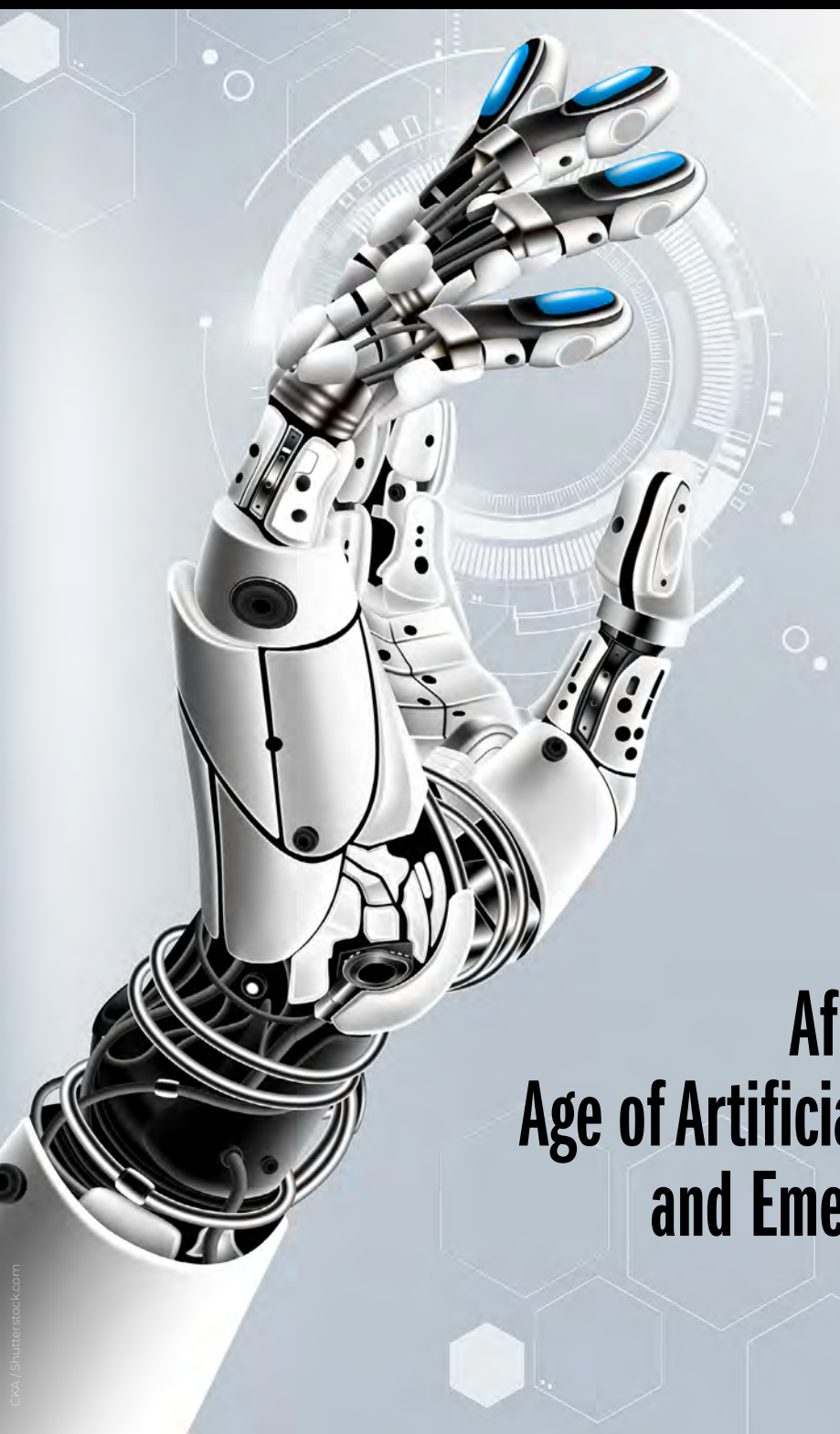

SPECIAL ISSUE ON

Envisioning an African Future in the Age of Artificial Intelligence (AI) and Emerging Technologies

EDITED by Prof Tapiwa Chagonda

The Thinker

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IN THIS ISSUE

The University of Johannesburg acquired *The Thinker* in April 2019 from Dr Essop Pahad. Over the last decade, *The Thinker* has gained a reputation as a journal that explores Pan-African issues across fields and times. Ronit Frenkel, as the incoming editor, plans on maintaining the pan-African scope of the journal while increasing its coverage into fields such as books, art, literature and popular cultures. *The Thinker* is a 'hybrid' journal, publishing both journalistic pieces with more academic articles and contributors can now opt to have their submissions peer reviewed. We welcome Africa-centred articles from diverse perspectives, in order to enrich both knowledge of the continent and of issues impacting the continent.

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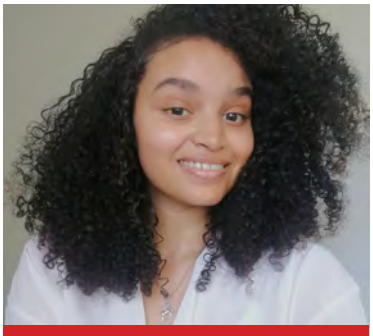

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FOREWORD

by Prof. Tapiwa Chagonda,
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As the African continent stands at the cusp of profound technological advancement, it finds itself compelled to confront both the pros and the cons of the digital revolution. Artificial intelligence (AI), robotics, mobile commerce, and advanced machine learning (ML) are no longer emerging phenomena in distant economies; they are deeply embedded in Africa's sociopolitical, economic, and cultural fabric. This special issue of *Technology and Society within the African Context,* illuminates the multidimensional implications of these advancements, recognising the urgency of both proactive engagement and ethical stewardship. Through ten insightful contributions, this issue seeks to provide a deep understanding of how Africa might harness these technologies to foster resilience, inclusivity, and sustainability across sectors.

Generative AI, as discussed in my paper, represents both an unprecedented opportunity and a complex risk for African societies. With technological giants like Google and Meta accelerating development in this area, Africa must urgently draft an ethics-driven framework—grounded in Ubuntu, Africa's philosophy of shared humanity—to protect its citizens, particularly those who are marginalised. This ethical approach is essential for safeguarding against algorithmic biases that may not reflect the continent's unique cultural and socioeconomic landscape. By involving bodies like the African Union and UNESCO, the article suggests that Africa can and should participate in creating AI guidelines that both empower and protect its people, moving the continent from consumer to co-creator of these technologies.

The integration of technology in election administration has been touted as a means to increase transparency and trust. However, as Daniel Godwin's paper on Nigeria's 2023 presidential election in this issue reveals, technology alone cannot guarantee electoral integrity. The controversies surrounding technical glitches in vote transmission underscore the necessity of both technical reliability and human accountability in electoral processes. It is evident that Africa's democratic aspirations depend on a holistic approach that includes not only technological tools but also trust in the institutions that manage them.

AI wearables, explored in Ireen Manyuha and Elizabeth Lubinga's paper, highlight another transformative application of technology on the continent. With a focus on AI-powered smartwatches and their use for eHealth, this study reveals a promising avenue for personal health engagement. Yet, it raises critical questions about data literacy, showing that many users may lack the expertise to interpret health data meaningfully. The study's findings urge health professionals and AI developers to consider these knowledge gaps, ensuring that innovations are accessible and beneficial to the average user, rather than a privileged few.

The Fourth Industrial Revolution (4IR), which has dramatically altered workplaces globally, has left an indelible mark on Africa, especially in the light of the COVID-19 pandemic. Irene Marindi's paper reveals that digital and remote work, while offering flexibility, also blurs the boundaries between personal and professional life, impacting mental well-being. This shift necessitates a re-evaluation of work practices in Africa to prevent burnout and maintain productivity, as virtual work environments continue to grow in prominence.

For many Africans, m-commerce explored in Mogau Mashishi and Mpho Primus's paper represents a critical avenue for economic inclusion. With mobile commerce adoption accelerating in South Africa's townships, findings from Soweto and Tembisa indicate that social media and trust are pivotal to successful adoption. M-commerce is a powerful tool for reaching underserved populations, but trust-building and ensuring secure digital environments are paramount. The study calls for more focused efforts to address the unique barriers faced by residents in townships, including security concerns and reliable infrastructure.

The issue of economic growth and resilience informs Botlhale Modisaotsile's paper, which examines South Africa's struggle with premature deindustrialisation. This paper provides an in-depth analysis of industrial policy, urging South Africa to draw lessons from countries like Brazil and South Korea. As the continent grapples with high unemployment rates and economic inequality, such policy insights are crucial for guiding Africa toward sustainable growth and positioning it as a formidable player in the global economy.

Seriane Morapeli and Tshegofatso Ratale's paper focuses on the mental health effects of social media platforms, particularly Black Twitter (now X). This study, focusing on Black South African millennials, reveals a double-edged experience: social media offers community and activism but also exposes users to harmful content. The paper calls for a balanced view that recognises social media's mental health implications, advocating for more awareness around safe and supportive online communities.

Climate change poses a pressing threat to Africa's agrarian economies, and Willard Munyoka, Nkhangweni Mashau & Modimowabarwa Kanyane's paper presents an urgent case for adopting 4IR technologies to bolster food security. By developing a framework for small-scale farmers to adopt AI and other digital tools, the paper argues for a smart farming approach that can aid in achieving the

UN's Sustainable Development Goal of zero hunger. It emphasises the need for government support and an African-specific model that addresses the unique challenges faced by rural farmers.

The pervasive issues of bias and lack of diversity in AI are explored in H. Titilola Olojede's paper. This piece emphasises the critical need for inclusivity, particularly gender inclusivity, in Africa's AI landscape. With stark disparities in digital participation, the paper calls for a communal approach to AI development that actively includes underrepresented groups. It proposes that African societies incorporate gender-sensitive frameworks to ensure equitable access and prevent AI systems from perpetuating historical inequalities.

Finally, Edmund Terem Ugar's paper delves into the potential for AI, ML, and robotics in African healthcare. While AI in diagnostics holds immense promise, the study reveals that a direct import of such technologies from the Global North may overlook the contextual specificities of African healthcare systems. This paper urges Africa to build its infrastructure for data collection and analysis, tailoring AI solutions to its healthcare realities. Such efforts can ensure that advanced technologies serve African populations equitably and ethically.

In conclusion, this special issue of *Technology and Society within the African Context,* underscores the transformative potential of digital technologies across sectors. However, the articles collectively remind us that this potential is not inevitable; it requires deliberate actions to navigate ethical, economic, and cultural complexities. As we look forward, Africa must position itself not merely as a consumer but as an active shaper of these technological tides. By grounding digital advancements in the values and unique contexts of African societies, we can ensure that these tools serve to empower, rather than exploit, the continent's diverse populations.

Chatbot Programmes' 'Arms Race': Africa and Artificial Intelligence (AI) Ethics

By Tapiwa Chagonda

Abstract

This paper argues that the AI revolution which is currently unfolding and being fuelled by the significant strides in Generative AI-powered technologies, calls for an urgent response by the African continent, to ensure that possible harms associated with this cutting-edge technology are mitigated. The 'arms race' to create chatbots that can rival Open AI's ChatGPT-4.0 technology by big technology companies such as Google and Meta, is not only hastening the pace of the AI revolution but is also bringing to the fore the double-edged nature of this technology. The benefits of AI generative technologies such as chatbots in fields such as the academy; health; agriculture; music and art, have been touted in recent times, but the ethical concerns around issues of bias; possible proliferation of misinformation from algorithms that are trained on datasets that are not fully representative of the global South's realities, especially Africa; breaches in privacy issues and threats of job losses, still linger. The fact that in March 2023, an Elon Musk-led petition to have a six-month moratorium on AI chatbot innovations began circulating raises serious ethical concerns around the AI revolution, which makes it critical for a continent such as Africa, which has largely been a consumer of these technologies and not an innovator, to urgently draft measures that can protect it. The paper contends that even though Africa is not homogenous in nature, it needs to come up with an AI ethics-driven framework that protects the majority of its population which is mired in poverty and likely to be on the receiving end of any cons associated with AI technologies. This framework should be largely anchored in the African philosophy of Ubuntu, but also pragmatic enough to include positive facets of global-North philosophical strands such as deontology, which largely places currency on ethical principles and rules above the outcomes they produce. Organisations such as the African Union (AU) and the United Nations Education Scientific

and Cultural Organisation (UNESCO) can play a critical role in coming up with an AI framework that is binding to member states. This will help protect vulnerable and marginalised groups on the continent from some of the negative effects of AI innovations.

Introduction

The Fourth Industrial Revolution (4IR) and its array of technologies such as artificial intelligence (AI), robotics, machine learning, cloud computing, 3D & 4D Printing, quantum computing, Internet of things (IoT) and other highly advanced technologies, has ushered in a brave and fascinating new era which is full of possibilities but also fraught with challenges. Huge strides are being witnessed in AI, especially, which are being felt in many spheres of life and shaping many sectors' operations. This explosion of AI technologies, which mostly have their origins from the global North, has led a number of scholars to interrogate the efficacy of some of these AI programmes within contexts such as Africa, which appear to be mostly consuming these technologies that are designed from Western perspectives and driven by values from the same. Scholars such as Birhane (2020) and Kwet (2019) have even gone further to define the technological relationship between the global North and Africa within the context of 4IR, as the algorithmic colonisation of the latter, due to the proliferation of huge and powerful technological firms that are occupying the digital infrastructure and ecosystem of the African continent. Such a scenario around most of these big technological firms' technologies that are largely driven by AI raises ethical questions around what Zuboff (2019) terms surveillance capitalism, which is linked to issues of privacy and data protection, bias and fairness when it comes to accessing and consuming the benefits of these advanced technologies within the African context. The fierce and fast-paced AI competition among the big technological firms such as Google, Microsoft, Meta and Apple is intensifying, especially in light of Open AI's Chatbot GPT strides that are promising to revolutionise many sectors that range from art, music and the academy. The intriguing advancements that come with these Chatbot AI strides are also exponentially increasing the ethical risks around issues of privacy, management of big

"The fierce and fast-paced AI competition among the big technological firms such as Google, Microsoft, Meta and Apple is intensifying, especially in light of Open AI's Chatbot GPT strides that are promising to revolutionise many sectors that range from art, music and the academy."

data, potential job losses in the future and possible proliferation of fakeness. In the wake of what Swisher (2023) terms the 'arms race' of Chatbot AI and its attendant ethical questions, among the powerful technological corporations, where does this leave the continent of Africa?

The above question is critical and the importance of interrogating Africa's role in this AI revolution cannot be over-emphasised. Artificial Intelligence (AI) which has been described and defined by leading scholars in that field such as Marwala (2019: 56) as technology that makes machines 'intelligent' and as "a model created to solve a specific problem or provide a particular service", by Gates (2023: 1), co-founder of Microsoft, has exploded in recent times and its influence has been brought to the fore by advancements in machine learning, deep learning, and natural language processing, which has, in turn, led to the development of intelligent systems such as ChatGPT-4.0.

The interrogation of AI and ethics is particularly important in the context of Africa at this juncture, when the AI revolution's pace appears

to be hastening as a consequence of Open AI's ChatGPT-4.0 powers, which appear to have sparked an AI chatbot 'arms race' among the world's top technological firms. Chatbots, which are generative artificial intelligence algorithms are envisaged to make a huge impact in many facets of our lives, including work, education, health, art and music through their role of responding to prompts on tasks they might be asked to perform. In a bid to not get left behind in the AI revolution, which is unfolding, other big technological firms such as Google, Meta and Baidu, have also launched their own rival chatbots such as Gemini, Blenderbot and Ernie, respectively (BBC 2023). These strides in AI technologies such as the emergence of sophisticated chatbots are crucial from the African continent's perspective, as the continent is increasingly adopting AI technologies to solve problems in areas such as healthcare, agriculture, and education (Gwagwa et al 2022). However, the use of AI in these contexts raises a number of ethical concerns that must be addressed. For example, AI systems may perpetuate biases and discrimination if they are not designed and trained in an ethical manner (Crawford & Joler 2019). This is especially problematic in Africa, where historical and structural inequalities are already pervasive.

Moreover, the introduction of chatbots in Africa raises additional ethical concerns around AI. Chatbots can be used to provide support and information to users, but they can also be used to collect and analyse personal data, potentially infringing on users' privacy (Mittelstadt et al. 2016). Additionally, the use of chatbots may lead to job losses and a reduction in human interaction, which could have negative social and economic impacts (Brynjolfsson and Mitchell 2017).

To address these ethical concerns, it is important to ensure that AI systems are developed and used in an ethical manner. This can be done by promoting transparency, accountability, and participation in the development and deployment of AI systems (Taddeo and Floridi 2018). Additionally, efforts must be made to ensure that AI systems are designed to be inclusive and unbiased, and that they are used to promote social justice and human rights (Jobin et al. 2019). Ultimately, the ethical use of AI will be critical in ensuring that the benefits of these technologies are realized while minimizing their potential risks and harms in Africa and beyond.

AI Ethics and its Origins

The notion of AI ethics first came to the fore in the academy in the 1970s, with the publication of Joseph Weizenbaum's seminal text, *Computer Power and Human Reason: From Judgment to Calculation* (1976). Weizenbaum was among the first scholars to raise ethical concerns regarding the development of AI systems, arguing that the use of computers to make decisions about human lives was inherently problematic. Since then, numerous scholars and practitioners have contributed to the development of AI ethics as a field of study, including philosophers, computer scientists, lawyers, and social scientists.

> "The lack of ethical guidelines and regulations around the development and deployment of AI systems can lead to public mistrust and skepticism around their benefits *(Jobin et al. 2019).*"

AI ethics is a critical branch of ethics for a number of reasons. First, as AI technologies become increasingly ubiquitous, they have the potential to significantly impact society, both positively and negatively (Bostrom and Yudkowsky 2014). For example, AI systems may perpetuate existing biases and inequalities, or they may be used to infringe on individual rights and freedoms. AI ethics is, therefore, critical in ensuring that the development and use of these technologies are guided by moral principles that promote social justice and human well-being. Second, AI ethics is critical in promoting public trust and confidence in AI technologies. The lack of ethical guidelines

and regulations around the development and deployment of AI systems can lead to public mistrust and skepticism around their benefits (Jobin et al. 2019). Ethical considerations must, therefore, be integrated into the development of AI systems to ensure that they are transparent, accountable, and trustworthy. Within the African context, the discourse around AI ethics has been gaining a lot of traction, with organisations such as the African Union (AU), United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the World Economic Forum (WEF) leading these initiatives (Birhane 2020; Gwagwa et al. 2022), however, the continent still does not have a coherent ethics-driven framework or approach towards AI and its associated technologies.

Utility of AI Ethics in the Development and use of AI Technologies

Ethics is important in the development and use of AI technologies for several reasons. Firstly, AI technologies have the potential to impact various aspects of society, including employment, healthcare, and education, among others. Therefore, ethical considerations are necessary to ensure that their development and use align with societal values and do not lead to unintended consequences. Floridi and Sanders (2004), argue that ethical considerations are essential in the development and use of AI technologies to ensure that they promote human welfare and do not cause harm. They argue that this requires taking into account the potential risks and benefits of AI technologies, as well as the ethical implications of their use.

Secondly, Bostrom (2014), notes that ethical considerations are particularly important in the development of super intelligent AI, which could have significant impacts on society. ChatGPT-4 is a good example of such technology which has aroused both excitement and alarm around its capabilities. Bostrom (2014) further argues that ethical considerations are necessary to ensure that super intelligent AI does not pose an existential risk to humanity. This argument appears to be a crucial driving motive behind the call to put in place a six-month 'ceasefire' around the design of cutting-edge AI innovations.

Thirdly, Wallach and Allen (2010) state that ethical considerations are necessary to ensure that AI technologies are developed and used in a way that aligns with societal values, rather than just individual or corporate interests. This is easier said than done and this is where contexts such as Africa will always find themselves in a quandary as they interface with AI technologies that have their origins from the global North. Ensuring that societal values are at the core of AI technologies that are consumed by marginalised groups and that this trumps corporate interests, and the profit-motive is one formidable challenge which an AI ethics framework for Africa should grapple with. This task requires considering the potential impacts of AI technologies on various stakeholders, including marginalized communities and future generations.

> "This paper argues that the consequentialist approach should not be at the core of determining an African response to AI innovations because one of its major shortcomings in AI ethics is that it can be difficult to predict the consequences of AI systems."

Ubuntu versus the Consequentialist and Deontological Approaches to AI Ethics

In framing Africa's response to AI innovations, this paper argues that it is important to be guided by some ethical approach. The major approaches to ethics centre around consequentialism and deontology, which have their origins from the global North. However, scholars such as Gwagwa et al. (2022) and Mhlambi (2020), caution against being guided by Western ethical approaches when it comes to Africa's response to AI technologies and rather, advocate for the adoption of the *Ubuntu* approach, in Africa's interaction with

AI. What are the arguments of the Western and African approaches to ethics and what are their implications in the adoption of AI technologies?

The consequentialist approach to AI ethics prioritises the outcomes or consequences of AI systems above all else. In this approach, the ethicality of a decision or action is determined by the net positive or negative impact it has on society or individuals. One example of this approach in the African context is the use of AI in healthcare. AI systems can help doctors diagnose diseases more quickly and accurately, improving patient outcomes and saving lives. However, there are concerns about the potential for AI to exacerbate existing inequalities in healthcare access and outcomes. This paper argues that the consequentialist approach should not be at the core of determining an African response to AI innovations because one of its major shortcomings in AI ethics is that it can be difficult to predict the consequences of AI systems. This makes it hard to determine whether an action will have positive or negative consequences in the long term. In addition, the consequentialist approach has the potential for unintended consequences. This means that even if an action is intended to have positive consequences, it may have unintended negative consequences. This is one of the challenges of emerging AI technologies, thus, their adoption should not be premised upon consequentialist reasoning.

The deontological approach, on the other hand, prioritises ethical principles and rules above the outcomes they produce. In this approach, AI systems must adhere to ethical principles such as respect for individual autonomy, beneficence, non-maleficence, and justice. This approach appears to have been influential in informing the European Commission High-Level Expert Group on Artificial Intelligence (2019) and AI guidelines by Jobin et al. (2019) that are mostly in use in the global North.

Finally, Ubuntu, which loosely means that, 'a person is a person through other persons', (Mbiti 1970) makes for an ideal approach to frame Africa's response to AI because of its emphasis on the values of community, interdependence, and empathy (Metz 2011). Such an approach would recognise that AI systems exist within a broader social and cultural context, and that ethical considerations must be grounded in the values and experiences of the communities they serve. Given the importance of the collective within the African context, this approach, coupled together with deontology's progressive principles of beneficence, non-maleficence and justice, would create a robust framework that would endeavour to include a lot of marginalised groups within the African context who might be excluded or suffer from some of AI's harms based on their gender, race, class or geographical location fault lines. Thus, pragmatism of combining the Ubuntu approach and positive elements of some of the West's guiding AI principles might work in Africa's interests, as the continent grapples with a response to AI innovations. The next section underscores the value of such a guiding framework in a context such as Africa.

Importance of AI Ethics in the African Context

There are several ethical challenges associated with adopting Western-developed Artificial Intelligence (AI) technologies in the African context and some of these include:

1. **Bias and Discrimination**: AI algorithms can perpetuate biases and discriminatory practices, especially if they are trained on data that is not representative or inclusive of diverse populations. This is one of ChatGTP's challenges, as it is not fully trained on data that speaks to the realities of the African context, as characterised by some of the inaccurate responses it gives to questions related to this context. This could lead to the widening marginalization of certain groups, reinforcing existing inequalities, especially in highly unequal societies such as South Africa.
2. **Cultural Aptness**: AI technologies that are developed in Western contexts may not be culturally appropriate for African communities. For example, facial recognition technology may not work as well on dark-skinned individuals, which could lead to false identifications and mistrust (Kwet 2019).
3. **Privacy and Data Protection**: AI technologies often rely on large amounts of data to function, which raises issues of privacy and data protection. In Africa, where data protection laws may be weaker or non-existent, there is a risk that personal data could be misused or exploited. Italy's brief ban of ChatGPT in 2023 brought to the fore this challenge.

"The lack of trust in institutions, including government and technology companies, can result in skepticism and mistrust of AI technologies *(Jobin et al. 2019).*"

4. **Job Displacement**: As AI technologies become more advanced, they may replace human workers in certain industries, leading to job losses and economic insecurity. This could have a disproportionate impact on vulnerable populations in Africa that rely on informal or low-skilled work.
5. **Ownership and Control**: AI technologies are often developed and owned by large multinational corporations, which can raise questions about who has control over the technology and its applications. In the African context, this could lead to a loss of sovereignty and control over important decision-making processes (Birhane 2020; Kwet 2019).

The above AI ethical concerns are just a few examples of the ethical challenges associated with the adoption of Western-developed AI technologies in the African context. It is important for stakeholders to address these challenges in a thoughtful and collaborative manner to ensure that AI technologies are developed and used in ways that are ethical, inclusive, and beneficial for all on the African continent.

Influence of Cultural, Social, and Economic Factors in Shaping Africa's AI Ethical Response

Cultural, social, and economic factors play an important role in shaping ethical considerations around AI development and use in Africa. In this section, I will discuss how these factors can influence the ethical considerations surrounding AI in the African context.

Cultural factors can have a significant impact on the ethical considerations around AI development and use in Africa. For example, in some African cultures, traditional beliefs and practices may be prioritized over technological advancement (Gwagwa et al., 2020). This can affect the uptake and acceptance of AI technologies and may raise ethical concerns around issues such as privacy, data ownership, and consent. Additionally, cultural norms around power and authority may influence the way in which AI systems are designed and deployed. For example, AI systems that are designed to replace human decision-making may be viewed as threatening to traditional hierarchies and power structures.

Social factors such as trust, transparency, and accountability can also influence ethical considerations around AI development and use in Africa. The lack of trust in institutions, including government and technology companies, can result in skepticism and mistrust of AI technologies (Jobin et al. 2019). This lack of trust can be compounded by the opacity and complexity of AI systems, making it difficult for individuals to understand and hold accountable those responsible for their design and deployment. Additionally, social structures such as gender and socio-economic status can also affect the ethical implications of AI technologies. For example, AI systems that perpetuate existing biases may have a disproportionate impact on marginalised communities, such as women and low-income groups (Gwagwa et al. 2020).

Finally, economic factors can also shape ethical considerations around AI development and use in Africa. The digital divide, which refers to the gap between those who have access to digital technologies and those who do not, can create ethical concerns around the equitable distribution of benefits and harms associated with AI technologies (Gwagwa et al. 2020). Additionally, the economic interests of technology companies and governments may conflict with the ethical principles of transparency and accountability. For example, in some African countries, AI technologies may be developed and deployed without adequate public consultation or oversight, in order to serve the economic interests of governments or corporations (Gates 2023).

The Role of International Organisations in Promoting AI Ethics in Africa

International organisations such as the United Nations (UN), the African Union (AU), and the World Economic Forum (WEF) have been playing a crucial role in promoting AI ethics in Africa, however, more still needs to be done to ensure a coherent response to AI by the continent. The UN, AU and the WEF have developed various initiatives and frameworks aimed at addressing ethical concerns arising from the use of AI technologies in Africa. The UN, for instance, has established the High-Level Panel on Digital Cooperation, which seeks to promote cooperation among different stakeholders on issues related to AI ethics (United Nations 2021). The AU, on the other hand, has developed the Digital Transformation Strategy for Africa, which aims at promoting AI and other digital technologies while ensuring that they adhere to ethical principles (African Union 2020). The WEF has also been involved in promoting AI ethics in Africa through its Centre for the Fourth Industrial Revolution in South Africa, which seeks to promote best practices in the use of AI and other emerging technologies (World Economic Forum 2021).

The above initiatives and frameworks provide important guidelines for the development and implementation of AI technologies in Africa, ensuring that they are used in a way that is sustainable, transparent, and fair to all stakeholders. They also promote the establishment of clear regulatory frameworks that guide the use of AI and other emerging technologies, ensuring that they are not misused or abused. How effective have been these organisations in making sure that Africa responds in lockstep to AI innovations, given that their policies and advice on how to approach AI innovations is not binding?

In terms of UNESCO, the organisation has been making efforts to address ethical considerations around AI in Africa. For example, it organised the "AI Ethics and Africa" workshop in 2019 to promote discussions on ethical considerations and how AI can be used to achieve the Sustainable Development Goals in Africa. However, it remains to be seen how effective these efforts will be in the long run, as UNESCO's resources and reach are limited.

The African Union has also made some strides in addressing ethical considerations around AI. In 2019, they adopted the "AI for Africa" strategy, which aims to promote the development and use of AI in Africa while ensuring that it is used in a responsible and ethical manner. However, again, it remains to be seen how effective this strategy will be, as many African countries face challenges such as inadequate infrastructure and lack of skilled personnel to effectively implement and regulate AI technologies.

Lastly, the World Economic Forum (WEF) has also been working on ethical considerations around AI in Africa. In 2019, they launched the "Responsible AI for Social Empowerment" initiative, which aims to promote the development and use of AI in Africa in a responsible and ethical way. However, like the other organisations, the effectiveness of this initiative remains to be seen.

While UNESCO, the African Union, and the World Economic Forum have all made strides to address ethical considerations around AI in Africa, it's too early to tell how effective these efforts will be in the long run. Many challenges still need to be addressed, such as infrastructure and skilled personnel, to ensure that AI is used in a responsible and ethical way in Africa, in addition to making some of the frameworks around AI innovations, binding to African countries that are members of the AU and the UN.

Potential Future Directions for international Organisations to romote AI ethics in Africa

One potential direction for international organisations to promote AI ethics in Africa is through capacity building and education initiatives. This could involve providing training and resources to stakeholders, including government officials, industry leaders, and civil society organisations, to help them understand the ethical implications of AI technologies and develop strategies for addressing these implications. By promoting AI ethics education and capacity building initiatives, international organisations can help to build a culture of ethical awareness and responsibility around AI technologies in Africa. In institutions of higher learning, teaching of AI Ethics should be introduced to all students, regardless of disciplinary background. The teaching of AI ethics, which should

be introduced from the undergraduate level, will expose our future generation of policymakers, technological designers, business and political leaders of the need to approach our interaction with AI technologies in general from an ethical and human-centred perspective.

A further potential direction for international organisations to promote AI ethics in Africa is through the development of ethical guidelines and frameworks. It is important that organisations such as the AU and UNESCO make these binding to African member states, given the number of potential dangers which AI innovations can cause in the African context. These guidelines and frameworks could be developed in collaboration with stakeholders in Africa, including some of the marginalised groups and could provide guidance on best practices for the ethical development and use of AI technologies in the region. For example, the Institute for Electrical and Electronic Engineering (IEEE) Global Initiative on Ethics of Autonomous and Intelligent Systems has developed a set of ethical guidelines for the development of AI technologies, which could be adapted and contextualised for use in Africa. By developing ethical guidelines and frameworks that are specific to the African context, international organisations can help to ensure that AI technologies are developed and used in a way that promotes social justice and human well-being in the region.

A third potential direction for international organisations to promote AI ethics in Africa is through the establishment of ethical review boards and oversight mechanisms. If these are to be introduced in all member states of the AU and UNESCO and made binding, that would be a step in the right direction in ensuring that AI innovations are interrogated and reviewed before just being opened up to the public. These mechanisms could be responsible for reviewing AI projects and technologies for ethical implications and ensuring that they comply with ethical guidelines and frameworks. For example, the European Union has established an Ethics Advisory Group to provide independent advice on the ethical implications of AI technologies (European Commission, n.d.). By establishing similar oversight mechanisms in Africa, international organisations can help to ensure that AI technologies are developed and used in a way that is consistent with ethical principles and values.

> “In 2019, the World Economic Forum (WEF) launched the “Responsible AI for Social Empowerment” initiative, which aims to promote the development and use of AI in Africa in a responsible and ethical way.”

Conclusion

The world is on tenterhooks and at a crossroads, given the immense advancements that have occurred in recent times in the field of AI and no wonder Bill Gates terms these technological developments, a revolution unfolding right before us. The challenge is around the opportunities and ethical dilemmas which Generative AI technologies are posing for a continent such as Africa, whose context is replete with poverty, inequality and non-existent binding ethical frameworks on how to respond to AI technologies. Given the fast-paced nature of the AI revolution, urgent attention towards developing an AI ethics framework that is binding is required to safeguard the continent from some of the harmful effects of AI technologies. With the active cooperation of African states, bodies such as the AU and UNESCO should lead the charge in drafting a binding AI ethical framework which can serve the interests of vulnerable and marginalised groups on the African continent, thus, forestalling possible harms associated with AI technologies.

References

African Union. (2019). *AI for Africa Strategy*. Available from: https://au.int/en/documents/20191206/ai-africa-strategy [Accessed: 22/11/24].

African Union. (2020). *Digital Transformation Strategy for Africa*. Available from https://au.int/en/documents/20200626/digital-transformation-strategy-africa [Accessed: 22/11/24].

BBC.2023. *ChatGPT-Style Tech Brought to Microsoft 365*. Available from https://www.bbc.com/news/technology-64970062. [Accessed: 22/11/24].

Birhane, A. (2020). Algorithmic Colonization of Africa. *Scripted*, 17(2), pp. 389-409.

Bostrom, N. (2014). *Superintelligence: Paths, dangers, strategies.* Oxford: Oxford University Press.

Bostrom, N. & Yudkowsky, E. (2014). The Ethics of Artificial Intelligence. In Frankish, K. and Ramsey, W., (Eds.), *Cambridge Handbook of Artificial Intelligence*. New York: Cambridge University Press pp. 316-334.

Brynjolfsson, E & Mitchell, T. (2017). What can machine learning do? Workforce implications. *Science*, 358(6370), pp. 1530-1534.

Crawford, K & Joler, V. (2019). Anatomy of an AI System. *Virtual Creativity*, 9(1), pp. 117-120.

European Commission. n.d. *Ethics guidelines for trustworthy AI*. Available from: https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai [Accessed: 22/11/24].

Floridi, L., & Sanders, J. W. (2004). On the morality of artificial agents. *Minds and Machines*, 14(3), pp. 349-379.

Floridi, L., Cowls, J., Beltrametti, M. et al. (2018). AI4People—An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Minds and Machines,* 28(4), pp. 689-707.

Gates, B. (2023). *AI is most important tech advance in decades*. Available from: https://www.bbc.com/news/technology-65032848 [Accessed: 22/11/24].

Gwagwa, A. *et. al.* (2022). The role of the African value of Ubuntu in global AI inclusion discourse: A normative ethics perspective. *Patterns,* 3(4), 100462.

IEEE. (n.d.). *IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems*. Available from: https://ethicsinaction.ieee.org/ [Accessed: 22/11/24].

Jobin, A., *et. al*. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence*, 1(9), pp. 389-399.

Kwet, M. (2019). Smart CCTV Networks Are Driving an AI-Powered Apartheid in South Africa. *Vice*. Available from: https://www.vice.com/en_ca/article/pa7nek/smart-cctv-networks-are-driving-an-ai-poweredapartheid-in-south-africa [Accessed: 27/11/24].

Marwala, T. (2019). Artificial Intelligence, At Africa's Door. *The UNESCO Courier*, 2019 (2), pp. 56-57.

Mbiti, J.S. (1970). *African religion and philosophy*. London: Heinemann.

Metz, T. (2011). Ubuntu as a moral theory and human rights in South Africa. *AHRLJ*, 11(2), pp. 532-559.

Mhlambi, S. (2020). *From Rationality to Relationality: Ubuntu as an Ethical and Human Rights Framework for Artificial Intelligence Governance*. Cambridge: Harvard Kennedy School, Harvard University.

Mittelstadt, B.D et al. (2016). The ethics of algorithms: Mapping the debate. *Big Data & Society*. Available from https://doi.org/10.1177/2053951716679679 [Accessed: 22/11/24].

On with Kara Swisher Podcast (2023). *OpenAI CEO Sam Altman on GPT-4 & the A.I. Arms Race* [Apple podcasts]. Transmission date: 23 March 2023. Available from: https://podcasts.apple.com/us/podcast/openai-ceo-sam-altman-on-gpt-4-the-a-i-arms-race/id1643307527?i=1000605522804 [Accessed: 27/11/24].

Taddeo, M & Floridi, L. (2018). How AI can be a force for good. *Science,* 361 (6404), pp. 751-752.

UNESCO. (n.d.). *AI Ethics Education for Africa.* Available from https://en.unesco.org/ai-ethics-education-africa [Accessed 22/11/24].

UNESCO. (2019). *AI Ethics and Africa Workshop.* Available from https://en.unesco.org/events/ai-ethics-and-africa-workshop [Accessed 22/11/24].

United Nations. (2021). *High-Level Panel on Digital Cooperation*. Available from https://www.un.org/en/digital-cooperation-panel/ [Accessed 22/11/24].

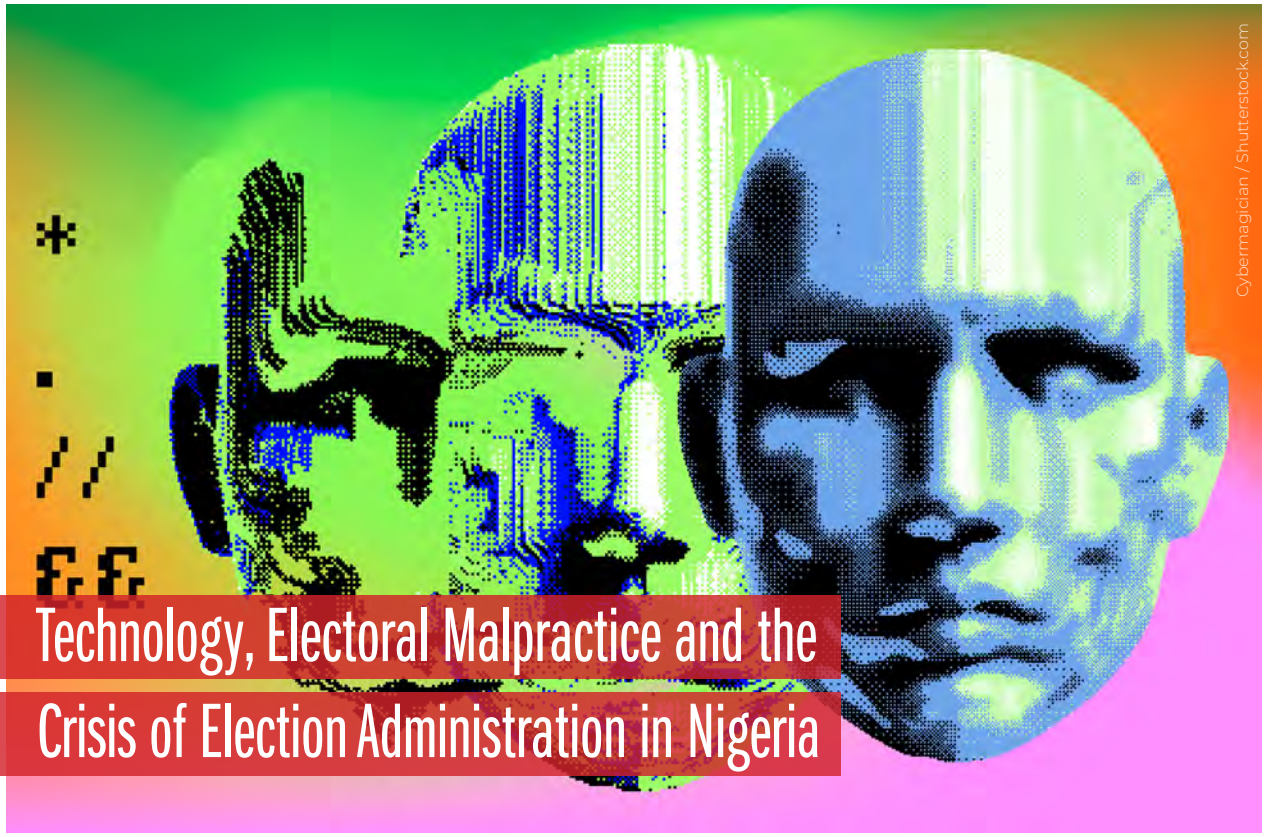
Wallach, W., & Allen, C. (2010). *Moral machines: Teaching robots right from wrong.* Oxford: Oxford University Press.

Weizenbaum, J. (1976). *Computer power and human reason: From judgment to calculation*. Washington: W. H. Freeman.

World Economic Forum. (2019). *Responsible AI for Social Empowerment*. Available from https://www.weforum.org/projects/responsible-ai-for-social-empowerment [Accessed 22/11/24].

World Economic Forum. (2021). *Centre for the Fourth Industrial Revolution South Africa.* Available from https://www.weforum.org/centre-for-the-fourth-industrial-revolution-africa [Accessed 22/11/24]

Zuboff, S. (2019). *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power.* London: Profile Books.



Technology, Electoral Malpractice and the Crisis of Election Administration in Nigeria

By Daniel Godwin

Abstract

The integration of technology into the various elements of the electoral value chain has contributed significantly to election administration both in established and transitional democracies of the world. In Nigeria, the integration of technology into the electoral process began in 2011 and has continued since then with significant positive impact on the outcome of all the elections held since 2011, especially the 2023 general elections. However, the outcome of the 2023 presidential election has been enmeshed in controversies and criticism from various stakeholders including local and international observers. One of the leading reasons for the controversy was attributed to technology (technical glitch) by INEC. This paper argues that the lack of transparency by INEC as revealed in its failure to electronically transfer results as promised and its refusal to upload results in real-time undermined the integrity of the 2023 presidential election. The paper examined the strategic contributions of the technological innovations used in the 2023 general elections. Principal-agent theory provided the framework, while a qualitative desk research design was adopted for the study. The paper relied on secondary sources of data. Findings showed that the introduction and integration of technologies into the electoral process cannot deal with the problem of electoral malpractice as a standalone initiative without the complementary uprightness from the EMBs. The paper concluded that the failure by INEC to keep to its guidelines as provided has to some extent compromised and eroded the confidence of Nigerians on the outcome of the 2023 presidential election.

Introduction

The integration of technology into the various elements of the electoral value chain has contributed significantly to election administration both in established and transitional democracies of the world (see for example: Castells 1996 and 2000; Srnicek and Williams 2015; Webster 2014; and Zuboff 2019). The increasing explosion of

> The paper examined the strategic contributions of the technological innovations used in the 2023 general elections.

technologies and increasing access to these technologies by both citizens and election administrators is partly because of rising concerns about the sanity of elections around the world. For instance, the U.S. Senate Intelligence Committee report showed evidence of Russian interference and media manipulation of the U.S. presidential election in 2016 (United States Senate Intelligence Committee 2019a and 2019b). There are instances from some other democracies suggesting manipulation and fraud in their electoral process which is beckoning the electoral management bodies to up their games to tackle the menace of electoral malpractice (Garnett and James 2020). In Nigeria, the integration of technology into the electoral process began in 2011 and has continued since then with significant impact, though sometimes controvertible, on the outcome of all the elections held since 2011, especially the 2023 general elections. Historically, elections in Nigeria are rarely said to be perfect. Elections in Nigeria can at best be described as a work in progress marked by different shades of fraud and malpractice (Olivia 2011; Sulaiman 2022). In a bid to check the menace of electoral malpractice, the electoral management body decided to improve the electoral laws by progressively introducing innovative ideas that will enhance the capacity of election administration and the general management of the electoral process. It was this effort that led to the introduction and integration of technology in the electoral value chain in Nigeria. Technology has proven to be one of the emerging responses to the problem of electoral fraud and malpractice especially in developing democracies like Nigeria (Ogwu 2016). The spread and application of technology to governance has gained and continues to gain attention.

The future of democracy in Africa is threatened by the level of electoral malpractice experienced in recent times. This has in part, accounted for the surge in the number of military coup on the continent. As a result, some African countries, including Nigeria, have introduced technological reforms in their electoral management laws with the aim of enhancing the quality of elections and to minimize the incidents of electoral malpractice. Sulaiman (2023) captures some of the areas in the electoral value chain where policy response is targeted: gender inclusion, voter registration, participation of people living with disability, and the participation and inclusion of marginalised groups. In Nigeria, the electoral Acts of 2015 and 2022 made salient provisions for the adoption of technology in the electoral process. Specifically, Sections 47 and 50 of the 2022 Electoral Act made provision for the use of technology for voter accreditation and electronic transmission of results. On the other hand, Section 62 (2) gave INEC the mandate to maintain an electronic register of votes. The 2022 Electoral Act gave INEC the requisite legal to adopt, use and apply technology as may be appropriate for the enhancement of their duty. The intention of these provisions in the Electoral Act was to address, in most cases, the intractable problem associated with election administration in Nigeria. Electoral malpractice in Nigeria happens in various forms such as ballot snatching/stuffing, falsification of results, over-voting, and multiple registration/voting, which usually results in a lack of confidence in the election management body, among others (Godwin 2016). It is against this backdrop that this paper examined the strategic contributions of the technological innovations used in the 2023 general elections with a view of exploring the fact that lack of transparency by the Independent National Electoral Commission as revealed in its failure to electronically transfer results as promised and its refusal to upload results in real-time undermined the integrity of the 2023 presidential election. The study engaged this objective by adopting a qualitative research design. This design is favoured due to its capacity to utilise in-depth and clear secondary sources of data for analysis. The paper was divided into the following sections:

introduction, conceptual clarification, theoretical framework, literature review, technology and election administration, the application of technology and the 2023 presidential election, INEC/technology and the outcome of the result, and finally conclusion.

Conceptual Clarification

Technology: In the context of this study, technology refers to the technical software and hardware designed for the organisation and implementation of elections. It includes such front-end technology as vote scanning machines and back-office equipment like voter registration database software.

Electoral Malpractice: This is when the electoral process is flawed with irregularities inconsistent with the provision of the electoral guidelines. Electoral malpractice is characterised by manipulation of the electoral process and abnormal behaviour known as misconduct (Alvarez et al. 2012; Birch 2011; Norris 2015). Electoral malpractice can take three principal forms: manipulation of the rules governing elections, manipulation of vote preference formation and expression, and manipulation of the voting process.

Election Administration: This entails and captures how the electoral register is compiled as well as how votes are cast and counted. Election administration is important since the method adopted or employed by the Electoral Management Body (EMB) has implications for the entire process. For instance, if the EMB decides to adopt an automated or manual voter registration system, this will have implications for the number of people that will register, vote, raise or dampen the confidence of people over the process, and possibly the tendency for manipulation (Catt et al. 2014; Wall et al. 2006).

Theorising the Relationship between INEC, Technological Integration and the Outcome of the 2023 Presidential Election.

The theoretical foundation of this paper rests on the major assumptions of the principal-agent approach. The theory deals with the principles of delegation. The principal-agent theory was chosen because it highlights the dynamics of the implications of the configurations of authority, organisational structures and power on the

> “The future of democracy in Africa is threatened by the level of electoral malpractice experienced in recent times.”

integration of technology in election administration in Nigeria. The theory's classical idea rests on the following assumptions: the actions of the agent are critical to the wealth or well-being of the principal, as such, the principal is expecting some payoff from the agent; the agent has some information or abilities that the principal does not have and he (the principal) is compelled to patronise the agent; the principal and agent are assumed to have differing preferences, not a mutual one; the initiative to create contract terms lies with the principal to which the agent agrees or not; finally, both the principal and the agent know the basics on which the agent will be engaged in the contract and how to executed it (Miller 2005).

The principal-agent theory therefore as applied, sees a sovereign state operated under the guise of government as the principal who has the deciding authority to appoint or delegate responsibilities and at the same time has the prerogative to influence political decisions or outcomes undertaken by the agents appointed. From this context, the Independent National Electoral Commission (INEC) and other public agencies that have election-related responsibilities are seen as agents managing elections in accordance with the wishes of the appointing authority – the government. In Nigeria, there is a tiny separating line between Electoral Management Bodies (EMBs) and the government that created them. Most times, they serve as institutions with delegated responsibilities. Some of them are labelled with the word *independent commission,* but independence is solely in the name and not in practice. So, it, therefore, follows that the state

will not saddle EMBs with the mandate to conduct elections unless they will serve their interest. Again, it suggests that the democratic ambition that comes with the integration of technology in the electoral process may remain or never go beyond the level of ambition. This is more so because there is no separation of power between the election management body, personnel, and procedures on the one hand and the government on the other hand (Mude 2022). So, the wide-scale integration of technology into election administration will remain an effort in futility insofar as the Nigerian government maintains a culture of interference with INEC. The outcome of the 2023 presidential election in Nigeria can be explicitly understood from this lens.

Technology and Election Administration

The integration of technology into government operations, and more specifically electoral management, has gained more attention and acceptance in recent times. For instance, the electoral management surveys gave cross-national data on the use and adoption of technology. EMBs were requested in a study to indicate areas where they use technology in the electoral value chain. Findings showed that the majority of countries surveyed used technology for the tabulation of votes (60%) and voter registration (54%). The application of technology for candidate registration appeared to be common (44%). The report indicated that biometrics, one of the most used technologies, has been in use for just about 25 years (Piccolino 2016). One of the least areas technology has been adopted in the electoral value chain relates to the voting process. From the report, this includes internet voting (7%) and voting machines (14%). The spectrum of technological applications in the electoral process from this report has shown potential for the increasing adoption of technology at the registration, voting and result tabulation stages (Loeber 2017). For Garnett and James (2020), the evolution in the use of technology in the electoral process began slowly but in recent times has experienced what they described as an explosion. They noted that among the new technologies amenable to the electoral process are electronic voting and internet voting, however, technology has been found to be amenable and applicable to all the stages involved in an election.

“The spectrum of technological applications in the electoral process from this report has shown potential for the increasing adoption of technology at the registration, voting and result tabulation stages *(Loeber 2017)*.”

At the dawn of the *third wave* democratisation in Africa, precisely around the 1990s, we could count only a handful of countries that had elected governments. Today the reverse is the case, as we can count only a few countries that do not have elected government. However, this transition was a quantitative one (Ibeanu 2022). Because the interest of African leaders was on the mere increase in the number of countries conducting elections. The increase in the number of countries conducting elections does not automatically translate into democratic consolidation. Again, there is the question of whether election outcomes reflect the wishes of the people or not (Adejumobi 2018). This is so, as elections in Africa are marked and characterised by gross irregularities and open malpractices. One of the options adopted to check election malpractice in Africa is the introduction and integration of technologies. Incidentally, the integration of technology in the administration of elections in Africa has shown mixed outcomes. While technology has improved voter registration and election data clean-up, as seen in some South African countries, it has not been able to deal with the problem of political power configuration in Africa that manifests in breach of the democratic principles of separation of power and separation of personnel (Mude 2022). On the successes, Turque Mude has noted that there is relative success in the application and integration of technology within the South African region. The same cannot be said

of Kenya and Nigeria. The progressive integration of technology in the electoral process in the DRC, Kenya, and Nigeria has shown quantitative progress but not qualitative. Other concerns relate to issues of trust deficit, the technology divide between the young and the old, and the rising cost of technology.

The conduct of a successful election requires some level of preparation and processes. For instance, electoral laws will be presumably passed, voters registered, and an electoral management body will be put in place for the implementation of the electoral laws. Technology is integrated and used throughout these processes. This can be from the adoption of simple computer databases used for the organisation of the polling units to more complex outward-facing systems used for voter registration. There are a variety of new technological innovations designed to improve, for instance, the voter registration system. This innovation is designed to make the voting process more credible for both prospective voters and the EMBs. In this case, biometrics are known to be reputable for registration where biodata such as fingerprints and facial photographs are captured for the purposes of registration and identification of voters (Piccolino 2016). There is also a gradual migration of the registration process to an online platform which can be used remotely (Barreto et al. 2010; Garnett 2019). For the campaigns, new technologies have also emerged. The Internet and social media have brought a new dimension to election campaigns, although introducing new challenges as well. Voter activities online have been found to influence the direction of contestants, political parties' campaigns and other interest groups. It was observed that political parties and candidates during campaign periods, contract firms to collate online information on voters' activities and preferences which is used for targeted advertisement (Persily 2017). During the final stage of the election process on Election Day, attention is shifted to the counting of votes and how these votes can be respected. During this process, the use of technology has also appeared to be useful.

Technology and Quality of Election Administration in Nigeria

The literature on the quality of elections, integration and application of digital technologies in the electoral process in Africa illustrates that elections' credibility is shaped by a number of factors. First, the rules governing elections – they include legislation, regulations and guidelines governing the electoral process of a nation. These regulations must be fine-tuned and finalised in good time. They must be made public for all the parties involved to adhere to. Elections are organised around formal rules which partly determine the quality of an election. Secondly, voters who desire to vote must be allowed to do so through a secret balloting system. Thirdly, the question of the principle of equality arises. All actors involved in an election such as voters, political parties and aspirants must be given a level playing ground. Put differently, the principle of fairness must be upheld to the latter. Fourth, the choices of voters must be respected and treated with sacredness as stipulated by the electoral laws. Put differently, there should be a strong affinity between the votes cast and the outcome of the election. Lastly, there should be genuine and unbiased opportunities for aggrieved parties to seek redress (Ibeanu 2022; Mozaffar and Schedler 2002).

> "…the choices of voters must be respected and treated with sacredness as stipulated by the electoral laws."

Ibeanu (2022) observed that in Africa, the above-mentioned factors are declining. This is, of course, attributed to a number of factors in his opinion, namely: institutional weakness, poor infrastructure and weak citizen engagement. He further highlighted that the weakness of electoral management bodies in Africa is manifested in the inconsistency of the electoral laws, poor compliance with electoral laws, and a low level of trust in the EMBs by the citizenry. Most of the time, citizens do not trust that the electoral umpire will act fairly without siding or taking to sectional interest.

A critical mass of Nigerian citizens believes that the EMB is always compromised, and this has undermined the level of trust the voters have for them. This is not only peculiar to the Independent National Electoral Commission, but to other public institutions as well. There are several explanations for the issue of the trust gap conundrum in Nigeria. Ibeanu (2022) observed that the history of this problem can be traceable to colonialism which functioned under the principle of *conquering and controlling the people to promote the colonial interest*. That is, Nigeria as a colonial state was from the beginning alienated from the people and never earned the trust of the people and so cannot, at present, serve as a unifying force. Instead, it has continued to serve as an instrument of sectional control and domination depending on the political parties, religious groups, and ethnic groups in power at the time. The lack of trust in INEC by the average Nigerian is further exacerbated by deficiency in their functional capacity. This is most times manifested in administrative deficiency in terms of requisite skills, the presence of powerful individuals who have no respect for the stipulated electoral guidelines and a general lack of accountability to the people.

Another major area of concern is the infrastructural deficit. The requisite quantity and quality of infrastructure needed for the conduct and management of elections in Nigeria is grossly inadequate. This has constituted a major problem in the operational weakness of INEC. A sizeable part of Nigeria as a country is remote without adequate communication facilities. Even in the metropolises, basic infrastructures like transportation, electricity and telecommunications are in a poor state. The combination of these factors has made the conduct of elections in Nigeria a difficult task. Another point of concern that affects the quality of elections in Nigeria is weak civic engagement. Notwithstanding, the role and contribution of civil society to elections in Nigeria are on an appreciable increase. These contributions are obvious in areas of election administration, voter education and electoral accountability (Ibeanu 2022). INEC has leveraged the areas of civil society's expertise in the electoral process such as voter registration, the application of ICT to elections, electoral advocacy and voter education among others. For instance, voter education has resonated as a key area of support from the CSOs to INEC, the other is ensuring accountability through election observation or monitoring. However, when all these interventions by the CSOs are placed side by side with Nigeria's size and population, it will be obvious that there is still much to be done. For instance, the data from CIVICUS on the space of civil society in Africa indicated that no African state including Nigeria was categorized as 'open', and 90% of CSOs in Africa were characterised by CIVICUS as closed, repressed or obstructed.

Given the above challenges, one of the options left for Nigeria is the integration and adoption of technology into the administration and management of elections. The integration of machine or technology options, if appropriately applied, may cover the trust gap and the inefficiency of INEC. It was these claims that led to the progressive integration of technology into the electoral process beginning from the 2011 general elections to the 2023 general elections despite its mixed outcome (Cheeseman et al. 2018).

The Use of Technology in the 2023 Presidential Election in Nigeria

Essentially, INEC introduced technological innovations to improve the administration and execution of the 2023 general elections. Among the technologies introduced were the Bimodal Voter Accreditation System (BVAS) and the INEC Results Viewing Portal (IReV). The BVAS's role was to first, biometrically verify voters to authenticate that the holder of the card is the original owner, and secondly, electronically transfer a photo of the polling unit result to the IReV – an online portal controlled and managed by INEC. The complementary innovation of both the Bimodal Voters Accreditation System (BVAS) and the INEC Result Viewing Portal (IReV) works through a portable technological device that is digitally designed to read the fingerprints of prospective voters captured during voter registration. The device also has a facial recognition capability that can compare the features of voters with those of INEC's database. The BVAS has an inbuilt camera with the capacity to capture polling unit-level results for onward transmission to the INEC's Collation Centre online (IReV). IReV is an online portal designed for the public to access results in real-time. It is designed in a manner that any interested party can access results captured

and transmitted from the various polling units in a PDF format. However, interested users need to create a user account before access is granted to the viewer.

The introduction of IReV after the 2019 general elections has served as a major improvement to the electoral process in Nigeria. Specifically, in the lead towards the 2023 elections, INEC had consistently reassured Nigerians and the world that the measures it has employed to make the poll more credible are reliable and will be upheld. This singular assurance by INEC restored the already fragile confidence that the people had in INEC and the entire process of electioneering in Nigeria. The huge financial investment in technology by INEC further boosted the confidence of the citizens. This was followed by multiple press briefings by INEC reiterating its confidence and justification for the procured technology. INEC profoundly told Nigerians that the procured technology has the ability to enhance transparency in the process and the general outcome of the election. This came at a time when Nigerians were desperately looking for a change in the history of electioneering and have been victims of electoral fraud repeatedly. Now technology holds the answer to free, fair, and credible elections. Concerning the 2023 general elections and the use of technology, the expectation is that free, fair, credible and verifiable elections supported by technology which guarantee transparent accreditation and uploading of polling unit results for citizens to view in real-time on election day will make the difference (Suleiman 2022). The intention is that technology will ameliorate the pervasive falsification of votes at polling units, and the inflation of both accredited voters, and collated results. It was also expected that technology would reduce computational errors, the issue of swapping result sheets, and poor recording by INEC staff (Itodo 2022). There were indeed high hopes for INEC and its technology before the 2023 general elections.

INEC, Technology, and the Outcome of the 2023 Presidential Poll

As mentioned earlier, Nigeria has consistently recorded a low level of electoral integrity over time. This situation explains the explosion in the adoption and integration of technology in the electoral process. The Nigerian 2023 general elections can be described as the most technologically advanced poll held in the Fourth Republic. However, the outcome of the elections, especially the presidential election, challenged the much-touted credibility guarantee that the adoption of such technology had promised.

For instance, voter participation in Nigeria since the Fourth Republic has been declining. Voter turnout in the 2023 presidential election declined to just 29 per cent. This is a gross reduction from 53% in 1999, 69% in 2003, 53% in 2007 and 53% in 2011, 43% in 2015, 34% in 2019. This is against the fact that voter registration has been on the increase since 1999. The data from INEC has shown a steady increase in the number of Nigerians who indicated interest in registering to vote and did so as indicated by the table below:

Table 1 shows the number of registered voters in each election since the beginning of the Nigerian Fourth Republic.

	1999	2003	2007	2011	2015	2019	2023
In millions	58m	61m	61.5m	73m	68m	82m	87m

Source: Compiled by the Author.

The disparity between the number of registered voters and the declining voter turnout during elections can be explained by the general distrust in the electoral process and in INEC. The record brandished by INEC with respect to the 2023 presidential election has been received with scepticism from several quarters. For instance, the EU Election Observation Mission in their report noted that:

> The 2023 general elections did not ensure a well-run transparent, and inclusive democratic process as assured by the Independent National Electoral Commission (INEC). Public confidence and trust in INEC were severely damaged during the presidential poll and was not restored in state level elections, leading civil society to call for an independent audit of the entire process (EU EOM Report 2023, p. 7).

It was actually in response to the incessant and reoccurring electoral fraud that the Commission with the support of other actors decided to integrate digital technology to: one, enhance transparency and integrity in the electoral process,

and two, increase citizens' confidence in EMB – INEC. The integration of digital technology in the 2023 general elections was expected to guarantee a more credible electoral process by ensuring a hitch-free voter accreditation process and public access to electronic results in real-time. However, the administration and handling of these technologies by INEC fall short of its promises and citizens' expectations. The European Election Observation report noted that:

> Lack of transparency in the implementation of election technology used and failure to promptly upload the presidential elections results on IReV contributed to decreased public trust in the credibility of the elections (EU EOM Report 2023, p.18).

The technology procured and deployed by INEC in the 2023 presidential elections proved to be insufficient in providing the required level of assurance. This happened, despite the fact that INEC had repeatedly assured Nigerians, the international community and other local stakeholders of its readiness and that all the resources needed for a hitch-free election had been provided by the federal government. Certainly, there was a substantial budgetary allocation for the administration of the 2023 general elections. The budgetary allocation for the 2023 general elections is double that of the 2019 budget. To be specific, in the 2019 general elections, INEC received N189 billion, while for the 2023 general elections, INEC submitted a budget of N400 billion, a chunk of which was used for the procurement of BVAS. The 2022 Electoral Act provided timely budgetary allocation. This is to facilitate a hitch-free preparation exercise in areas of technological deployment for voter registration, voters' verification and most importantly the real-time transmission of results. Still, the execution of the election was challenged on several fronts. Aside from the problems associated with insecurity and attacks on INEC facilities and staff, majorly in the south-east and fuel scarcity as well as the Naira shortage occasioned by the untimely Central Bank policy on Naira redesign, affected the operational delivery of INEC. There were multiple technical challenges around the technology deployed for the election (IRI/NDI report 2023). As part of its preparation, INEC introduced some new measures which were purportedly meant to improve the general exercise. For instance, INEC increased the number of polling units from 119,974 to 176,846. Yet, it was observed that a number of polling units had registered voters above the operational ceiling of 500 voters per polling unit as provided by INEC. It was also reported that INEC failed in building its in-house capacities which was shown in its administrative and operational weaknesses (IRI/NDI Report 2023). For instance, as part of its preparation for the election, the training of Ad-hoc staff by INEC was reported to have been delayed, in most cases overcrowded, and marked by an insufficient number of BVAS. Other items like manual forms for training were not adequate, and the training was not well focused on the use of technologies deployed for the election, counting procedure, as well as collation procedures (EU EOM Report 2023).

> "The trend of technological integration in the electoral process is not peculiar to Nigeria alone. Literature has shown that it's a global trend."

The trend of technological integration in the electoral process is not peculiar to Nigeria alone. Literature has shown that it's a global trend. We have seen a considerable move towards the utilisation of technology to improve electoral processes and outcomes in the past decade. This has also been prominent in the sub-Saharan states. We have seen the spread and explosion in the use of technology from fairly established democracies like Ghana utilising biometric technology for voter registration and verification to emerging democracies like Kenya whose digital release of raw polling station results in real time was profound (Crawford 2022).

One may be forced to ask then, why is the case in Nigeria different? Why is the application of technology in Nigeria's case not working? To answer

these questions, I would rather focus on INEC rather than on technology. INEC had piloted both the BVAS and the IReV in three off-cycle elections before applying these technologies in a nationwide election. INEC failed to do a nationwide stress test in advance before the February 25 elections. In my opinion, this act by INEC was not an oversight. It was a deliberate attempt to micromanage the outcome of the elections. INEC ignored all the early warning signs from the off-cycle elections before the February general election. During the off-cycle pilots' elections, there were challenges with some IReV uploaded images. The images were blank, blurry, or for the wrong polling unit. That means the tendency for repetition was high when such technology was used for a nationwide election without adequate reexamination. It, therefore, suggests that the success of these electoral technologies depends on the quality of their administration and application by the institution that deployed them.

The relationship between the deployment of digital technology and its role in checking electoral malpractices has been well-stated by proponents of technologies (Cheeseman et al. 2018; Gelb and Diofasi 2016). The Nigerian experience has shown that technology is yet to eliminate certain pre-election and post-election prejudices. For instance, it was noticed that digital technologies could not deter voter intimidation, suppression and vote buying that characterised the Nigerian 2023 general election. This was not just limited to Nigeria. In Zimbabwe's 2018 elections, Mhaka (2018) observed that similar malpractice was evident in the elections. This position was supported by Gelb and Diofasi (2016, p.15) when they argued that in Zimbabwe and Côte d'Ivoire's past elections, incumbent governments restricted registration centres to areas where parties in power had significant support and deprived areas where they felt the opposition had more control.

Like in the cases cited from Zimbabwe and Cote d'Ivoire, the Nigerian experience was not different. It could be attributed to the character of the political system as managed by INEC to twist the outcome of the 2023 general election, especially the presidential election. Like the previous elections since 1999, the contestation of the 2023 general elections results in Nigeria was, indeed, a product of a political system badly damaged with deliberate undemocratic tendencies and authoritarian practices. In the case of Nigeria, these practices are considered deliberate. This is because of the way the political system is pre-configured and pre-designed. The political system is designed in such a manner that it works by using all means, including state institutions, apparatus and resources to sustain the governing political party. However, we saw an incumbent party conceding to the opposition after the 2015 presidential election. Again, this is quite rare in Nigeria. Ideally, the integration of BVAS and IReV into the electoral system was to in all honesty minimise electoral malpractices, which it did at several points such as registration, voter identification, checking over voting etc. But due to INEC's institutional weakness, the final stage of the presidential election appeared illusory and failed promise. This was why Russel and Zamfir (2018, p.4) argued that even though digitalised voter registration lessens the scope of human error, it is not equal to instantaneous solutions to the elimination of electoral fraud from a corrupt political system. Russel and Zamfir's submission aptly summarises the conditions that dashed and rendered worthless the hope of Nigerians for the 2023 general elections, the use of digital technology, and a shift towards an ideal democratic election. The contention here is that the contestation around the presidential election result is not to be attributed to election technology as opined by INEC. Rather, the nature of political power concentration and the configurations of political structures in the Nigerian political systems. It is the interplay of these dynamics that constrained INEC from keeping to its promises.

The strategic role of civil society in monitoring the use of technology

The African political space is marked by weak civic engagement. Ironically, there is an increasing demand for the role of civil society in the electoral process in Africa. For instance, some of the traditional areas of demand include voter education, support for election administration, and electoral accountability. CSOs can be instrumental to election administration in many ways. For instance, CSOs are found to have expertise in voter registration, expertise in applied ICT, legal issues, and constituency delimitation (Ibeanu 2022). INEC can galvanise and leverage this poll of knowledge

to improve the quality of elections in Nigeria. Again, CSOs can mediate effectively between political parties, the government, and INEC. CSOs serve to absorb the excessive pressure generated by political parties and governments against INEC through their strategic advocacies. To be sure, CSOs, through their advocacy, have contributed to creating an enabling environment for INEC to retain the independence necessary to conduct free, fair, and credible elections. The pivotal role of CSOs in voter education in Nigeria cannot be overemphasized. Their role is necessary in boosting the level of voter turnout during elections. On accountability, CSOs are always instrumental in election observation or monitoring, which leads to the boosting of confidence or otherwise in the electoral value chain.

Conclusion

The paper aptly concludes that the integration of technology into election administration in Nigeria has appeared to be counterproductive to the envisaged role of election technology in curtailing electoral malpractice. From the outcome of the 2023 presidential election, it is glaring that digital technologies do not have the capacity to limit electoral malpractice without the support of EMBs and other agencies charged with electoral responsibilities. This is attributable to the nature of the Nigerian political system. The Nigerian political environment is characterized by unprofessionalism stained by corruption. The study observed that, in its present form, INEC's ability to act independently is in doubt. The appointment of INEC personnel by the executive has remained a point of worry. The failure by INEC to electronically transmit the photo sheet of the polling units' results in real-time as promised further questions INEC's autonomy. INEC claimed technical glitches were responsible for its failure to upload results in real-time. Some crucial questions may be raised as follows: At what point did INEC notice that there were technical glitches on the IReV? A glitch of a proportion that was capable of jeopardising the outcome of an election of that magnitude was not detected until days after the election. It took INEC three to four days to inform Nigerians that there was a technical glitch with the IReV. Such a delay by INEC eroded the already feverish trust Nigerians had for them. Hence, with the outcome of the 2023 presidential election, it is glaring that digital technologies do not have the capacity to limit electoral malpractice without the support of EMBs and other election-related institutions. It has been repeatedly recommended that the appointment of the INEC Chief should be taken away from the executive and given to the Judicial Council of Nigeria, this will limit the influence of the Executive on INEC and will enhance INEC's autonomy.

References

Adejumobi, S. ed. (2018). *Unbundling liberal democracy: institutions, participation and accountability*. In S. Adejumobi. (ed.) *Voice and power in Africa's democracy: institutions, participation and accountability*. Oxford: Routledge.

Alvarez, R. M., Lonna, R.A., and Thad, E.H. (2012). *Evaluating elections: a handbook of methods and standards*. New York: Cambridge University Press.

Castells, M. (1996). *The rise of the network society: the information age, economy, society and culture.* Oxford: Blackwell.

Castells, M. (2000). Materials for an explanatory theory of the network society. *British Journal of Sociology,* 51(1), pp.5-24.

Catt, H., Ellis, A., Maley, M., Wall, A., & Wolf, P. (2014). *Electoral management design*. International IDEA, Institute for Democracy and Electoral Assistance.

Cheeseman, N., Lynch, G., and Willis, J. (2018). Digital dilemmas: the unintended consequences of election technology. *Democratization*, 25(8), pp.1397-1418.

Garnett, H. A., and James, T. S. (2020). Cyber elections in the digital age: threats and opportunities of technology for electoral integrity. *Election Law Journal*, 19(2), pp.111-126.

Garnett, H. A. (2019). Evaluating online registration: the Canadian case. *Election Law Journal,* 18(1): pp.78-92.

Gelb, A., and Diofasi, A. (2016). *Biometric elections in poor countries: wasteful or a worthwhile investment.* Washington, DC: Investment Center for Global Development.

Godwin, D. (2016). Internal party democracy and the imperative of democratic consolidation in nigeria's fourth republic. *The Nigerian Journal of Sociology and Anthropology*, 14(2): pp.50-64.

Ibeanu, O.O. (2022). Digital technologies and election management in africa's democratisation process: more technocratic than democratic? *Africa Development,* 47,(2): pp.15-39.

Jinadu, A., and Pascal, K. (2011). *Election management bodies in west africa: a comparative study of the contribution of*

electoral commissions to the strengthening of democracy. Dakar: Open Society Foundations.

Loeber, L. (2017). Legislating for e-enabled elections: dilemmas and concerns for the legislator. In *Electronic Voting: First International Joint Conference, E-Vote-ID 2016, Bregenz, Austria, October 18-21, 2016, Proceedings 1* (pp. 203-217). Springer International Publishing.

Mhaka, T. (2018). How did Mnangagwa win Zimbabwe's landmark July 30 elections?. *Al Jazeera* [online], 6 August 2024. Available from: https://www.aljazeera.com/opinions/2018/8/6/how-did-mnangagwa-win-zimbabwes-landmark-july-30-election [accessed 21-01-2024]

Miller, G. J. (2005). The political evolution of principal-agent models. *Annual Review of Political Science*, 8(8), pp.203–225.

Mozaffar, S. and Schedler, A. (2002). Introduction: the comparative study of electoral governance, *International Political Science Review*, 23, (5), pp.5-27.

Mude, T. (2022). Digital technologies and election management in Zimbabwe: pseudo-democratic transition and contorted delirium?. *Africa Development,* 47(2), pp.179-197.

Norris, Pippa. (2015). *Why elections fail*. New York: Cambridge University Press.

Persily, N. (2017). The 2016 U.S. election: can democracy survive the internet?. *Journal of Democracy,* 28(2): pp.63-76.

Piccolino, G. (2016). Infrastructural state capacity for democratization? Voter registration and identification in Côte d'Ivoire and Ghana compared. *Democratization,* 23(3), pp.498-519.

Russel, M. and Zamfir, L. (2018). *Digital technology in elections: efficiency versus credibility*, European Parliamentary Research Service.

Srnicek, N., and Williams, A. (2015). *Inventing the future: postcapitalism and a world without work.* London: Verso.

Sulaiman A. O. (2023), Electoral Reforms and Democratic Stability in Nigeria: A Critical Review of the 2022 Electoral Act. *NILDS Journal of Democratic Studies Vol. 2, 2*

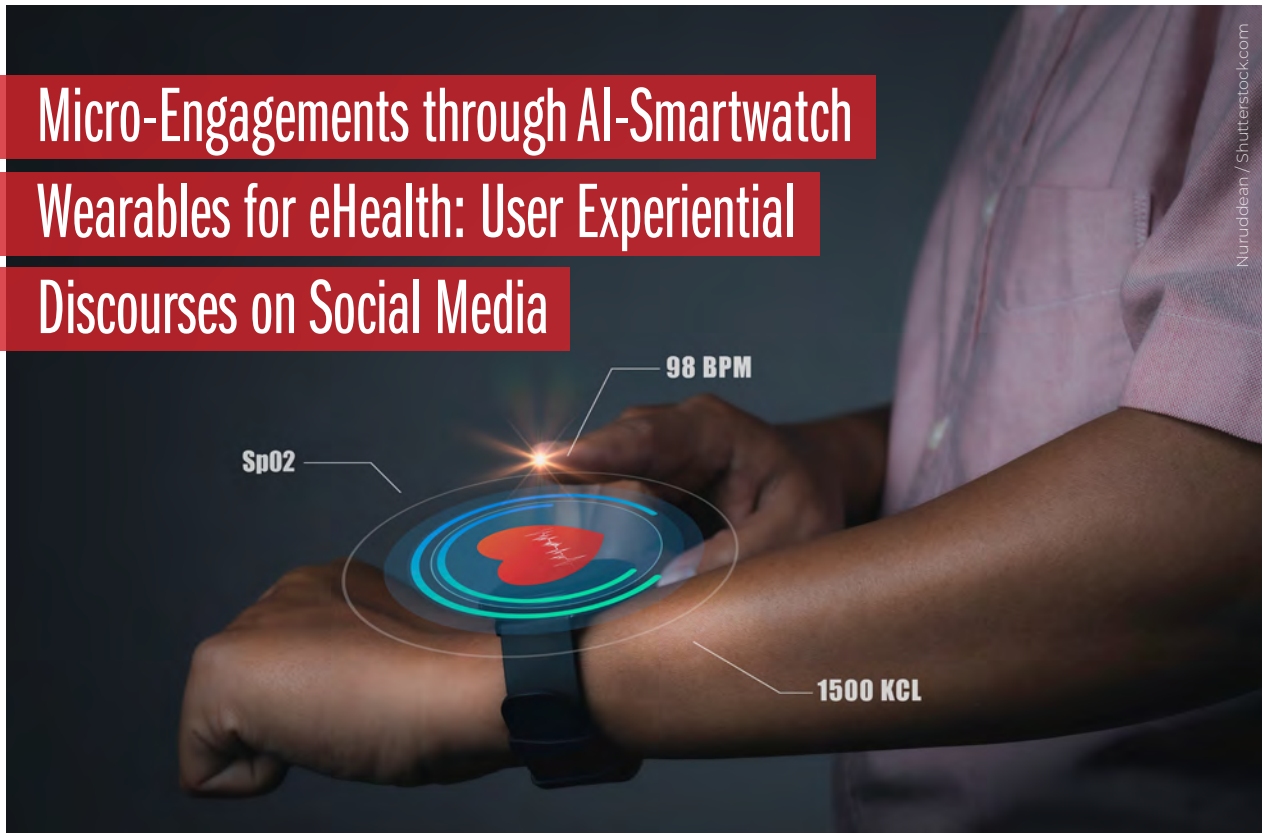
United States Senate Intelligence Committee. (2019a). *Russian active measures campaigns and interference in the 2016 U.S. election* [online]. Volume 2. Available from: https://www.congress.gov/congressional-report/116th-congress/senate-report/290/1 [accessed 12- 11- 2023].

Wall, A., Andrew, E., Ayman, A., Carl, W. D., Joram, R., and Sara, S. (2006). *Electoral management design: the international idea handbook*. Stockholm: International IDEA.

Webster, F. (2014). *Theories of the information society*. New York: Routledge.

Zuboff, S. (2019). *The age of surveillance capitalism: the fight for a human future at the new frontier of power.* London: Profile Books.

Micro-Engagements through AI-Smartwatch Wearables for eHealth: User Experiential Discourses on Social Media



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By Ireen Mmatlou Manyuha and Elizabeth Lubinga

Abstract

Globally, the use of Artificial Intelligence (AI) wearables including smartwatches has gained traction. AI-Smartwatches have emerged as powerful communication tools and their increased use for personal eHealth is driven by capabilities to facilitate micro-engagements with users. Micro-engagements enhance user experience and active interaction by providing real-time feedback that triggers the user to act. While smartwatches have the potential to effectively drive positive user health behaviour through instant communication, it is imperative to examine the strategic use of communication of these devices by smartwatch users. The purpose of this study was to examine AI-Smartwatch user experiences, specifically micro-engagement perceptions. Theoretically, the study was underpinned by The Unified Theory of Acceptance and Use of Technology. A qualitative approach, using a netnography design provided results from online discourses expressed on X (formerly known as Twitter), in response to a question tweeted about the effectiveness of smartwatches. Results indicate that the use of AI-smartwatches has propelled active personal engagement with health. Users reported tracking various aspects of their health due to instantly available data that is in turn used to seek solutions from health professionals. Conversely, it is unclear whether lay people who are not health professionals are skilled in interpreting the instant data that they are exposed to. This study provides much-needed insight into user experiences of strategic use of communication through AI-powered smartwatch devices using data-driven micro-engagements. It will inform Health Professionals, Health Service Organisations and AI Technology Developers among others regarding practice as well as improvement of technological services for digital public health.

Introduction

Artificial Intelligence (AI) is increasingly pervading human lives including personal health and well-being. In recent years, AI has revolutionised health (Ivancovic et al. 2023), affecting the way human beings conduct their lives, creating a customised, health data-driven ecosystem (Stevens et al. 2022). This data-driven ecosystem has become pivotal to enabling individuals to attain, manage and sustain good health as well as supplement and facilitate better health outcomes, previously the sole domain of healthcare providers. Most importantly, whereas health and well-being in general have always been central to human beings, personalised AI appears to have elevated individual human consciousness about health, subsequently influencing decisions to improve individuals' quality of life. Personalised AI has elevated the quality of human health from a state of well-being defined as a state of general health and happiness to wellness where individuals actively strive to achieve and maintain good health (Ometov et al. 2021).

The functions of wearables, namely, screening, monitoring, detection and prediction drive public use (Canali et al. 2022). Monitoring facilitates continuous data collection through tracking physiological metrics making remote health monitoring more efficient. Screening uses passive sensors that measure motion, steps, light, pressure, and sound, and as Contini et al. (2021) found, wearable clothing efficiently screened sleeping disorders. Additionally, through detection, wearables detect health conditions and alert users, and Perez et al., (2019) indicated that some smartwatches are multifunctional with capabilities of simultaneously fulfilling monitoring, screening and detecting functions. Wearables have also been used for the prediction of disease as Singh et al. (2020) established that a respiratory rate detector could predict the seriousness of respiratory diseases.

Apart from these functional benefits, from a communicative perspective, AI-powered wearables have facilitated micro-engagements between technology and people, ensuring subsequent communication with individuals about their wellness statuses through data collation by algorithms (Contini et al. 2021). Furthermore, AI has enabled the instant communication of such crucial data between healthcare providers and patients, reducing the time spent collecting data through face-to-face consultations, facilitating timeous diagnosis and enabling health-saving decision-making. This AI-facilitated multi-functional communication of health has altered and revolutionised the interpersonal context of health communication as well as interactions between health providers and patients. To a large extent, AI wearables are fulfilling the traditional roles of screening, monitoring, detecting and predicting health problems. Kang and Exworthy (2022) point out that health systems in many countries acknowledge the potential of wearables to improve health care. From a viewpoint of the intrapersonal communication context, individuals are able to monitor and make informed decisions about their personal health, increasing agency.

> "…smartwatches have the potential to effectively drive positive user health behaviour through instant communication…"

The article acknowledges that AI wearables have and are constantly changing personal health by facilitating customized services. However, despite the many benefits these technologies are conversely disadvantaging marginalized communities due to digital and technological divides.

Multiple Implications of Wearable Technologies for eHealth

Despite the benefits accruing from wearable technology developments, there are various emergent concerns. Questions arise about what the proliferation of wearables means in resource-constrained settings such as South Africa. As Meier

et al. (2020) specify, the advancement of wearables is largely driven by profit, with healthcare providers, insurers, and global technology companies constantly developing more sophisticated wearable devices embedded with medical technology to target a global consumer market.

Globally, different societies are operating at different levels of AI for personal eHealth and well-being, with some determinants being device sophistication, availability, and most importantly individual affordability of AI gadgets for personal use. At a societal level, the disparities between resource-slack and resource-constrained settings determine who benefits most from wearable technologies. Resource-constrained societies still lag behind resource-slack ones. Statista (2024) indicates for instance that even though the fitness-tracker market in South Africa is expected to grow to US$212.70m in 2024, with a projected US$278.60m by 2029, most revenue will be generated in the United States (US$10,990.00m in 2024).

Furthermore, at an individual level, while researchers acknowledge that wearables provide individuals with health-related agency, they emphasise that these technologies are instruments of empowerment. To some extent, wearables shift power in health provider-patient relationships to the latter, by assisting them to contribute to their health and to take greater control of their lives, also termed as patient empowerment by Kang and Exworthy (2022). However, Bravo et al. (2015) view patient empowerment as specific activities that foster self-management. Conversely, disempowerment arises for the poor and rural populations that cannot exercise wearable-enabled agency, and remain disadvantaged through a lack of access to technologies that facilitate self-management and health literacy as Denecke et al. (2021) argue. These researchers refer to the concept of participatory health informatics that attributes the role of technology as enhancing individual's self-management and health management leading to greater involvement in personal health and care.

In South Africa, while the average revenue per user on fitness trackers is expected to amount to US$38.73/R670, this amount is unaffordable for most South Africans. Therefore, nine million unemployed people who survive on a monthly

> "AI-powered wearables have facilitated micro-engagements between technology and people, ensuring subsequent communication with individuals about their wellness statuses through data collation by algorithms *(Contini et al. 2021)*"

R350 Special Social Relief of Distress Grant and potentially more than 26 million South Africans who receive social assistance per month (South African Government, 2024) are disempowered. The lack of disposable income to spend on buying wearables, especially among the poor, leaves these individuals who most need healthcare without access to technological advancement benefits. Even though individuals can afford to buy basic wearables, they may lack Internet access in remote areas or money to buy data, to enable connection between devices and data banks compounding marginalised populations' exclusion (Boloka and Ngoepe 2024).

In developing countries such as South Africa, it is mostly elite users and ardent health-conscious individuals who benefit from wearable technologies for individual and personalised ehealth-related use to the exclusion of the majority of the population. This is largely because health companies in South Africa subsidise buying wearable technologies or the use thereof, in a bid to stimulate and grow their use. By 2022, only 15.8% of South Africans were members of medical aid schemes (Statista 2023). Conversely, the lack of access to private

healthcare compounded by the inability to pay membership to health companies that offer these subsidies ostracises approximately 52 million South Africans (84.2%) who depend on public healthcare. Meanwhile, a new generation of wearables powered by artificial intelligence has emerged and is rapidly growing, in which smartphones are used as gateways to transmit data directly to the cloud.

Understanding Wearable Technologies

A rudimentary definition by Pataranutaporn et al. (2019), is that wearable technology refers to AI-enabled devices that can be worn on the user's body. This implies that any electronic devices that can be worn on a person's body can be classified as wearables since they have wireless communication capabilities that can be integrated into gadgets, accessories, or clothing (Nahavandi, et al., 2021). However, Zhu and Cahan (2016) build on this definition by referring to wearable devices based on their built-in sensors that track users' movements, location and provide biometric identification. This is in addition to wearable technology capabilities to capture and transfer data to cloud storage through wireless communication synched with the smartphone (Mishra et al. 2020). However, Bhushan and Agrawal (2020) argue that wearables also refer to devices that users can carry because they have multiple functions and connectivity to the outside world.

> "Globally, different societies are operating at different levels of AI for personal eHealth and well-being, with some determinants being device sophistication, availability, and most importantly individual affordability of AI gadgets for personal use."

Meier et al. (2020) conclude that the terms wearable technologies, wearable devices and wearables all refer to accessorised items and clothing that facilitate the collection and self-monitoring of personal health. This article uses the terms interchangeably. Based on the above, the definition of a modern wearable health device appears to be more complex based on functionality, access, aesthetics, ease of use, dynamic technological advancement and capabilities among a plethora of identifiers driven by AI. It is evident that AI has significantly transformed the design and capabilities of wearable technology in many ways. The use of AI algorithms enables wearables to process and interpret sensor data in real-time, allowing for more accurate insights.

Micro Engagements through the Use of Wearable Technologies

Communicatively, micro engagement, also termed as micro interaction, facilitates engagement generated when people use wearable technological devices (Saffer 2013). The prompts contained within the user interface of a digital device or system (Ntosti 2018) constitute interpersonal communication. In the context of artificial intelligence-embedded wearables such as smartwatches, micro engagements may be minimal yet purposeful interactions that take place within the user interface.

These micro engagements are also triggered when users interface with technological devices or systems, through various communicative message formats, such as notifications, indicators, or even in-situ assistance (Ntosti 2018). In terms of user responses, the use of micro engagements facilitates response user actions on digital devices by guiding users through complex processes, providing them with real-time feedback and support to enhance the overall user experience (Saffer 2013; Ntosti 2018). The communication environment in which micro engagements happen assists users in understanding the functionality of a digital device or system and ultimately creates an engaging and interactive digital environment for users. Furthermore, Motti and Caine (2015), posit that micro engagements should be seen as building blocks that enable an effective flow of communication between the end-user and wearable device, which makes user experience more interactive and personalised.

A form of customised eHealth marketing takes place with AI-integrated machine learning algorithms and sensors enabling the generation of tailored micro engagements which is crucial in enhancing user experience (Wu, & Luo, 2019). Additionally, through a form of persuasive communication, micro engagements attract users' attention, by presenting pertinent details, with the outcome of streamlining user activities efficiently and effectively (Motti and Caine 2015). These could include various forms of fitness milestones, haptic feedback to signal an incoming message, illustrations showcasing progress towards daily activity goals, or subtle animations when a task is completed successfully.

The feedback in the entire communication process includes various forms of engagement through smartwatches user activity, tracking progress, and engaging in healthy behaviours from the delivered personalised feedback. According to Saffer (2013), micro engagements can effectively capture user attention and influence behaviour, a feature that is crucial in the field of health and fitness wearables. By delivering timely and contextually relevant information, they can drive users towards healthier routines and behaviours.

Benefits and Limitations of AI Wearable Devices for eHealth

The advent of AI wearable devices for eHealth has created several benefits enabling active personal interaction with the management of personal health but conversely highlighting various functional and other limitations.

Unprecedented active micro engagements versus digital health inequities

The tailored approach to engaging with personal health-related data that is availed by AI wearables appears to have motivated individuals to take an active interest in their health (Bhushan and Agrawal 2020). Passive potential patients have been moved to a state of active alertness to ensure good health which Kang and Exworthy (2022) refer to as patient empowerment. On the other hand, these technologies have led to digital health inequities with a lack of affordability by large members of the South African population for instance to buy wearables, smartphones to run them and data. The optimal use of AI wearables requires the affordability of wearable devices that range from over R700 – R10,000. Predel and Steger (2020) argue that wearables are consumer goods leading to greater disparities between the rich and the poor. Furthermore, these devices need to connect to other systems using Bluetooth or the Internet. Internet penetration is low or non-existent in most rural areas and even though the Internet is available in some rural areas, people do not own smart devices because they live on the breadline (Aruleba and Jere 2022).

Shortened healthcare processes versus Interpersonal health communication contexts

Accessing healthcare globally is a process that has traditionally been lengthy involving collection of health data to enable healthcare providers to determine what the health problem is. Traditionally, the collection of basic health data would involve taking relevant health tests depending on the nature of reported health problems. The tests would have to be interpreted by knowledgeable health personnel before diagnosis of health problems and prescription of relevant drugs took place. However, due to the capabilities of AI wearables including the constant collection and transmission of information, healthcare processes that inform lifesaving decisions have been shortened (Dias and Cunha 2018). A combination of constant personalised health tracking by AI wearables together with instant transmission of health-related data to healthcare providers has activated remote patient monitoring (Ivankovic et al. 2023). Additionally, constant monitoring of individuals' health statistics by AI wearables has enabled a personal move to sustainable wellness (Wu and Luo 2019). Yet Predel and Steger (2022) warn that self-management of care may lead to poor health provider-patient relationships and that individuals still need professional interpretation of AI generated data. Furthermore, these authors question whether systems have adequately been established to train data and study cohorts.

Data drives insights for Personalised Diagnosis versus Data Interpretation and Contextualisation

Instant access to individuals' personalised health data by both individuals and healthcare

"If the device is not sophisticated enough, it will perform basic functions, incorrect use by the wearer as well as incorrect formatting or required information will affect the quality of information that accrues from the device *Dias and Cunha 2018)*, which makes smartwatch wearables subject to manipulation."

professionals provides early detection and insights into individuals' wellness, making it possible for optimisation of diagnosis as well as velocity (Steven et al 2022). The insights that individuals garner from AI health-related data enable them to make decisions including seeking healthcare in time and avoiding the escalation of diseases to serious illnesses. On the contrary, other researchers argue that the quality of data may lack accuracy and may deter use by producing unreliable data (Canali et al. 2022; Kang and Exworthy 2022).

The interpretation of health data has always been the domain of trained healthcare professionals. The average person is not literate enough to correctly interpret the meaning of the data. And data by itself is meaningless until it is correctly interpreted with contextualisation of the individual's health over a certain period. In developing countries such as South Africa with a majority of (semi) illiterate populations, correct interpretation of data, even if smartwatch devices were accessible, would be difficult. Zhang et al. (2022) argue for more contextual information as well as coherence for data quality. This is because the lack of contextual information about the data collected also makes it difficult for individuals to interpret it and may ultimately lead to mistrust of the technology. Sharon and Lucivero (2019) propose the expansion of the health data ecosystem for better contextualisation and interpretation.

Facilitated Tracking of Health Behaviour versus Data Privacy and Security

Both individuals and healthcare professionals as well as related organisations benefit from tracking health behaviour. Various health problems are caused by poor health behaviour as well as risky lifestyles (Shi et al. 2020). Sophisticated AI wearables can track whether an individual has drunk enough water and is exercising optimally based on age, weight, and gender among others. However, some researchers argue that wearables have also led to a lack of privacy and have facilitated intrusiveness (Canali et al. 2022). As Predel and Steger (2022) also argue, individuals' private information is easily accessible to private organisations exacerbating privacy risks and raising legal and ethical concerns.

As the case is with data that is available on the cloud, data privacy may become compromised. Health-related information has always been rendered private with concerned medical personnel having access to patient "files". Given that online data leaves a permanent digital footprint that is accessible to multiple end users, not limited to the primary healthcare provider, data privacy and security may be compromised.

Variations of accuracy and reliability of data versus Data Quality

The extent to which smartwatch wearables are rendered active and whether data is reliable as collected by the user varies depending on the level of sophistication, correct use by the wearer and formatting of the type of information that is required to enable the device to collect the correct data, among others. If the device is not sophisticated enough, it will perform basic functions, incorrect use by the wearer as well as incorrect formatting or required information will affect the quality of

information that accrues from the device (Dias and Cunha 2018), which makes smartwatch wearables subject to manipulation. Canali et al. (2022) argue that variations in wearable sensors and lack of consistency in data collection may compromise the quality of data. They propose that local standards of data quality should be established in individual countries to counter the poor quality of data.

Therefore, as the use of wearable devices in developing societies for eHealth increases, it is important for health communicators to gain an understanding of user experiences and how users interpret their experiences. While studies prevail about the use of AI wearables in developed societies (Ivancovic et al. 2023), studies about user experiences of wearable technologies for eHealth in resource-constrained countries are minimal. Yet it is important for healthcare professionals and health-related organisations to gain a better understanding of user experiences for purposes of improving machine learning and AI capabilities for maximisation of use (Lee 2018). And as Hu et al. (2024) also argue, user experiences and usability of wearable health devices play a crucial role in determining user acceptance.

The purpose of this study was to examine user experiential online discourses regarding micro-engagements on AI Smartwatch wearables for eHealth.

The following questions were asked:

1. How do users experience micro-engagements on AI Smartwatch wearables for eHealth?
2. What are user perceptions about micro-engagements on AI Smartwatch wearables for eHealth?

Theoretical Framework

The second Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh et al. (2012) aptly applies to this study. UTAUT2 combines a plethora of other theories, some of which have been used to gain insight into health-related behaviour including the Technological Acceptance Model by Davis (1989). Venkatesh et al. (2003 and 2012) argue that behavioural intentions determine the actual use of technology, adding that the effects of the four variables suggested by the model are in turn influenced by age, gender, experience and voluntariness of use.

The model is composed of 4 variables namely: performance expectancy which is the extent to which individuals believe that using the system, in this case AI technology, will help them to attain specific gains such as health-related gains. Social influence is the extent to which an individual perceives that others who are important believe he or she should use the system (Venkatesh et al. 2003). Effort expectancy is the degree of ease associated with the use of technologies and finally facilitating conditions which is the technical infrastructure put into place to support the use of the system. UTAUT2 introduced price value and habits to the acceptance and use of technologies. In application, this study examines how users shared experiences about how to use wearables and emergent experiences through health patterns which relate to social influence. Furthermore, how users shared experiences in online discourses about how wearables assist them to achieve their health-related goals in relation to performance expectancy. Additionally, the study assesses how users shared their effort expectancy through perceived ease of use of various wearables from their shared experiences.

Research approach

A qualitative research approach was employed for this study. The advantage of using a qualitative approach is that it allows researchers to gain insight through detailed observations, which can provide a fruitful and constructive analysis of the data (Minowa and Belk 2020). And Creswell and Cresswell (2018), point out that qualitative research is only best suited to provide insights into the opinions of a small sample, so its results cannot be generalised.

Research Design

The research design applied to this study was netnography. Netnography focuses on the interactions that take place through an online community such as social media platforms to gain insight into opinions, behaviours, or attitudes of individuals within those communities (Kozinets 2002, 2015 and 2020). As a method of observation, netnography is advantageous because it can be completely unobtrusive, making access to a large amount of data possible (Rachoane 2019) and it helps provide insights into the unique experiences of

individuals (Sitto and Lubinga 2020). Furthermore, the use of netnography allows researchers to gain a better understanding or insights into how people interact online (Varis, 2016). However, to successfully conduct a netnography study, Kozinets (2010) purports that researchers should identify an online community that is relevant, active, interactive, substantial, heterogeneous and data rich. Based on the guidelines provided by Kozinets, X platform is a suitable online community for conducting netnography studies for several reasons as follows:

- **Relevance** – X is a widely used social media platform, as of April 2023, the platform had over 372.9 million users across the world (Statista 2023).
- **Interactivity** – X platform is known for its high level of activity and interactivity. Users frequently post tweets, engage in discussions, share opinions, and participate in conversations in real-time. This dynamic nature of X provides researchers with a wealth of data to observe, analyse, and engage with.
- **Substantial** – X as a social media platform boasts a substantial user base with diverse demographics, including individuals from various cultures, and backgrounds. This diversity allows researchers to study different communities, subcultures, and user groups.
- **Heterogeneity** – the user base of X consists of individuals from different demographics and regions which makes X as an online community to be highly heterogeneous.
- **Data Richness** – X platform is a rich source of data for netnographic studies. Tweets are posted in various forms of data elements that offer researchers multiple dimensions to explore and analyse.

Data collection and analysis method

Immersion data was collected through X (Twitter) online conversations. Immersion enables researchers to immerse themselves in an online community to develop an depth understanding of the data (Kozinets 2015). As Kozinets (2020) posits, when people interact on an online public platform, they leave online traces which can be collected and used by netnographers.

The study used thematic content analysis to analyse the public sentiments expressed in response to the question tweeted about the effectiveness of smartwatches. The process involved two phases: initial coding and selective coding. During the initial coding phase, the data was systematically examined to identify common codes or categories (Creswell and Cresswell 2018). This coding process involved comparing and categorising the data based on its content, such as themes, topics, or patterns. The purpose was to organise the raw data into meaningful units that could be further analysed. Following the initial coding, the selective coding phase was conducted. This phase involved a more focused analysis, where specific codes were selected for further exploration. The selected codes were analysed in depth to identify overarching themes within the data. This process allowed the researchers to uncover meaningful insights and patterns within the online community's discussions and interactions.

Ethical standards were observed by maintaining the confidentiality and anonymity of informants. To ensure confidentiality, the identities of participants were protected, with their names, handles, or usernames removed from the data.

Findings and Discussion

A total of 174 tweets were posted under the question tweeted about the practical use of AI-smartwatch wearables were coded and analysed. Respondents replied to the question by sharing their experiences about the usefulness of smartwatches for personal health and wellness. The following themes emerged from the recurring tweets and sentiments expressed by users:

Sharing User Experiences about Tracked Health Patterns

Users expressed the view that AI-smartwatch wearables are valuable gadgets to track their overall health and wellness. The capabilities and functionalities of smartwatch wearables in monitoring different health parameters were appreciated by users. Users specifically mentioned the benefits of monitoring heart rate levels, sleep quality patterns, blood oxygen, stress level and blood pressure measurements amongst others. Users also highly rated smartwatches for their capabilities to detect heart risks or conditions such as abnormal heart rate, sleep apnea, low or high blood pressure, and heart attack symptoms before the actual testing or face-to-face medical assessment.

The quantity and quality of sleep is one of the most crucial indicators of a healthy lifestyle. Long periods of poor sleep can lead to a variety of health issues such as high levels of anxiety and stress, depression, diabetes and high blood pressure (Chen et al. 2013). This is an indication of the importance of monitoring sleep patterns which may assist in early detection of any potential sleep disorders. Users shared these experiences regarding using smartwatch devices to track their overall health patterns (see Table 1 below):

Table 1: Tweets about smartwatch usage to track health patterns

Tweets
"I sleep with my watch, so it tracks my sleep and lets me know how many hours of deep, I light and REM sleep I've had".
"I like that it measures BP, heart rate, blood oxygen, body composition, calories burnt, steps taken and stress levels"
"Mine measures my stress levels when my stress is too high it tells me what to do".
"Really helps keep track of your health, sleeping patterns, oxygen levels, blood pressure, stress levels. It's the most helpful tech purchase I have had regarding health".
"Alert me when my stress levels are too high, and it directs me on how to relax with a breathing exercise on my phone".

Enabling Early Detection

Smartwatch users expressed that smartwatch wearables can be a life-saving tool due to its ability to detect health conditions or risks in advance (Zhu and Cahan 2016). This shows that the data collected by smartwatches can track health patterns and identify early signs of serious medical conditions for users. During COVID-19 pandemic, smartwatch wearables have proven to be a useful tool to detect early signs of infection which were crucial in effectively mitigating the transmission of the virus (Mishra et al. 2020). A user shared a similar experience on how a smartwatch has saved his or her life during COVID-19.

> "*When covid hit me, it was my smartwatch that notified me when my oxygen level dropped below 90%, that's when I knew it's getting real and had to rush to hospital".*

Wearables provide real-time data of users' health patterns which is crucial in identifying potential diagnoses before a patient seeks professional medical care or before they even start showing symptoms (Zhu and Cahan 2016). Users' testimonials bear true to this important feature of smartwatch wearables in detecting medical conditions such as sleep apnea, heart attack, influenza 2 and irregular heartbeat of an unborn baby. These are some of the tweets posted:

Table 2: Tweets about smartwatch usage for early detection of ill-health

Tweets
"The heart rate detector saved my friend's husband. He was about to have a heart attack and it was detected. He knew a couple of minutes before he collapsed and called his wife".
"2017, via my Fitbit, noticed erratic heart rate all night at gigs, though feeling fine! Went to ER and they found I had influenza 2… straight to ICU and isolated for almost a week!!! My current Garmin does 500 more things! Only need to charge it twice a week. Sometimes even once!"
"The apple watch was able to detect an irregularity in unborn babies' heartbeat and save it, it is truly out of this world live saving tech".
"When I bought my Apple Watch It was mostly the sync between my watch and phone, being able to get notifications, calls etc. It then detected my sleep apnea 1st before actual testing happened. I like that it tracks when my habits change and it's my personal cheerleader".
"My one helped just the other day I woke up in the middle of the night feeling unwell when I put it on. My heart rate was way too fast and so was my BP at least I then knew what to do".

Instant Transmission of communication to health systems

Users positively expressed that smartwatch wearables are useful for detecting emergency incidents, and they provide instant alerts to emergency healthcare systems or services for rapid response in saving lives. Crime levels continue to rise in most countries and personal safety has become a priority for everyone. According to Statistics South Africa, theft and hijacking of cars are among the leading common crimes experienced by citizens. In 2022, over 137 000 hijackings were reported (Stats SA 2022). Users took to Twitter (X) to share their lived experiences on how their smartwatch wearables saved their lives during emergency situations. These are some of the tweets posted:

See Table 3 on page 40.

Table 3: Tweets about smartwatch usage for instant transmission of communication to health systems

Tweets
"I live alone abroad, one time i fell because of exhaustion and my watch called 911, and I was taken to ER, it can warn you of a possible heart attack"
"Mine notified my emergency contacts when I collapsed from a panic attack. Funny that the watch notified me a few minutes prior "abnormal heart rate detected" & that time I'm feeling proper".
"A cyclist once had a heart failure in Cape Town while cycling in a non-busy area and the watch contacted the emergency number".
"I had a bad fall while alone in the house. It immediately informed my sister and emergency services about the fall".
"I was in an accident last year and my Apple Watch sent a crash alert to my insurer and emergency services who came to the scene within seconds thought that was pretty impressive"

Discussion and Conclusion

The findings of this study reveal that smartwatches offer a wide range of functionalities that enhance users' quality of life and contribute to their overall well-being. One useful pattern identified by users in this study is the enhancement of tracking health patterns and early detection facilitated by smartwatches. Participants acknowledged the capability of these wearables to continuously monitor vital signs and provide timely alerts for potential health concerns. By tracking metrics such as heart rate, abnormal heart rhythms, and other health indicators, smartwatches offer users the opportunity for early detection of potential health issues. In line with (Stevens et al. 2021) smartwatch wearables are at the forefront of driving a customised, health ecosystem where users have become active participants in their personal health.

However, while the self-tracking function removes individuals' health responsibility from health professionals in terms of tracking well-being, the burden of interpreting large amounts of data moves to a public that may not be literate enough to meaningfully sustain health. Nonetheless, this feature empowers individuals to take proactive measures and to seek immediate medical attention, when necessary, potentially leading to early intervention and improved health outcomes (Steven et al. 2022). The ability of smartwatches to serve as a personal health assistant, constantly monitoring and providing insights into health patterns, adds a significant dimension to their practical use.

Sleep tracking also emerged as another valuable feature of smartwatches. Participants appreciated the ability to monitor their sleep patterns, including sleep duration, different sleep-promoting wellness and preventive care. It is evident that smartwatches not only offer convenience and connectivity but also contribute to overall health and well-being. This information empowers users to make informed

Active Optimisation of Wellness

The online testimonials of users reveal that smartwatch wearables provide active optimisation of wellness through a combination of sensors, data analysis, and software features. Smartwatches continuously monitor physical activities of users throughout the day and track metrics such as steps taken, distance travelled, calories burned, and heart rate. Users find this information helps in managing their wellness and staying motivated to achieve their health and fitness goals. Some of the online discourse includes the following:

Table 4: Tweets about smartwatch usage for active optimisation of wellness

Tweets
"I am a runner. I bought mine to keep tabs on my running progress and overall fitness and or health. To me personally my smart watch is very important and special as you put it".
"I'm a data person and being able to look at my fitness data and be able to track my exercise routines, steps, runs, and hikes is very useful for motivation and for keeping fit; but that's why I use Garmin watches instead of the Apple or Samsung one".
"I enjoy mine for the Daily reminders for my water intake, breathing exercises & stress level notifications".
"It's perfect for my active lifestyle as it tracks gym and running activities, stress & sleep patterns, respiration, and even VO2 max".
"My smartwatch motivates you to keep fit and healthy".

decisions about their sleep habits and take steps towards improving the quality and duration of their rest (Chent et al. 2013). Stress management capabilities were highlighted as a significant advantage of smartwatches. By leveraging heart rate variability data and providing guided breathing exercises or relaxation techniques, smartwatches help users manage stress levels and promote well-being (Nahavandi 2022).

An emerging disadvantage is the exclusion and disempowerment of people who cannot afford to buy the devices or cannot receive concessions from healthcare organisations such as medical aid organisations, some may not have smartphones to link devices to applications or may not afford to buy data (Kang and Exworthy 2022). Therefore, while there are benefits, certain populations are unable to tap into them and their experiences remain unshared. Future research should continue to explore the long-term impact of smartwatch wearables on individuals' health behaviours and overall well-being. AI Smartwatches are tools that ensure sustainable and optimised health (Davenport and Kalakota 2019) and ensure patient empowerment. Their features, including activity tracking, sleep monitoring, stress management, fitness coaching, and integration with health apps, provide users with valuable insights and tools to actively optimise their well-being (Dias and Cunha 2018). As technology continues to advance, smartwatches are expected to evolve further, incorporating more sophisticated features and capabilities.

References

Aruleba, K. and Jere, N. (2022). Exploring digital transforming challenges in rural areas of South Africa through a systematic review of empirical studies. *Scientific African*, 16, pp. 2468-2276.

Bhushan, D. and Agrawal, R. (2020). Security challenges for designing wearable and IoT solutions. In: Valentina, E. B., Vijender, K. S., Raghvendra, K. and Ahad, M.A.R,. eds. *A handbook of internet of things in biomedical and cyber physical systems.* New York: Springer International Publishing, pp.109-138.

Canali, S., Schiaffonati, V., and Aliverti, A. (2022). Challenges and recommendations for wearable devices in digital health: Data quality, interoperability, health equity, fairness [online]. *PLOS Digital Health* 1(10). Available from: e0000104. https://doi.org/10.1371/ journal. Pdig.0000104 [accessed 27/11/24]

Chent, Z., Lint, M., Chent, F., Lanett, N.D., Cardone, G., Wangt, R. Lit, T., Chen, Y., Choudhury, T. and Campbell, A.T. (2013). Unobtrusive sleep monitoring using smartphones. In: *2013 7th International Conference on Pervasive Computing Technologies for Healthcare and Workshops 2013, Venice* [online], pp.145-152. Available from: https://ieeexplore.ieee.org/document/6563918 [accessed 27/11/24].

Contini, M., Sarmento, A., Gugliandolo, P., Leonardi, A., Longinotti-Buitoni, G., Minella, C. et al. (2021). Validation of a new wearable device for type 3 sleep test without flowmeter. *PLoS ONE* [online], 16(4). Available from: https://doi.org/10.1371/journal.pone.0249470 [accessed 27/11/24].

Creswell, J. W. and Cresswell, J.D. (2018). Research design: qualitative, quantitative and mixed methods. Thousand Oaks, CA: Sage.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3): pp.319–340.

Davenport, E. and Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal*, 6(2): pp. 94–98.

Denecke, K., Gabarron, E., Petersen, C., and Merolli, M. (2021). Defining participatory health informatics – a scoping review. *Informatics for Health and Social Care*, 46(3): pp. 234–43.

Hu, L., Chen, Y., Cao, E., and Hu, W. (2024). User experience & usability of wearable health device: a bibliometric analysis of 2014–2023. *International Journal of Human–Computer Interaction* [online], pp. 1–20. Available from: https://doi.org/10.1080/10447318.2024.2357905 [accessed 27/11/24].

Ivankovic, D., Garel, P., Klazinga, N. and Kringos, D. (2023). Data-driven collaboration between hospitals and other healthcare organisations in Europe during the covid-19 pandemic: an explanatory sequential mixed-methods study among mid-level hospital managers. *International journal of integrated care*, 23(1): pp. 28-41.

Kang, H.S., and Exworthy, M. (2022). Wearing the future-wearables to empower users to take greater responsibility for their health and care: scoping review. *JMIR mHealth and uHealth,* 10(7). Available from: https://doi.org/10.2196/35684 [accessed 27/11/24].

Kozinets, R.V. (2002). The field behind the screen: Using netnography for marketing research in online communities. *Journal of Marketing Research*, 39(1): pp. 61-72.

Kozinets, R.V. (2010). *Netnography. Doing ethnographic research online*. Thousand Oaks, CA: Sage Publications.

Kozinets, R.V. (2015). *Netnography: Redefined*. London: Sage Publication Limited.

Kozinets, R.V. (2020). *Netnography: The essential guide to qualitative social media research.* London: Sage Publication Limited.

Laricchia, F. (2024). Smartwatch statistics and facts. *Statista* [online], 2 August 2024. Available from: https://www.statista.com/topics/4762/smartwatches/ [accessed 27 November 2024].

Minowa, Y. and Belk, R.W. (2020). Qualitative approaches to life course research: Linking life story to gift giving. *Journal of Global Scholars of Marketing Science*, 30(1), pp. 60-75.

Mishra, S., Mishra, B.K., Tripathy, H.K. and Dutta, A. (2020). Analysis of the role and scope of big data analytics with IoT in the healthcare domain. In: Balas, V.E., Solanki, V.K., Kumar, R., and Khari, M., eds. *A Handbook of Data Science Approaches for Biomedical Engineering*. Academic Press, pp. 1-23.

Mishra, T., Wang, M., Metwally, A.A., Bogu, G.K., Brooks, A.W., Bahmani, A., Alavi, A., Celli, A., Higgs, E., Dagan-Rosenfeld, O., Fay, B., Kirkpatrick, S., Kellogg, R., Gibson, M., Wang, T., Hunting, E.M., Mamic, P., Ganz, A.B., Rolnik, B., Li, X., and Snyder, M.P. (2020). Pre-symptomatic detection of COVID-19 from smartwatch data. *Nature Biomedical Engineering*, 4(12), 1208–1220.

Motti, V. G. and Caine, K. (2015). Micro interactions and multi-dimensional graphical user interfaces in the design of wrist worn wearables. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* [online], 59(1), pp.1712-1716. Available from: https://doi.org/10.1177/1541931215591370 [accessed 27 November 2024].

Nahavandi, D., Alizadehsani, R., Khosravi, A. and Acharya, U.R. (2022). Application of artificial intelligence in wearable devices: Opportunities and challenges. *Computer Methods and Programs in Biomedicine*, 213, pp. 106541.

Ntosti, A. (2018). Why micro-interactions are important for UX. *Medium* [online], 24 July 2018. Available from: https://uxdesign.cc/why-micro-interactions-matter-318e1409a6b2 [accessed 27 November 2024].

Ometov, A., Shubina, V., Klus, L., Skibinska, J., Saafi, S., Pascacio, P., Flueratoru, L., Quezada-Gaibor, D., Chukhno, N., Chukhno, O., Ali, A., Channa, A., Svertoka, E., Qaim, W.B., Marqués, R.C., Holcer, S., Torres-Sospedra, J., Casteleyn, S., Ruggeri, G., Araniti, G., Burget, R., Hosek, J., & Lohan, E.S. (2021). A Survey on Wearable Technology: History, State-of-the-Art and Current Challenges. *Computer Networks,* 193, pp.108074.

Pataranutaporn, P., Jain, A., Johnson, C.M., Shah, P. and Maes, P. (2019). Wearable lab on body: combining sensing of biochemical and digital markers in a wearable device. In: *41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society* July [online], pp. 3327-3332. Available from: https://pubmed.ncbi.nlm.nih.gov/31946594/ [accessed 27 November 2024].

Perez, M.V., Mahaffey, K.W., Hedlin, H., Rumsfeld, J.S., Garcia, A., Ferris, T., Balasubramanian, V., Russo, A.M., Rajmane, A., Cheung, L., Hung, G., Lee, J., Kowey, P., Talati, N., Nag, D., Gummidipundi, S.E., Beatty, A., Hills, M.T., Desai, S., Granger, C.B., Desai, M., Turakhia, M.P., and Apple Heart Study Investigators (2019). Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation. *The New England journal of medicine,* 381(20), 1909–1917. https://doi.org/10.1056/NEJMoa1901183 [accessed 27 November 2024].

Predel, C., and Steger, F. (2021). Ethical challenges with smartwatch-based screening for atrial fibrillation: putting users at risk for marketing purposes? *Frontiers in cardiovascular medicine* [online], 7, pp. 615927. Available from: https://doi.org/10.3389/fcvm.2020.615927 [accessed 24 November 2024].

Saffer, D. 2013. *Micro-interactions: Designing with Details*. O'Reilly Media, Inc.

Sharon, T., and Lucivero, F. (2019). Introduction to the special theme: The expansion of the health data ecosystem–Rethinking data ethics and governance. *Big Data and Society,* 6. Available from: doi: 10.1177/2053951719852969 [accessed 24 November 2024].

Shi, J., Liu, S., Zhang, L., Yang, B., Shu, L., Yang, Y., Ren, M., Wang, Y., Chen, J., Chen, W. and Chai, Y. (2020). Smart textile-integrated microelectronic systems for wearable applications. *Advanced Materials*, 32(5), pp. 1901-958.

Singh, G., Tee, A., Trakoolwilaiwan, T., Taha, A., and Olivo, M. (2020). Method of respiratory rate measurement using a unique wearable platform and an adaptive optical-based approach. *Intensive Care Medicine Experimental,* 8(15). Available from: https://doi.org/10.1186/s40635-020-00302-6 [accessed 24 November 2024].

Sitto, K. and Lubinga, E. (2020). Gendered myths, risks and the social amplification of male rape: online discourses. *Communitas*, 25, pp. 1-24.

South African Government 2024. *SoNA-in-Numbers – 2024* [online]. Available from: https://www.gov.za/news/sona-numbers-2024 [accessed 24 November 2024].

Statista. (2024). Fitness trackers – South Africa. *Statista* [online]. Available From: https://www.statista.com/outlook/hmo/digital-health/digital-fitness-well-being/fitness-trackers/south-africa [accessed 27 November 2024].

Steven, G., Haulson, L., Larmuseau, M. and Verdonck, P. (2022). A human-centred, health data-driven ecosystem. *Discover Health Systems* [online], 1(10). Available from: https://link.springer.com/article/10.1007/s44250-022-00011-9 [accessed 27 November 2024].

Varis, P. (2016). Digital ethnography. In: Georgakopoulou, A. and Spilioti, T. eds. *The Routledge handbook of language and digital communication.* London: Routledge, pp. 55-68.

Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. (2003). Unified theory of acceptance and use of technology (UTAUT). *MIS Quarterly*, 27 (3), pp. 425-478.

Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. (2003). User acceptance of information technology: towards a unified view. *MIS Quarterly*, 27, pp. 425-478.

Venkatesh, V., Thong, J.Y.L., and Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36(1), pp. 157–178.

Wu, M., and Luo, J. (2019). Wearable technology applications in healthcare: a literature review. *Online Journal of Nursing Informatics*, 23(3), pp. 1-11.

Zhang, J., Symons, J., Agapow, P., Teo, J.T., Paxton, C.A., Abdi, J., Mattie, H., Davie, C., Torres, A. Z., Folarin, A., Sood, H., Celi, L.A., Halamka, J., Eapen, S., and Budhdeo, S. (2022). Best practices in the real-world data life cycle. *PLOS digital health*, 1(1), e0000003. https://doi.org/10.1371/journal.pdig.0000003

Zhu, X., and Cahan, A. (2016). Wearable technologies and telehealth in care management for chronic illness. In: Weaver, C., Ball, M., Kim, G., Kiel, J. (eds). *Healthcare information management systems. health informatics*. Cham: Springer.

Remote Work and Digital Progressions during the Covid-19 Pandemic for Auditors and Financial Managers in Johannesburg, South Africa

By Irene Marindi

Abstract

The emergence of the Fourth Industrial Revolution (4IR) marks a significant transformation, introducing technological and digital advancements that are reshaping how work is conducted, largely through virtual platforms (Abe 2020: xviii). This shift is altering both the nature of work and traditional workplace concepts. While research acknowledges developments across various employment sectors, the increasing reliance on virtual arrangements has yielded mixed outcomes. This paper argues that the 4IR, coupled with the Covid-19 pandemic, has blurred the boundaries between physical and virtual work environments, often rendering physical workplaces less relevant. This transformation holds the potential to significantly impact worker engagement and well-being. Using a qualitative research approach, 26 interviews were conducted with auditors and financial managers in Johannesburg-based firms. The exploratory findings revealed that the Covid-19 pandemic accelerated the adoption of digital accounting practices for auditors and financial managers working remotely. Moreover, working from home was a double-edged sword for the participants in this study, as they compared their experiences during and before the pandemic. The findings demonstrate that digital processing dictates how work is conducted in the accounting and financial sectors.

Introduction

The nature of current and future employment practices is undergoing a transformation, and it is uncertain whether traditional work models will persist or collapse in the future (Okoye 2019; Balkaran 2016). According to the World Economic Forum (WEF) (2018, p. 90), personal interactions between customers and employees may become limited as digital platforms increasingly dominate working hours. Technological and digital

"In the digital age, vast quantities of data and products can be generated within minutes and applied across numerous industries, irrespective of location."

advancements that are changing how human beings manage their work have been observed worldwide. The growth of virtual platforms from the third industrial revolution to the Fourth Industrial Revolution (4IR) has opened new ways of conducting work that can limit face-to-face interactions (Mohajan 2020; Agarwal and Agarwal 2017; Schwab and Samans 2016). The benefits of the 4IR in the workplace are largely focused on its ability to enhance the work environment and provide employees with new and/or additional skills (de Ruyter et al. 2019, p. 38). Moreover, 4IR may improve productivity, as it allows for better understanding of new products and market conditions, saving time and money, supporting more informed decision-making, and can improve employee health and energy levels. Additionally, global connectivity may expand (Corfe 2018, p. 14-20). Importantly, the concept of a fixed workplace is shifting within the context of 4IR, as the physical location of work becomes less relevant due to the increasing reliance on virtual work environments (Prisecaru 2016, p. 59).

In the digital age, vast quantities of data and products can be generated within minutes and applied across numerous industries, irrespective of location. To fully benefit from this revolution, all sectors must collaborate to ensure that access to skills, knowledge, and technologies is democratised and utilised to address challenges. The extent to which the 4IR will influence human practices depends largely on how we utilise, depend on, and adapt to new technologies (Schwab and Davis 2018, pp. vii-viii). Various observations have been made regarding the use of digital and technological advancements in the workplace. Some scholars are optimistic about the contributions of the 4IR in the work context, highlighting the benefits of new innovations and the skills they will bring to workers across different industries (Asghar et al. 2020; de Ruyter et al. 2019; Corfe 2018; Ohene-Afoakwa and Nyanhongo 2017; Schwab and Davis 2018; Schwab and Samans 2016). However, others have pointed out certain drawbacks (Routley 2020; Mzekandaba 2019; Corfe 2018; Prisecaru 2016). Common critiques regarding the potential impact of the 4IR on employment include concerns about job losses and reduced job satisfaction as technology increasingly dominates the workplace (Mzekandaba 2019; Corfe 2018; Prisecaru 2016). With many businesses recently embracing the 4IR, there has been a decline in human labour involvement across various areas of work. In numerous fields, new machinery and technology now perform tasks in ways that either mirror or surpass human capabilities (Schwab and Samans 2016).

The changing nature of work in the accounting and financial sector

This technological growth in the employment sector has led to a reduction in manual tasks, transformed traditional work practices, increased reliance on digital tools, promoted remote work, and redefined the roles and responsibilities of accountants. Global shifts in manufacturing are continually evolving the skills and responsibilities required in the accounting and financial sectors (Ghasabeh et al. 2015). Business environments, shaped by urbanisation, societal demands, globalisation, and technological advancements, constantly change. These factors create a diverse range of roles for accountants, who now support businesses and individuals with financial advice, budget oversight, financial inspections, tax preparation, and more (Saxunova 2017). However, South Africa's financial sector faces unique structural challenges due to globalisation, political and economic shifts, market instability, and evolving global standards, all of which impact regulatory frameworks and raise concerns about the future of accounting professions (Deloitte 2017; CFO South Africa 2017). The adoption of

advanced technologies and software that can organise, calculate, and guide financial decisions continues to grow, and many tasks traditionally performed by accountants and auditors are now automatable. This trend raises questions about the profession's future (SAICA 2018; Susskind and Susskind 2015). Robotic Process Automation (RPA), for instance, has transformed the field by automating expert-level tasks, including data entry from multiple sources, receivables and payables, account reconciliation, regulatory implementation, financial reporting, planning, budgeting, and hypothesis testing (Onyshchenko et al. 2022; Arthur 2020; SAICA 2018). RPA's ability to alert auditors to irregularities and patterns enhances efficiency, reduces fraud, and minimises human error. While RPA poses a potential threat to the profession, a balance between human expertise and technology is essential since automated programs, though intelligent, can produce faulty algorithms if not carefully monitored by experts (Onyshchenko et al. 2022; SAICA 2018).

Additionally, Blockchain and Enterprise Resource Planning (ERP) systems are significantly impacting the accounting and financial sectors in the 4IR. Blockchain offers secure online storage through distributed ledgers, reducing fraudulent activities with enhanced security, especially valuable in banking (Onyshchenko et al. 2022). ERP systems improve workflow and information-sharing, providing accurate inventory management and creating centralized databases. The integration of the Internet of Things (IoT) into ERP systems is also instrumental in developing "smart factories" that capture manufacturing data. However, quantifying intellectual capital and intangible assets, such as multimedia content, remains challenging (Onyshchenko et al. 2022; Arthur 2020; SAICA 2018). In summary, big data, cloud computing, AI (Artificial Intelligence), blockchain, RPA, ERP systems, and IoT are reshaping skills, work environments, and the overall landscape of the accounting and financial sectors in the 4IR (Onyshchenko et al. 2022; Arthur 2020; Naqvi 2020; SAICA 2018; Susskind and Susskind 2015). The potential impact of the "essential eight technologies" in the accounting profession—including AI, augmented reality, blockchain, drones, IoT, robotics, virtual reality, and 3D printing—has garnered significant attention. These technologies offer promising opportunities to enhance ethical standards in the financial sector, particularly in areas of traceability and transferability. Working alongside these technologies could help accountants develop new skills, sustaining the profession while increasing accuracy in financial tasks (SAICA 2018, pp.52-54).

Furthermore, the use of technologies in the workplace allows for work flexibility as evidenced during the COVID-19 pandemic when remote work became standard practice globally. This marked a fundamental change in human interaction; it can be argued that the 4IR has inadvertently been propelled by the Covid-19 pandemic, as many businesses observed changes in the workplace. This questions the extent to which the technological revolution will shape work organisation in the future (Mhlanga and Moloi 2020, p. 2). Remote work demonstrated the power of technology however, it poses questions on employee's wellbeing as the ability to adjust varies from person-to-person (Appel-Meulenbroek et al. 2019). Factors such as household and family structure also influence adaptability to remote work which impact employee's career path, focus, productivity, and team cohesiveness (Routley 2020, p.1). The findings below illustrate how 4IR coupled with remote work contributed to the work organisation of auditors and financial manager in Johannesburg, South Africa.

> "Robotic Process Automation's ability to alert auditors to irregularities and patterns enhances efficiency, reduces fraud, and minimises human error."

Findings: Organisation of work during Covid-19 for auditors and financial managers in Johannesburg-based firms

The qualitative research methodology was employed to examine the narratives of 23 auditors and three financial managers working in firms around Johannesburg, South Africa. The methods and tools that were used to capture the narratives of the participants materialised through in-depth and semi-structured interviews. All interviews were conducted online in the year 2021 due to the Covid-19 restrictions where face-to-face contact with the participants was hindered. Moreover, the names of the participants presented in the findings below are anonymised through the use of pseudonyms.

Remote working for auditors and financial managers during the pandemic

Although working from home is not new for many auditors and financial managers who have clients in other regions. Most of the participants that were interviewed were working from the office before the Covid-19 pandemic. A number of the participants noted some changes brought about by the pandemic and thus this had been argued as a condition that hastened the 4IR. Josh expressed how quickly the firm that he worked for found solutions to the management of work during the pandemic. He felt that working from home was the direction that the firm wanted to take before Covid-19. He put forward that adaption to technology happened quickly which made it seem like the firm was ready however, he also conveyed the possibility that his employer *"had time to learn from other countries."* During this period, most of the auditors and financial managers that were interviewed communicated the over-reliance on Microsoft teams and cloud storage thus, most of the participants indicated that before the Covid-19 pandemic they had to work through a mixture of physical documentation and online data. However, working from home increased their dependence on electronic records hence, Carol underlined that remote working would be the new normal even after the pandemic. She noted that her superiors were working with the Information Technology (IT) department to transform some of their roles. Sam and Josh revealed that during the time they were working from home they learned about new features and shortcuts through Microsoft excel that supported their work. Mike praised online auditing and stipulated that more work was done virtually for the period of the pandemic because progress could be monitored easier.

Furthermore, some of the participants acknowledge the benefits of technology and how it enabled them to stay employed during the pandemic. Tom stated that *"it [technology] has ensured that we can still provide a service and retain our jobs, audits can be done from a distance."* Didi also detailed that working remotely had shown her that there was no need to go to the client's office as often as she did before the pandemic because she could perform all her responsibilities through a digital device. Like other participants, Nicky voiced that *"the work has not changed, it is the location that has changed."* These narratives demonstrate the ability to work anywhere through technology (Corfe 2018; Prisecaru 2016) and the rise of the 4IR revolution as well as its impact on the workplace. Arguably, working from home could have been more challenging during the previous revolutions for many sectors. According to Prince most of the administrative work has lessened due to new software. Peter accounted for the increased reliance on technology hence, he praised the use of technology and proclaimed that it limited "*back-and-forth communication that can cause delays."* Thembi who enjoyed working from home said, *"commuting and physical meetings are replaced by working via teams in the comfort of our homes"* Correspondently, working from home through technology improved productivity this was noted by Schwab and Samans (2016) alongside the ability to reduce traveling and increase the well-being of employees. Mary, Paris, and Zack applauded how online data was protected, stored, and shared between colleagues as well as clients during the pandemic. Moreover, these participants also explained how online data was stored and shared securely with limited access and restrictions. Sutherland (2019) noted the security measures that companies need to put in place against hackers to successfully work virtually. The firms that these participants work for appeared to be wary of the risks of storing information online and had placed measures to restrict any misuse of data. Peter voiced that *"we are also being introduced to systems that can verify transactions and reveal if*

the documents have been amended, I think this will be helpful to avoid fraud." Thembi said, *"we do digital audits now and use more data analytics to analysis data because of covid that pushed us into remote working without a choice."* She also mentioned that storing data online would minimise fraud because most documents could be traced quicker. The findings also suggested that the pandemic provided the participants with new skills and opportunities for learning.

A paperless workplace and a decline in physical engagement

There was a decline in paper documents and physical interaction during the pandemic, this was proclaimed by Jane who also indicated that the data processing method changed, resulting in a decline in paper-based work. Sharon expressed that technology had taken over most aspects of her work. She said, *"before it was a mixture of technology and physical documents now everything is digital; I don't know when last I dealt with physical documents."* She further explained that the firm that she worked for had data analytical tools that aided her in concluding audits faster than before. Moreover, she communicated that face-to-face meetings were a thing of the past because she relied on Microsoft teams as a result of the pandemic. Developments in digital accounting practices were also communicated by Mia who specified that the clients that she worked for had adapted to data storage and capturing systems and this made working from home even easier. Likewise, Cathy stated that digital accounting software and financial functions were guiding how she worked. She uttered "*Covid promoted the use of new automated functions. The manual way is defiantly decreasing, in a few years to come most functions will be automated. Our data analytics have been upgraded, and now predictions and diagnostics can conclude quicker. This makes life easier and adds to the accuracy and adds value to decision making and overall reporting."* The use of technology in the workplace can offer critical analysis tools and support employees' ability to conduct their duties. Currently, accountants have to accommodate different technological advancements as a result of the 4IR, such as the introduction of Robotic Process Automation (RPA) and AI (Akhter and Sultana 2018, p.143). These developments have been put in place to raise levels of efficiency for individuals who do repetitive work and jobs that require a high level of accuracy, such as accounting (Ohene-Afoakwa and Nyanhongo 2017, p. 5). Rights Capital Inc., a software company in the US, has, however, argued that the work for employees in the financial services sector will be less stressful in future, with easy-to-use financial software tools that provide quick and efficient results being at the disposal of such workers (WEF 2018, p. 117).

Like Cathy, Pearl communicated the reliance on technology during the pandemic and how systems were upgraded. She uttered, "*more tools that help us capture, calculate and generate reports this has made life easier… most gets analysed or grouped for us then we interpret and advice."* Sharon spoke of intelligence in technology and how data analytics, cloud, remote access software, and AI have improved her level of efficiency. Likewise, Beth said, *"there are Computer Audit Assistant Technologies (CAATs) that we use that allows us to test multiple accounts simultaneously, it allows us to be data-driven, analyse data and respond appropriately. We also call them data analytics tools that help us group and test appropriate data so that we can easily conclude an audit they also help us find anomalies quicker."* Daniel pointed out various systems that made working from home a success during the pandemic. He uttered, *"Advanced Power BI (Business Intelligence) in order to analyse big data has helped a lot. Software automation on accounting packages to avoid repetitive actions… advanced excel courses, Power BI, and financial modelling courses to cut the time taken in analysing big data and find more efficient manner of building dashboards."*

The participants highlighted that manual work was declining due to updated accounting software. Carol stated that most of the manual transactions have been automated through scanning and reporting tools in accounting software. She communicated that she did not manually produce statements anymore because all entries have been computerised therefore reports can be created in a few minutes. She further voiced that *"we now incorporate tools designed by the firm to extract data to provide more precise analytics which used to be manually performed by individuals and was time-consuming. Through software, data is more organised and can be grouped more efficiently."*

Likewise, Mary expressed that she did not prepare financial statements manually using Microsoft excel but relied on accounting packages that generated reports at a click of a button. Moreover, she communicated that *"asset management is major one where you would record manually, they detail including where its located. So, with the asset tagging chip, it's easy to get the list of assets available, numbers, and location."* This was also communicated by Prince who explained that physical inventory assessments can be completed virtually through asset location numbers he further explained that during the pandemic every part of his work was done online unlike before Covid-19 when he had face-to-face engagements.

Adaption to digital processes

The majority of the participants that were interviewed for this study specified that they had access to facilitates and information on new and/or upgraded digital techniques. Most of them indicated that the firm they worked for provided them with training, workshops, and learning material on new and/or upgraded systems. Mary pointed out that *"with sophisticated systems packages sometimes it's a struggle to adapt to new technology however, training before implementation helps a lot. In my workplace, it's communication before implementation, then creating a demo training for staff to have an understanding of the reasons for changes so they have an appreciation of the new technology."* Most of the participants did not struggle with adjusting to new digital advancements at work during the pandemic because they were required to take part in web-based learning offered by their employers. Didi said, *"we have e-learnings at work which are aimed to assist us in staying up to date with the digital world."* In Thembi's words *"I know quite a lot about the software that we use. The e-learnings are helpful for all of us because we also do online tests to test our knowledge."* Carol stated that she had to complete online practicals with multiple attempts on how to use new software.

In the spirit of the 4IR and the working arrangement brought about by the Covid-19 pandemic, the participants seem to be aware of the manner in which the workplace is transforming and saw the need to educate themselves on work-related technologies. Some of the participants voiced that they did their research intending to grasp new and/or upgraded advancements. Cathy indicated that in addition to the training that she received at work she enrolled in business intelligence and information systems courses. This expanded her knowledge of digital literacy and helped her cope with updates in software at work. Furthermore, she communicated that she did her research on technology-related topics. Susan considered registering for a short course in IT because is believed that her work duties were changing. She proclaimed that "*we are going to experience more software's in the near future because of the 4IR the world is depending on new software more and more to do business.*" In the interim, she proclaimed that she educated herself on technology-related topics through the internet and web-based learnings offered at work. Nicky specified the importance of practicing and learning about new digital software's she stated that she attempted to learn new formulas on her own. Josh and Peter are amongst those who indicated that they do their research on new and/or updated software. Although, Daniel did not witness many innovations in his sector he indicated that he still read about innovations in the private sphere because he did not want to be left behind. He voiced *"I'd need to have constant practice to keep up. The private sector embraces the 4IR more than the public we are larking behind. I still read a lot about private sector innovations as I am in the public sector and try to keep up to not fall behind. I practice in my spare time and sometimes try to introduce those new digital vibes during my tasks. But because I work in the public sector where technology is feared I try not to be too tech savvy I just do things the manual way."* In light of this, Paris said, *"I plan to learn more about digital innovation through training as well as hearing about others' experiences. I want to speak to others in different firms to hear how they are coping.*" Keith uttered the following *"I seek help from my colleagues and my managers or I go back to the online learnings to refresh my mind."* Comparably, Beth expressed that she surrounded herself with individuals with different capabilities so that when she is stuck, she can call someone to assist with the *"technological glitches."*

A few of the auditors and financial managers stated that they align themselves with experts in the IT department with the aim to learn more about

the digital processes they were confronted with. In addition to the online learning material, Jane communicated that she also had access to the IT department and could ask them for assistance if she needed it. Most of the participants shared that their IT department at work was always available to aid them with any technical difficulties that they had. She shared that the IT staff could access her laptop from home and had user guides for employees who needed technical support. Prince, Sharon, and Thembi also sought help from the IT department at work on improved auditing technologies. Michelle who was married to an IT technician indicated that her husband has educated her on various shortcuts in excel which have been valuable to her work. She further said, *"I learned from him so he is beneficial but he does not understand all accounting-related formulas if I have a problem with those, I have to ask for help from the IT department at work who have access to my laptop."* Michelle also indicated that she also relies on knowledge from other colleagues, Google, and YouTube. Divergent to the narratives above Mia conveyed that she was tech savvy and her work experience granted her knowledge on digitisation. She further expressed *"I am part of the generation that grew up with technology."* The findings illustrate how adjustments can be possible in this new era through training, education, and research. Thua, Adapting to new and/or updated technologies is a task set out for employers and employees.

Discussion and conclusion

The industrial revolutions throughout the years have recognised changes and developments in the workplace. In the first and the second industrial revolution, human labour worked hand in hand with different machinery (Mohajan 2020; Agarwal and Agarwal 2017; Schwab and Samans 2016). The third and fourth industrial revolution demonstrates a great involvement of technological and digital advancements in the workplace (Sako 2020; Mzekandaba 2019; Corfe 2018; Prisecaru 2016). With many businesses embracing the 4IR, recently, there has been a decline in the involvement of human labour in various aspects of work. In many fields, new machinery and technology conduct work in a similar and/or progressive fashion to humans. Today, we are still witnessing technological and digital advancements that are changing how human beings conduct their work. The growth of virtual platforms from the third industrial revolution to date has opened new ways of doing things (Mohajan 2020; Agarwal and Agarwal 2017; Schwab and Samans 2016). Like observed during the Covid-19 pandemic whereby digital practices were introduced to auditors and financial managers working from home. The growth in digital accounting processes was mentioned by the participants who also noted the decline in paper-based documents. Most of the participants communicated that the use of technology increased accuracy and productivity. The technology offered the participants some new skills and retained their jobs during the novel Covid-19. The participants interviewed for this study acknowledged that they need technology to successfully conduct their work. In other words, regardless of the efforts and challenges that come with understanding new and or updated software all of the participants agreed that it would be difficult work without technology. The narratives illustrate how the pandemic in this context accelerated the 4IR by adapting to digital accounting practices. This paper adds value to the literature on digitisation of the workplace in the African continent as well as labour scholars throughout the world. It is vital to investigate the changing nature of work so that we can prepare for what is yet to come and also acknowledge the differences within the various contexts of the world.

References

Abe, E.N. (2020). *Future of work, work-family satisfaction, and employee well-being in the fourth industrial revolution*. United States: IGI Global.

Agarwal, H. and Agarwal, R. (2017). First industrial revolution and second industrial revolution: technological differences in banking and financing of the firms. *Saudi Journal of Humanities and Social Sciences,* 2(11), pp. 1062-1066.

Akhter, A and Sultana, R. (2018). Sustainability of accounting profession at the age of fourth industrial revolution. *International Journal of Accounting and Financial Reporting,* 8(4), pp. 139-158.

Arthur, C. (2020). Fourth Industrial Revolution: How Latecomers and Laggards can Catch up. *United Nations Industrial Development Organisation* [online], 5 February 2020. Available from: https://www.unido.org/stories/fourth-industrial-revolution-how-latecomers-and-laggards-can-catch [accessed 20 September 2020].

Appel-Meulenbroek, R., Vosters, S., Kemperman, A., and Arentze, T., (2019). Workplace needs and their support: are millennials different from other generations?, unpublished paper presented at: *Twenty Fifth Pacific-Rim Real Estate Society Conference*. Melbourne, Australia: January 2019.

Balkaran, S. (2016). The fourth industrial revolution its impact on the south african public sector. *Academia* [online]. Available from: http://academia.edu/22826511/the_fourth_industrial_revolutionits_impact_on_the_south_african_public_sector [accessed 12 July 2019].

CFO South Africa, (2017). SA has the ability to produce great talent, says Citibank SA CFO Nico Botha. *CFO South Africa* [online]. Available from: http://cfo.co.za/profiles/blogs/cfo-interview-nico-botha-citibank [accessed 20 June 2020].

Corfe, S. (2018). *4IR in the workplace: ensuring employers and employees benefit.* London: The Social Market Foundation.

Deloitte. (2017). *Banking regulatory outlook 2017.* United States: Deloitte.

De Ruyter, A., Brown, M. and Burgess, K. (2019). Gig work and the fourth industrial revolution: conceptual and regulatory challenges. *Journal of international affairs,* 72(1), pp.37-50.

Ghasabeh, M.S., Soosay, C. and Reaiche, C. (2015). The Emerging Role of Transformational Leadership. *The Journal of Developing Areas,* 49(6), pp. 459–467.

National Institute for Communicable Diseases. (2020). First of COVID-19 Coronavirus reported in SA. *National Institue for Communicable Diseases* [online]. Available from: https://www.nicd.ac.za/first-case-of-covid-19-coronavirus-reported-in-sa/ [accessed 20 April 2020].

Mhlanga, D. and Moloi, T. (2020). COVID-19 and digital transformation of education: what are we learning on 4ir in south africa?, *Education Sciences*, 10(180), pp.1-11.

Mohajan, HK. (2020). The second industrial revolution has brought modern social and economic developments. *Journal of Social Sciences and Humanities,* 6(1), pp.1-14.

Mzekandaba, S. (2019). SA Millennials Fear Impact of Industry 4.0 on Jobs. *IT Web* [online]. Available from: https://www.itweb.co.za/content/6gxrkmy8bjq7b3wj [accessed 6 November 2019].

Naqvi, A. (2020). *Artificial Intelligence for audit, forensic accounting, and valuation: A strategic perspective.* New Jersey: John Wiley and Sons.

Ohene-Afoakwa, E. and Nyanhongo, S. (2017). Banking in Africa: strategies and systems for the banking industry to win in the fourth industrial revolution. *BankSETA* [online]. Available from: https://www.bankseta.org.za/wp-content/uploads/2018/08/ba3dd51-1.pdf [accessed 12 January 2020].

Okoye, CJ. (2019). Think Outside the Box to Survive 4IR. *The Citerzen* [online]. Available from: http://www.google.co.za/amp/s/citerzen.co.za/business/businessnews/2152651/think-outside-the-box-to-survive-4ir/amp/ [accessed 10 July 2019].

Onyshchenko, O., Shevchuk, K., Shara, Y., Koval, N., and Demchuk, O. (2022). Industry 4.0 and accounting: directions, challenges, opportunities. *Independent Journal of Management and Production (IJM&P)*, 13(3), pp.161-195.

Prisecaru, P. (2016). Challenges of the fourth industrial revolution. *Knowledge Horizons-Economics*, 8(1), pp.57- 62.

Routley, N. (2020). 6 charts that show what employers and employees really think about remote working. *World Economic Forum* [online]. Available from: https://www.weforum.org/agenda/2020/06/coronavirus-covid19-remote-working-office-employees-employers [accessed 15 September 2020].

Sako, M. (2020). Artificial Intelligence and the future of professional work. *Communication of the ACM,* 63(4), pp.25-27.

Saxunova, D. (2017). Accountants and auditors and their skills and competences in contemporary environment. *Socialno-Ekonomicka revue*, 15(2), pp.43-52.

Schwab, K. and Samans, R. (2016). *The future of jobs: employment, skills and workforce strategy for the fourth industrial revolution.* New York: World Economic Forum.

Schwab, K. and Davis, N. (2018). *Shaping the fourth industrial revolution.* New York: World Economic Forum.

Susskind, R. and Susskind, D. (2015). *The future of the professions: how technology will transform the work of human experts.* Oxford: Oxford University Press.

Sutherland, E. 2019. The fourth industrial revolution – the case of South Africa. *South African Journal of political studies,* 47(2), pp.233-252.

The South African Institute of chartered accountants (SAICA). (2018). Current and future relevance of the profession. *SAICA* [online]. Available from: https://www.saica.co.za/portals/0/documents/Current_and_future_relevance_profession_Full_Research.pdf [accessed 20 June 2020].

The World Economic Forum (WEF). (2018). The new physics of financial services. *World Economic Forum* [online]. Available from: http://www3.weforum.org/docs/wef_new_physics_of_financial_services.pdf [accessed 13 November 2019].

Determinants of M-Commerce Platform Adoption Among Individuals in South African Township Communities

By Mogau Mashishi and Mpho Primus

Abstract

Since the COVID-19 pandemic outbreak in 2020, there has been an increase in the adoption of e-commerce (electronic commerce) from which m-commerce (mobile commerce) was born. M-commerce is the use of a mobile phone to purchase goods and services. Most of the South African population resides in townships and rural areas and contributes significantly to the economy. The study researched m-commerce adoption in South African townships by determining the factors that affect m-commerce adoption in South African townships. The study only focused on two townships in Johannesburg: Soweto and Tembisa. A conceptual research model based on the following factors from the UTAUT2 technology model: performance expectancy, hedonic motivation, and facilitating conditions, with social media and trust as two additional constructs. A digital online survey was used to collect respondents' data, and it was analysed quantitatively using SPSS. The findings of the study are discussed in detail, including testing the hypotheses formulated. Social media and perceived security have a significant, positive effect on the trust of South African township residents to adopt m-commerce platforms. Performance expectancy, hedonic motivation, trust, and facilitating conditions positively affect the intention of South African township residents to adopt m-commerce; however, trust and facilitating conditions were insignificant.

Introduction

South African townships have revolutionised and have, over the years, become economic hubs with infrastructure improvements, shopping centres, and malls (McGaffin et al. 2015). A township is "a residential area outside towns and cities with predominantly black, coloured, or Indian people and associated with low-cost housing and a lack of infrastructure" (Mahajan 2014). South African townships and informal settlements account

for 60% of unemployment in the country (Urban & Ndou 2019.). The rise in economic activity and improvement in many individuals' lifestyles has sparked a desire to obtain a better understanding of the economic landscape of South African townships and how it contributes to the economy of the country with digital transformation at the forefront of everything and with recent growth in electronic commerce (e-commerce) and mobile commerce (m-commerce).

Mobile commerce (m-commerce) comprises various aspects, which include online retail shopping, mobile banking, and mobile payments (Tiwari & Buse 2007). Due to technological advancements, South African townships and rural communities have been encouraged to embrace digital transformation. As a result, mobile devices have become convenient tools for people because they can use them to perform multiple transactions in their hands, leading to m-commerce becoming more favoured over e-commerce. After all, transactions can be conveniently done on the go (Abdelkarim & Nasereddin 2010).

Over the years, as more research has become available, m-commerce adoption has been studied using different technology adoption frameworks. The most well-known used theories are: The Theory of Reasoned Action (TRA) (Ajzen & Fishbein 1980), the Theory of Planned Behaviour (TPB) (Ajzen, 1985), the Technology Acceptance Model (TAM) (Davis 1986), the Diffusion of Innovation Theory (Rogers 1962/2003), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003) and the Unified Theory of Acceptance and Use of Technology2 (UTAUT2) being the latest developed model (Venkatesh et al. 2012).

As South Africa undergoes significant economic and digital transformation, understanding the adoption of mobile commerce (m-commerce) within these townships is essential. M-commerce holds the potential to empower residents by providing greater access to markets, financial services, and valuable information (Mhlongo et al. 2017). However, factors such as limited internet connectivity, low disposable income, and varying levels of digital literacy create a complex landscape that influences engagement with mobile commerce platforms Mitchel & Odendaal 2015). Examining m-commerce adoption in townships offers insights into how communities navigate digital changes amidst their historical and socio-economic challenges, underscoring the need for targeted interventions that consider local contexts to foster inclusivity in the digital economy.

> "…mobile devices have become convenient tools for people because they can use them to perform multiple transactions in their hands, leading to m-commerce becoming more favoured over e-commerce."

Although research has been conducted in the past regarding m-commerce adoption in townships, using technology acceptance models to investigate the acceptance of m-commerce, there has yet to be known literature regarding how social media platforms and other factors affect m-commerce adoption in South African townships from the consumers' perspective. Dakduk et al. (2020) studied m-commerce adoption by low-income consumers and Dzimati (2017) researched online shopping in South African townships using the Unified Technology Acceptance and Use of Technology model (UTAUT). The purpose of this study is to take it a step further by focusing specifically on m-commerce adoption in South African townships using a conceptual model based on the Unified Technology2 (UTAUT2).

The research objectives of the study are to:

1. Determine whether perceived security and social media affect trust to adopt m-commerce by individuals in South African townships.
2. Determine whether individuals in South African townships trust m-commerce platforms.

3. Determine whether individuals in South African townships are motivated to use m-commerce platforms.
4. Determine whether technological constraints and conditions affect m-commerce adoption by individuals in South African townships.

This study can contribute to the government's plan by understanding the factors influencing mobile commerce adoption in South African townships from both a consumer and a business perspective and what initiatives government can create to assist in the economic growth of townships. M-commerce retailers can also use this study to understand the challenges faced by customers in the townships and how they can assist customers to overcome those challenges. According to the researcher's knowledge, literature has yet to be discovered regarding m-commerce adoption in South African townships from the consumers' perspective. This study can also contribute academically to further research regarding m-commerce adoption in South African townships.

M-commerce Adoption and Acceptance

Chonker et al. (2017) performed a study to investigate mobile commerce adoption based on all the above technology adoption frameworks and found that the Technology Acceptance Model (TAM) was the most popular framework, and the Unified Technology Acceptance and Use of Technology model (UTAUT) was gaining traction. Asastani et al. (2018) used both the UTAUT model (Unified Theory of Acceptance and Use of Technology) and TAM (Technology Acceptance Model). They concluded that performance expectancy, effort expectancy, social influence, and perceived trust influence of the use of m-commerce while facilitating condition and perceived cost have no significant effect on the use of m-commerce.

Using Chong's research model, Cullen & Kabanda (2018) only focused on two factors affecting m-commerce adoption in South Africa: demographic and motivational factors (Chong 2013). Demographic factors are the characteristics of the individual and include, amongst others, age, gender, and educational level (Cullen & Kabanda 2018). Both studies performed by Chong (2013) and Cullen & Kabanda (2018) concluded that mobile commerce adoption is negatively affected by the age, educational levels, and gender of an individual.

The following researchers moved away from the technology acceptance model (TAM). Instead, they focused on the Unified Theory of Acceptance and use of technology (UTAUT) to explore m-commerce adoption amongst low-income consumers (Dakduk et al. 2020) and South African townships (Dzimati 2017), similar to the study. Dakduk et al. (2020) included the trust and perceived security elements in the UTAUT. They concluded that perceived trust, habit, positive motivation, and facilitating conditions affected the of individuals to use m-commerce. Dzimati (2017) also added perceived security and trust as additional constructs to the UTAUT model for the study of online shopping acceptance in South African townships and concluded that effort expectancy, performance expectancy, social influence, perceived security, and trust are significant factors to adopting online shopping.

As with Dzimati (2017), our study focused on South African townships. However, it narrows the study to mobile online shopping and the use of social media to accelerate it. Lian and Yen (2014) also used the UTAUT together with innovation resistance theory to study factors affecting the acceptance of online shopping by older customers and revealed that Performance expectancy and social influence constructs have a significant effect on the acceptance of online shopping by older adults and younger consumers had higher drives and lower barriers towards acceptance as compared to older consumers. However, unlike Lian and Yen (2014), this study focused on all age groups above the age of 18 and not only on older adults.

Gharaibeh et al. (2020) used the UTAUT2 model as a base for their study on m-commerce adoption; however, they extended the model by adding social media as an additional construct. Although the study by Gharaibeh et al. (2020) was done in Jordan, situated in Western Asia, it is similar to this study because it also focuses on the impact of social media on the intention to adopt m-commerce. The conclusion was made that the six constructs of the UTAUT2 model and social media immensely affect the intention of consumers in Jordan to adopt m-commerce. Unfortunately, no available literature has shown evidence of a similar study performed in South Africa, specifically in townships.

> The growth of social media platforms has allowed businesses to have direct and quick access to their consumers.

Lin and Theingi (2019) extended the UTAUT2 model by adding disturbance concerns and perceived trust. They concluded that social influence, facilitating conditions, price value and habit, and trust, positively influence the behavioural intention of m-commerce adoption. Lastly, Bendary and Al-Sahouly (2018) focused on Egypt, exploring the UTAUT2 factors' effect on perceived usefulness and ease of use on mobile commerce. They concluded that social influence and hedonic motivation were the most predominant factors.

Security and Trust in the Adoption of M-Commerce

In the absence of brick-and-mortar shopping experience, trust becomes a significant factor between the vendor and the customer, especially with the perceived risks encompassing technological advances such as m-commerce (Corbitt et al. 2003). Trust is "a subjective belief that a party will fulfil their obligations," and in the context of m-commerce, the following factors: privacy of customer information, quality of information, m-commerce usability, vendor's trustworthiness and reputation, influence trust (Siau et al. 2003). According to Cho et al. (2007), situational normality, calculative trust, and familiarity with a trustworthy online vendor are the factors a customer considers concerning trusting m-commerce. Trusting beliefs in the online environment can be classified into either external or internal factors (Salo and Karjaluoto, 2007). External factors include consumer characteristics, products and services, past experiences of the consumer, and risk perception (Salo and Karjaluoto 2007). Internal factors include the information system and privacy protection (Salo and Karjaluoto 2007).

Vasileiadis (2014) concluded that both security and trust are critical factors in the adoption of m-commerce by using the Technology Acceptance Model (TAM) and extended it by adding perceived trust and perceived risks (security and privacy concerns) as additional factors. Likewise, Armesh et al. (2010) stated that the security and privacy of information affect trust & trustworthiness, and loyalty in online marketing in Malaysia.

The growth of social media platforms has allowed businesses to have direct and quick access to their consumers. With social media proliferating, individuals are using social media to share and access information quickly. According to Bekmagambetov et al. (2018), social media assesses m-commerce websites and allows customers to quickly manoeuvre to the desired m-commerce page, also serving as a direct mode of communication between business and the customer (Pelet and Papadopoulou 2015). Hajli (2014) adopted the Technology and Acceptance Model (TAM) to determine how social media has allowed consumers to interact with other consumers and found that when consumers interact on social media, it increases trust and their intention to purchase products. According to Pelet and Papadopoulou (2015), social media use on mobile devices is growing, and there is a positive attitude towards m-commerce. The factors affecting m-commerce and social media adoption are trust, reputation, speed, ease of use, and security.

Mani and Gunasekaran (2018) discovered that social media and m-commerce adoption are affected by factors such as trust, product reputation, ease of use, and security, and the gap filled by this research study was to take it a step further by focusing on South African townships. Hossain et al. (2020) investigated the role of social networking in driving m-commerce from a different perspective, using the Uses and Gratifications (U&G) Theory (Gan 2017). This is a theoretical framework that is used to explain the different reasons why an individual uses a specific media platform focusing on both mobile online shopping and the mode of payment, and found that from the customer's perspective using m-commerce through social networking sites (SNSs)

is easy, saves time and secure if the following factors, namely trust, mobile application compatibility, the perceived value of online shopping mobile apps and online payment are met. Our study extended the demographics of Hossain et al. (2020) to South African townships to determine whether different results may be yielded.

Conceptual Framework and Model

A conceptual research framework was used to develop the research model for hypotheses development based on constructs of the Unified Theory of User Acceptance and Use of Technology2 (UTAUT2) acceptance model that was developed by Venkatesh et al. (2012), together with social media, perceived security, and trust as additional constructs.

The Unified Theory of User Acceptance and Use of Technology2 (UTAUT2) model was used to develop a conceptual research model for this study because it is the latest technology acceptance model. The UTAUT2 model has seven constructs: performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit. It also consists of three moderators: age, gender, and experience.

However, only the hedonic motivation, facilitating conditions, and performance expectancy constructs were considered for this study. Due to resources and time constraints, the price value and habit constructs were not considered. The effort expectancy construct was also not considered in the study because it conflicts with facilitating conditions constructed in mobile shopping adoption, according to Yang and Forney (2013). According to Venkatesh et al. (2003), the facilitating conditions construct becomes a predictor of intention when the effort expectancy construct is not included in the model. Wu et al. (2007) states that effort expectancy is not critical for consumer technology adoption. Therefore, the compatibility of the mobile device, including features and functions, is more important than the ease of use of the services of the mobile devices (Yang and Forney 2013).

The social influence construct was not used directly in the conceptualised research model (Figure 1). It has been replaced with social media construct. Perceived security and trust are the two additional constructs to the research model because, with online shopping and payments, security is vital in gaining customers' trust and loyalty (Özgüven 2011). Figure 1 below illustrates the conceptualised research model. The hypotheses are described in Table 1 below.

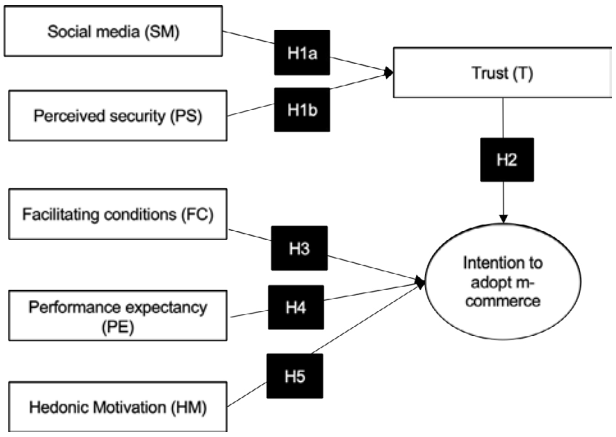

Figure 1: Conceptualized research model

Table 1: Hypotheses table

Hypothesis	Description
H1a	Social media (SM) positively affects users' trust in m-commerce (T) in South African townships.
H1b	Perceived security (PS) positively affects users' trust in m-commerce in South African townships.
H2	Trust (T) positively affects a user's intention to adopt m-commerce in South African townships.
H3	Facilitating conditions (FC) positively affect users' intention to adopt m-commerce in South African townships.
H4	Performance expectancy (PE) positively affects users' intention to adopt m-commerce in South African townships.
H5	Hedonic motivation (HM) positively affects a user's intention to adopt m-commerce in South African townships.

Trends in South African Townships

In 2022, the Township CX Report conducted a survey and noted that 70% of the respondents were making purchases online compared to 29% in 2021, and 48% of respondents have Wi-Fi in their residential homes (Rogerwilco et al. 2022); this is evidence that online shopping is rapidly growing; thus, providing a basis for understanding the factors affecting m-commerce usage is amongst residents. Therefore, this study focuses solely on townships because the economy of the South African township and online shopping has gained traction (Rogerwilco et al. 2022).

Despite a growing body of literature on mobile commerce (m-commerce) in South Africa, significant gaps remain, particularly concerning the role of social media in shaping consumer trust within township contexts. While studies by Dakduk (2017) and Dzimati (2020) have explored various dimensions of m-commerce adoption, they often overlook the critical influence of social media as a trust-building mechanism among consumers in these unique socio-economic landscapes.

This study aims to fill this gap by examining how social media platforms facilitate trust among township residents when engaging with m-commerce. By focusing specifically on the interplay between social media usage and consumer trust, this research seeks to contribute to a more nuanced understanding of m-commerce adoption in South African townships. This approach not only highlights the distinct socio-economic dynamics of these communities but also underscores the importance of social media as a transformative tool in the digital economy.

Data Collection and Sampling

The deductive approach was followed for this research by testing the hypotheses developed from the conceptual research framework; hence the quantitative approach was followed. In our study, we used a cross-sectional survey to collect data using a digital survey. According to Statista (2022b), the estimated populations of Soweto and Tembisa are 1,695 000 and 512 000 respectively. The targeted population of this study was individuals residing in Soweto and Tembisa, who met the following criteria:

- Be 18 years or older,
- Have a compatible mobile phone,
- Residents of Soweto or Tembisa

For this study, non-probability convenience sampling was used. Convenience sampling is selecting readily available participants (Taherdoost 2016). The sample is selected on the basis of the convenience of the researcher (Acharya et al. 2013). The reason why convenience sampling was used for this research was because it was less time-consuming and convenient to select respondents in different public areas, e.g. shopping malls and workspaces. Convenience sampling also allowed the researcher the flexibility to reach participants on online social platforms. A sample size of 220 respondents was used across both townships.

The digital survey was sent to respondents via email, embedding a link to the survey, and the link was shared with them on social media platforms like WhatsApp, Facebook and LinkedIn. This distribution method was chosen because of its ease of accessibility, convenience, limited resources, and cost-saving benefit.

The hypotheses and constructs were derived from various literature sources. The questions to address each of the hypotheses and constructs were also adopted from literature sources that had used similar questions. Some of the questions were changed for the suitability of this research.

A Likert scale questionnaire was used because it allowed the researcher to gather data effectively from a large sample (Nemoto & Beglar 2014) and because participants could indicate their emotions and attitudes with the topic statements (Zikmund 2003).

Data processing

The data collected for this study was analysed using Statistical Package for Social Science (SPSS) version 28. Regression analysis was used to determine the cause-and-effect relationship between the variables (Sykes 1993).

Multiple linear regression analysis is applied to a dependent variable which has more than one independent variable, as is the case in this study. For this study, multiple linear regression was used in two instances. In the first instance, trust (T) is the dependent variable, with social media (SM) and perceived security (PS) as the independent variables. In the second instance, the independent variables are social media (SM), trust (T), facilitating conditions (FC) and performance expectancy (PE), with intention to adopt m-commerce (IA) as the dependent variable.

Two hundred and twenty (220) responses were received and recorded on Qualtrics XM. From the 220 responses received, it was noted that only a hundred and ninety-eight (198) responses were fully completed, with all the questions fully answered; this resulted in a 90% total response rate. Furthermore, a normality test was performed (see below) to determine whether the data was normally

distributed before analysing it. Table 2 provides the socio-demographic profile of the respondents.

Table 2: Socio-demographic profile of the respondents

Profiles	n	Percentage (%)
Gender		
Female	104	52.5
Male	94	47.5
Total	**198**	**100**
Age (Years)		
18 - 24	35	17.7
25 - 30	56	28.3
31 - 40	63	31.8
41 - 50	34	17.2
51 - 60	9	4.5
60+	1	0.5
Total	**198**	**100**
Qualifications		
Lower than matric	4	2,0
Matric	46	23,2
Higher certificate	32	16,2
Diploma	40	20,2
Degree	51	25,8
Postgraduate degree/diploma	25	12,6
Total	**198**	**100**
Monthly income range		
No income		19
R0 - R7 999	36	18.2
R 8 000 - R15 999	44	22.2
R16 000 - R24 999	38	19.2
R25 000 - R34 999	34	17.2
R35 000+	22	11.1
Total	**198**	**100**

Measurements

A Likert scale questionnaire was used because it allowed the researcher to gather data effectively from a large sample and because participants could indicate their emotions and attitudes with the topic. According to Zikmund (2003), a Likert scale usually has five options to agree with a statement: strongly agree, agree, uncertain, disagree or strongly disagree, the questionnaire used this five-point scale.

The data collected for this study was analysed using Statistical Package for Social Science (SPSS) version 28[1]. Regression analysis was used to determine the cause-and-effect relationship between the variables. Regression analysis is defined as "a statistical technique for estimating the relationship among variables which have reason and relation" (Uyanık and Güler 2013). Multiple linear regression was used for this study because there is more than one independent variable and only one dependent variable.

Descriptive and inferential statistics were used to analyse and interpret the data collected. According to Fisher & Marshall (2009), descriptive statistics are used to analyse the characteristics of a sample numerically and graphically. Descriptive statistics include determining the data's mean, mode, variance, and standard deviation (Louangrath & Sutanapong 2015). Inferential statistics is defined as estimating the population and forming a conclusion based on observations described by descriptive statistics (Louangrath & Sutanapong 2015).

Preliminary analysis

As part of the descriptive statistics, the following data was obtained from respondents using a Likert scale, as indicated in table 3.

Normality testing

As indicated in Table 4 below, as analysed in SPSS version 28, the skewness of -0.462 is greater than -1, indicating that the data is normally distributed. Furthermore, kurtosis is -0.601, which is greater than -1 and indicates normal distribution.

Skewness and Kurtosis testing

Do you intent to use mobile commerce (m-commerce) when given the chance to?	Statistic	Std. Error
Skewness	-0,462	0,173
Kurtosis	-0,601	0,344

Validity and reliability testing

Factor analysis testing in SPSS included Kaiser-Meyer-Olkin (KMO) and Barlett's test for Sphericity,

1 The researcher used SPSS to perform calculations and present data graphically.

Table 3: Descriptive statistics

Profiles	n	Percentage (%)
Intention to adopt m-commerce platforms		
Definitely not	16	8.1
Probably not	28	14.1
Might or might not	49	24.7
Probably yes	69	34.8
Definitely yes	36	18.2
Total	**198**	**100**
Items purchased via m-commerce*		
Groceries and personal care	78	22
Clothing and fashionable items	88	25
Furniture and appliances	31	9
Electronics and media	75	21
Toys, Hobbies and DIY	48	13
Other	35	10
Total	**355**	**100**
Reasons to use your mobile device to do online shopping*		
Convenience	124	25.6
Security features of the m-commerce platform	97	20.0
Social media views about the product and services	97	20.0
Easy check-out and payment process	86	17.8
Brand reputation of vendor	80	16.5
Convenience	124	25.6
Total	**484**	**100**

** Respondents could select more than one answer*

as illustrated below in Table 5. KMO is 0,943, which is greater than 0,6 (Pallant 2020). and Barlett's test is 0,000, less than 0,05 (Pallant 2020). Therefore, this research has achieved a good factor analysis and indicates that the variables have patterned relationships. As illustrated in Table 6 all constructs indicate a Cronbach Alpha of 0,914 and are therefore reliable.

Table 5: KMO and Barlett's test for Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,943
Bartlett's Test of Sphericity	Approx. Chi-Square	4650,52
	df	465
	Sig.	0,000

Table 6: Reliability statistics

Cronbach's Alpha	N of Items
0,914	7

Descriptive statistics of combined variables

The 30 related questions of the digital survey were combined in SPSS to obtain the six constructs below, as indicated in Table 7. The dependent variable, the intention to use, is also included in Table 12; there was only one question relating to intention to use in the survey. A Likert scale was used to measure the variances, with 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. Trust has the highest mean of 3,5949, rounded off to 4; performance expectancy has the second highest mean of 3,4263, rounded off to 3; intention to use is third with 3,4100; facilitating condition is fourth with 3,3889, rounded off to 3, which is neither agree nor disagree on the Likert scale. Perceived security followed with a mean of 3,2485, rounded off to 3, being neither agree nor disagree. Social media has a mean of 3,1182, and hedonic motivation has the least mean of 3,0818, which rounds off to 3, which is neither agree nor disagree on the Likert scale.

Multiple regression analysis to determine trust (T)

As per the research model indicated below, trust (T) is both a dependent variable and is integrated into the model as an independent variable. Furthermore, social media (SM) and Perceived security (PS) are the independent variables to determine trust (T); therefore, multiple regression was performed for trust (T).

Statistical acceptance of the model (Trust)

Table 8 illustrates the Analysis of Variance (ANOVA) results indicating that the regression model is acceptable (Aasland, 2008). The data is split into two components regression and residual. The regression row indicates information about the variation accounted for by the regression model, and the residual row indicates the variance not accounted for by the mode (Aasland 2008). The F-ratio measures whether the regression model is a good fit (Laerd statistics 2018). $F(2,195) = 77,05$; $p < 0,05$ indicates that the multiple regression model to determine trust is statistically significant and a good fit.

Table 7: Descriptive statistics of combined variables

Constructs		N	Minimum	Maximum	Mean	Std. Deviation
Social media	SM	198	1	5	3,1182	1,10576
Perceived security	PS	198	1	5	3,2485	0,82626
Trust	T	198	1	5	3,5949	0,91761
Facilitating conditions	FC	198	1	5	3,3889	0,99424
Performance expectancy	PE	198	1	5	3,4263	1,00623
Hedonic motivation	HM	198	1	5	3,0818	0,96158
Intention to adopt m-commerce	IU	198	1	5	3,4100	1,17500

Table 8: ANOVA[a] (Trust)

Model		Sum of Squares	Df	Mean Square	F	Sig,
1	Regression	73,221	2	36,611	77,05	<0,001
	Residual	92,654	195	0,475		
	Total	165,875	197			

a, Dependent Variable: T (Trust)
b, Predictors: (Constant), PS (Perceived Security), SM (Social Media)

Multiple regression analysis to determine the intention to adopt m-commerce platforms

Intention to adopt m-commerce platforms (IU) is the dependent variable with the following independent variables, namely, trust (T), facilitating conditions (FC), performance expectancy (PE), and Hedonic motivation (HM). Multiple regression analysis was used to determine the intention to adopt m-commerce platforms.

Statistical acceptance of the model (Intention to adopt m-commerce platforms

Table 9 illustrates the Analysis of Variance (ANOVA) results, indicating that the regression model is acceptable (Aasland 2008). The data is split into two components regression and residual. The regression row indicates information about the variation accounted for by the regression model, and the residual row indicates the variance not accounted for by the mode (Aasland 2008). The F-ratio measures whether the regression model is a good fit (Laerd statistics 2018). F (4,193) = 49,385; p <0,05 indicates that the multiple regression model to determine trust is statistically significant and a good fit.

Table 9: ANOVA[a] (Intention to adopt m-commerce platforms)

Model		Sum of Squares	Df	Mean Square	F	Sig,
1	Regression	137,513	4	34,378	49,385	<0,001[b]
	Residual	134,351	193	0,696		
	Total	271,864	197			

a. Dependent Variable: Intent to adopt m-commerce platforms (IA)
b. Predictors: (Constant), HM (Hedonic motivation), T (Trust), FC (Facilitation conditions), PE (Performance expectancy)

Hypotheses results

Four hypotheses are supported by the research model as indicated in table 9. H2 and H3 are null hypotheses and accepted by the study. All the hypotheses have positive coefficients (beta's) which indicate that they are moving in the same direction as the dependent variables – Trust (T) and Intention to adopt m-commerce (IA). H2 and H3 are insignificant and null because p> 0.05, and H1a, H1b, H4 and H5 are significant hypotheses.

Table 10: Hypotheses results

Hypothesis number	Regression weights	Coefficients (beta)	Adjusted R^2	P - value	t-value	Hypothesis supported	Hypothesis results
H1a	SM T	0,245	0,436	<0,001	3,715	Accepted	The more a user in South African townships engages in social media, the higher the user's trust (T) of m-commerce in South African townships.
H1b	PS T	0,490	0,436	<0,001	7,419	Accepted	The higher the perceived security (PS), the higher the user's trust (T) of m-commerce in South African townships.
H2	T IA	0,013	0,496	p = 0,847	0,193	Accepted. Null hypothesis	Trust (T) does not affect a user's intention to adopt m-commerce in South African townships (IA).
H3	FC IA	0,157	0,496	p = 0,061	1,887	Accepted. Null hypothesis	Facilitating conditions (FC) does not affect a user's intention to adopt m-commerce in South African townships (IA).
H4	PE IA	0,257	0,496	p = 0,009	2,650	Accepted	The more a user in South African townships perceives the high performance of m-commerce platforms, the more likely they are to adopt and use m-commerce platforms.
H5	HM IA	0,357	0,496	<0,001	4,382	Accepted	The more a user in South African townships is motivated to use m-commerce platforms, the more likely they are to adopt and use m-commerce platforms.

Findings of the study

Based on the analysis results, demographically, half of the research respondents (52%) were female. The younger generation was also the most respondents, with 78% younger than 40%. These results indicate that the younger generation in South African townships is embracing technology advancements, specifically m-commerce adoption.

As per the research model, perceived security and social media were indirect predictors of the intention of South African township residents to adopt m-commerce platforms. However, the research model determined whether they positively affected the trust of the individuals residing in South African townships to adopt m-commerce. Perceived security and social media were found to have a significant, positive effect on the trust of the individuals residing in South African townships to adopt m-commerce. Perceived security is the most significant predictor of trust compared to social media.

The intention of residents in South African townships to adopt m-commerce platforms was tested by determining which of the following factors, namely: trust, facilitating conditions, performance expectancy, and hedonic motivation, affect it. All four factors have a positive effect on the intention of residents in South African townships to adopt m-commerce platforms. Performance expectancy and hedonic motivation were significant predictors of the intention of residents

in South African townships to adopt m-commerce platforms; trust and facilitating conditions were insignificant predictors of the intention of residents in South African townships to adopt m-commerce platforms.

Limitations

This research had the following limitations:

- The digital survey is limited to participants from the two townships, and,
- only certain areas in Soweto and Tembisa were covered due to resource limitations.

Recommendations for future research

The research included only some of the constructs of the UTAUT2 model. Instead, a conceptual research model was developed based on the UTAUT2. The following constructs were excluded: effort expectancy, social influence, price value, and habit. The moderating factors, age, gender, and experience were also excluded due to limited time. The researcher recommends that the full UTAUT2 model be used in the future.

The data collected was quantitatively analysed, which limited the exploration of other factors that affect m-commerce platforms by South African township residents. However, the qualitative method can be used to understand the respondents' characteristics and attitudes. Therefore, the researcher recommends applying a mixed research method, including qualitative and quantitative methods.

References

Aasland, A. (2008). A User Manual for SPSS analysis. *Norwegian Institute for Urban and Regional Research*. Oslo. Available on https://d1wqtxts1xzle7.cloudfront.net/33593628/SPSS_analysis_%281%29-libre.pdf?1398841707=&response-content-disposition=inline%3B+filename%3DA_User_Manual_for_SPSS_Analysis_CNAS_200.pdf&Expires=1732568068&Signature=IcruBadPbs7tuYvYeE1AvCZPz4kKRekgLJGYfqD9asNNeAuJp0zeaFoKXRNwwTPz2bCOSXe-L94bYbfhGuUeHayhA8K9BO0Al8umSGXsXTDisQkY0SHxq-HZoXmxVhuiYcgvC86dvdDlv20OoJQKlv2pI0HMcHnSO~C270ezIJFEPSDgQEJyVt4zRuoxJ~KcbdC3njtT-Gij3VkqW4zR2vswrE3j5tadyPS6TLptkO85FkdifYSj5Wm1Y2YbICxVltAGBNclte8KrlRTvl5aDPz3zupPU4VIsN~RZfoeWIuWbUNMZHwYdFFubtxOI7x2dZ5-SiIWYzvmdkDnKiVF4w__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA [accessed on 25.11.25]

Abdelkarim, A., & Nasereddin, H. (2010). Mobile commerce. *Journal of Mathematics and Technology*, 4(1), pp. 51–56.

Acharya, A.S., Prakash, A., Saxena, P., and Nigam, A. (2013). Sampling: Why and How of it? *Indian Journal of Medical Specialities*, 4(2), pp. 330–333.

Ajzen, I. (1985). *From intentions to actions: A theory of planned behavior*. In Action-control: From cognition to behavior. Heidelberg: Springer.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ, Prentice-Hall.

André Queirós, Daniel Faria, & Fernando Almeida. (2017). Strengths and limitations of qualitative and quantitative research methods. *European Journal of Education Studies*, 3(9), pp. 369–387

Armesh, H., Salarzehi, H., Yaghoobi, N.M., Heydari, A., & Nikbin, D. (2010). The effects of security and privacy information on trust & trustworthiness and loyalty in online marketing in Malaysia. *International Journal of Marketing Studies*, 2(2), pp. 223 -234.

Asastani, H.L., Harisno, Kusumawardhana, V.H., & Warnars, H.L.H.S. (2018). Factors Affecting the Usage of Mobile Commerce using Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT). 2018 *Indonesian Association for Pattern Recognition International Conference (INAPR)*. Available from: https://doi.org/10.1109/inapr.2018.8627003 [accessed on 24/11/24].

Bekmagambetov, A., Wagner, K.M., Gainous, J., Sabitov, Z., Rodionov, A., & Gabdulina, B. (2018). Critical social media information flows: political trust and protest behaviour among Kazakhstani college students. *Central Asian Survey*, 37(4), pp. 526–545.

Bendary, N., and Al-Sahouly, I. (2018). Exploring the extension of unified theory of acceptance and use of technology, UTAUT2, factors effect on perceived usefulness and ease of use on mobile commerce in Egypt. *Journal of Business & Retail Management Research*, 12(02), pp. 60 - 71

Chhonker, M.S., Verma, D., and Kar, A.K. (2017). Review of Technology Adoption frameworks in Mobile Commerce. *Procedia Computer Science*, 122, pp. 888–895.

Cho, D., Kwon, H.J., and Lee, H. (2007). Analysis of Trust in Internet and Mobile Commerce Adoption. *IEEE Xplore*. Available from: https://doi.org/10.1109/HICSS.2007.76 [accessed on: 24/11/24].

Chong, A.Y.-L. (2013). Mobile commerce usage activities: The roles of demographic and motivation variables. *Technological Forecasting and Social Change*, 80(7), pp. 1350–1359.

Corbitt, B.J., Thanasankit, T., and Yi, H. (2003). Trust and e-commerce: a study of consumer perceptions. *Electronic Commerce Research and Applications*, 2(3), pp. 203 – 215.

Cullen, M., & Kabanda, S. K. (2018). The role of demographic and motivational factors on mobile commerce usage activities in South Africa. *SA Journal of Information Management*, 20(1), pp. 1 – 8.

Dakduk, S., Santalla-Banderali, Z., and Siqueira, J.R. (2020). Acceptance of mobile commerce in low-income consumers: evidence from an emerging economy. *Heliyon*, 6(11), e05451.

Davis, J.F.D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results.* Ph.D Thesis. Massachusetts Institute of Technology.

Dzimati, S. and Kekwaletswe, R. (2017). *Acceptance of online shopping by individuals in South African townships*. Ph.D Thesis. University of the Witwatersrand, Faculty of Commerce, Law and Management.

Fisher, M.J., & Marshall, A. P. (2009). Understanding descriptive statistics. *Australian Critical Care*, 22(2), pp. 93–97.

Gan, C. (2017). Understanding WeChat users' liking behavior: An empirical study in China. *Computers in Human Behavior*, 68, pp. 30–39.

Gharaibeh, N., Gharaibeh, M.K., Gharaibeh, O., & Bdour, W. (2020). Exploring intention to adopt mobile commerce: Integrating UTAUT2 with social media. *International Journal of Scientific and Technology Research*, 9(3), pp. 3826–3833.

Hajli, M.N. (2014). A study of the impact of social media on consumers. *International Journal of Market Research*, 56(3), pp. 387–404.

Hossain, S.F.A., Xi, Z., Nurunnabi, M., & Hussain, K. (2020). Ubiquitous Role of Social Networking in Driving M-Commerce: Evaluating the Use of Mobile Phones for Online Shopping and Payment in the Context of Trust. *SAGE Open*, 10(3), 215824402093953.

Laerd statistics. (2018). How to perform a Multiple Regression Analysis in SPSS Statistics. Available from: https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php [date accessed 24/11/24].

Lian, J.-W., and Yen, D.C. (2014). Online shopping drivers and barriers for older adults: Age and gender differences. *Computers in Human Behavior*, 37, pp. 133–143.

Lin, Z., & Theingi, H. (2019). Extended UTAUT2 Model On Factors Influencing Of Mobile Commerce Acceptance In Yangon, Myanmar. *Au-Gsb E-Journal*, 12(2), pp. 3–18.

Louangrath, P. I., & Sutanapong, C. (2015). Descriptive and inferential statistics. *International Journal of Research & Methodology in Social Science*, 1(1), pp. 22 - 35.

Mahajan. S, ed. (2014). Economics of South African townships, special focus on Diepsloot. *World Bank Publications*. Available from: https://books.google.de/books?hl=en&lr=&id=D6c-BAAAQBAJ&oi=fnd&pg=PP1&dq=Economics+of+South+African+townships,+special+focus+on+Diepsloot.+&ots=icxfCE_KZh&sig=cyVlYYlhnnZLq_tR72j3iFQdcJI&redir_esc=y#v=onepage&q=Economics%20of%20South%20African%20townships%2C%20special%20focus%20on%20Diepsloot.&f=false [accessed on 25/11/24].

Mani, V., & Gunasekaran, A. (2018). Four forces of supply chain social sustainability adoption in emerging economies. *International Journal of Production Economics*, 199, pp. 150–161.

McGaffin, R., Napier, M., & Karuri-Sebina, G. (2015). South African Township Economies and Commercial Property Markets. *Urban Landmark*. Available from: http://www.urbanlandmark.org.za/downloads/SACN_ULM_township_economies.pdf [accessed on 24/11/24].

Mhlongo, K., Mtsweni, J. and Modiba, F. (2017). Assessing the diffusion and use of mobile payment solutions: A case of South African townships. In *2017 IST-Africa Week Conference (IST-Africa)*, pp. 1-11.

Mitchell, H. and Odendaal, N. (2015). From the fringes: South Africa's smart township citizens. In: Foth, M., Brynskov, M., Ojala, T. (eds). *Citizen's right to the digital city: Urban interfaces, activism, and placemaking.* Springer, Singapore. https://doi.org/10.1007/978-981-287-919-6_8.pp.137-159.

Nemoto, T. and Beglar, D., 2014, November. Likert-scale questionnaires. In *JALT 2013 conference proceedings*, 108 (1), pp. 1-6.

Özgüven, N. (2011). Analysis of the Relationship Between Perceived Security and Customer Trust and Loyalty in Online Shopping. *Chinese Business Review*, 10(11), pp. 990 – 997.

Pallant, J., (2020). *SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS*. Routledge.

Pelet, J.E., and Papadopoulou, P. (2015). Social media and m-commerce. *International Journal of Internet Marketing and Advertising*, 9(1), pp. 66 - 84.

Rogers, E.M. (2003). Elements of diffusion. *Diffusion of innovations*, 5(1.38), p.453.

Rogerwilco, Marketing Mix, & Survey54. (2022). The *2022 South African Township CX Report*. Available from: https://www.rogerwilco.co.za/sites/default/files/The-2022-South-African-Township-CX-Report-(1).pdf [accessed on 24/11/24].

Salo, J., & Karjaluoto, H. (2007). A conceptual model of trust in the online environment. *Online Information Review*, 31(5), pp. 604–621.

Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students (8th ed.)*. London: Pearson.

Siau, K., Sheng, H., & Nah, F. (2003). *Development of a Framework for Trust in Mobile Commerce.* SIGHCI 2003 Proceedings, pp. 85–89.

Statista. (2022b). *South Africa: cities with the largest population 2022*. Available from: https://www.statista.com/statistics/1127496/largest-cities-in-south-africa/ [accessed on 24/11/24].

Sykes, A. O. (1993). An Introduction to Regression Analysis. *Coase-Sandor Institute for Law & Economics, Working Paper No. 20.* Available from https://chicagounbound.uchicago.edu/law_and_economics/51/ [accessed on 25/11/24].

Taherdoost, H. (2016). Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. *SSRN Electronic Journal*, 5(2), pp. 18–27.

Tiwari, R., & Buse, S. (2007). *The Mobile Commerce Prospects: A Strategic Analysis of Opportunities in the Banking Sector.* Hamburg: Hamburg University Press.

Uyanık, G. K., & Güler, N. (2013). A Study on Multiple Linear Regression Analysis. *Procedia – Social and Behavioral Sciences*, 106(1), pp. 234–240.

Urban, B. and Ndou, B., 2019. Informal entrepreneurship: A focus on South African township entrepreneurs. *Journal of Developmental Entrepreneurship*, 24(04), p.1950021.

Vasileiadis, A. (2014). Security Concerns and Trust in the Adoption of M-Commerce. *Social Technologies*, 4(1), pp. 179–191.

Venkatesh, V., Morris, M., Davis, F.D., & Davis, G.B. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), pp. 425–478.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, 36(1), pp. 157 - 178.

Wu, Y. L., Yang, P. C., & Tao, Y. H. (2007). Using UTAUT to explore the behavior of 3G mobile communication users. 2007 *IEEE International Conference on Industrial Engineering and Engineering Management*, pp. 199–203.

Yang, K., & Forney, J. C. (2013). The moderating role of consumer technology anxiety in mobile shopping adoption: differential effects of facilitating conditions and social influences. *Journal of Electronic Commerce Research*, 14(4), pp. 334 - 347.

Zheng, W., & Jin, L. (2018). A Consumer Decision-Making Model in M-Commerce. *Mobile Commerce*, pp. 107–130.

Zikmund, W.G., 2003. Exploring Marketing Research. Cincinnati, Ohio: Thomson/South-Western Zulkifli, DA, & Aslam, MM (2015). Public acceptance of renewable energy in Malaysia: a NIMBY approach. *Australian Journal of Basic and Applied Sciences*, 9(8), pp.74-81.

Industrial Policy in Post-Apartheid South Africa: An Outlook on Technology and Industrial Policy in the cases of Brazil and South Korea

By Botlhale Modisaotsile

Abstract

South Africa is a country that has experienced premature deindustrialisation due to its inability to move out of middle-income status. The role of industrial policy in South Africa is pivotal to taking the country to greater economic heights and a higher-income status. South Africa's historical context indicates that the country experienced its highest GDP growth rates during the apartheid economy.

Since the demise of apartheid, the post-apartheid economy has experienced poverty and economic inequality that the South African government cannot eradicate. This research addresses the failure of South Africa to overcome premature deindustrialisation, and it discusses the state of the political economy and economic growth in a pre-apartheid and post-apartheid context. The thesis also addressed the significance of industrial policy through the establishment of the Industrial Policy Action Plan (IPAP). The shortcomings and successes of IPAP form a critical part of the research and present an analysis of different economic sectors. This research also assesses the state of industrial policy using two countries as case studies: Brazil and South Korea.

Introduction

This research project will use the political economy framework to analyse industrial policy in post-Apartheid South Africa. Hooks and Crookston (2013) define the political economy as a branch of social sciences that studies the relationship between a nation's population and its government when public policy is enacted. The assessment of the political economy framework is significant because it explains how society behaves when the government acts in their best interests. In the context of South Africa, this thesis will study how government actions and views toward industrial policy have emerged and evolved. The political

economy comprises the following elements: utility, wealth, value, commodity, labour, land, and capital (Jevons 1879). Grasping an understanding of the elements mentioned above is the first step to understanding the political economy. The political economy framework explains how power used by special interest groups enables the creation of rules that measure the balance of rent-seeking goals. The assessment of the South African political economy is essential because 30 years after the dismantling of apartheid, South Africa is still home to poor socioeconomic outcomes for its majority Black population. The overarching goal is to understand why South Africa's industrial policy failed to prevent premature deindustrialisation. The achievement of this goal will be done through a comparative case study analysis of two countries: Brazil and South Korea.

Industrial Policy Theory Framework

The key issue here is that South Africa has failed to prevent premature deindustrialisation in the

post-apartheid era. The assessment of the issue would have to start with the development and growth of South African industrial policy from the start of the twentieth century to the post-apartheid era.

When looking at the start of the twentieth century, South Africa became a state that was about to establish its economy as well as its government.

> "The assessment of the political economy framework is significant because it explains how society behaves when the government acts in their best interests."

From 1910 to 1994, South Africa was divided into four provinces made up of the two former British colonies of the Cape and Natal, and the two former Boer republics of the Transvaal (previously the South African Republic) and Orange Free State (Feinstein 2005). A key highlight of South African industrial policy is the establishment of ESCOM in 1922 through the Electricity Act (Freund 2018). Freund (2018) asserts that the idea behind ESCOM was to make it as independent as possible both from private capital and from any political interest within South Africa. ESCOM distancing itself from private capital and political interest gave it autonomy to become a sole provider of electricity and to contribute to the economy in sectors that require electricity.

Another key highlight of South African industrial policy is the election of the apartheid government in 1948. Ashman and Newman (2013) point out that the election of the Nationalist Party government in 1948 marked the pinnacle of the disjuncture between economic and political power in South Africa.

The apartheid government in South Africa had the power to ensure that the economic and political interests of the country are aligned on the condition that they benefit from these interests. The power dynamics of the apartheid government played a pivotal role in governing the native majority of the South African population. Consequently, the onus was on the apartheid government to inspire economic growth in their political position. Apartheid did not enable South Africa to grow more rapidly than countries that did not have similar low-wage, labour-repressive economies, but neither did it prevent a successful performance (Feinstein 2005).

The economic history of South Africa plays a pivotal role in the research context because it maps out the story of South Africa's economic development and the state of South African industrial policy. Furthermore, industrial policy is integral to the development of any economy, especially if it is well-constructed and strategically implemented. The final highlight of South African industrial policy is the post-apartheid era. The state of the South African economy in the post-apartheid era is equally important as its economic history. Both the past and present of the South African economy

will provide key information on the development of South African industrial policy. According to Ashman and Newman (2013), the new government of 1994 recognised the limitations of Industrial Policy driven by the desire to build up Afrikaner capital and to create employment for white workers. Essentially, the new government of 1994 was left with the task of reconfiguring South African industrial policy that accommodates all South Africans. In terms of key economic policies, the Mandela and Mbeki presidencies generated several policy documents such as the Macroeconomic Research Group (MERG) Report, the New Growth Path (NGP), the National Development Plan (NDP), among others (Francis *et al*. 2022). The journey of generating key policy documents paved the way for the creation of the Industrial Policy Action Plan (IPAP) and the National Industrial Policy Framework (NIPF) in the late 2000s.

Brazil Case Study

The significance of using Brazil as a case study is that it is a developing country with several challenges and successes across its industrial policy formulations and implementations. Furthermore, it is rich in numerous resources and a critical participant in the global economy like South Africa. According to Kharas and Kohli (2011), Brazil is the largest economy in Latin America, accounting for almost 40 per cent of the total GDP. Thanks to its rich resource base, Brazil grew at around 6 per cent for nearly a century (from 1900 onwards). Brazil's economy represents a large part of Latin America's total GDP, and the region's total GDP has continued to thrive based on Brazil's optimal performance. This section of the paper will address the state of import-substitution industrialisation and the protectionist regime of Brazil in the 1950s. This chapter will also discuss the establishment of Embrapa, and how Embrapa has shaped the agricultural sector in the Brazilian economy. This section of the paper will also outline the Brazilian political economy context and the state of Brazilian industrial policy in the 2000s.

Significance of using Brazil as a case study

Brazil's economic performance showed promising and consistent growth, making it one of the best developing economies. "In 1965, it was one of the wealthiest developing countries with a per capita income of $1,700 (in 2007 US dollars); Brazil continued to grow until 1978, when it reached $5,500 per capita, with an average growth of almost 9.5 per cent a year" (Kharas and Kohli 2011, p.283). It is worth noting that the per capita income is an average of how much people earn, and the average is not equally distributed. The growth of per capita income indicates wealth and prosperity for the economy. However, this success was short-lived because the Brazilian economy saw a period of decline, represented by the economy falling into the middle-income trap. "Brazil entered a long period of decline and stagnation. It did not regain its 1978 per capita income until 1995 and then only briefly in the burst of activity that followed the end of hyperinflation and the beginning of stabilisation – it was only with the commodity boom in 2006 that Brazil again surpassed its 1978 income" (Kharas and Kohli 2011, p.283-284).

> "…industrial policy is integral to the development of any economy, especially if it is well-constructed and strategically implemented."

To better understand the Brazilian case study, it is critical to discuss the start of Brazil's development of industrial policy strategies throughout the twentieth century, the 2000s and the early 2010s. Coutinho *et al.* (2012) point out essential six policy instruments that lead to effective Brazilian industrial policy, namely: financing, tax, trade-related measures, public procurement, technical and informational assistance, and regulation.

Import-substitution industrialization and Protectionism

The Brazil case study is prevalent because it addresses the three key structural challenges of

the middle-income technology trap (breaking into, linking up and back, and keeping pace). The main

industrial policy strategy adopted by the Brazilian government between the 1950s and 1970s was based on a protectionist regime structured around ad valorem tariffs (Andreoni and Tregenna 2020). The purpose of this industrial policy strategy was to strengthen the domestic economy. The protectionist mechanism strictly ensures that businesses within the domestic economy are thriving. Protectionism refers to a practice that protects a country's domestic industries from foreign competition through the taxing of imports, thereby boosting the domestic production of goods and services and limiting the presence of foreign goods and services in the market (Corporate Finance Institute 2022). The protectionist regime in the Brazilian economy aimed to advance domestic production, and it is key to note that domestic growth will require more participants (workers) to maintain the standards of the economy. Subsequently, the higher the workforce (the employment rate) is, the greater the GDP will be.

Because Brazil is rich in resources, the focus of the protectionist regime between the 1950s and 1970s considered their resources by implementing the Law of Similarities. The Law of Similarities states that a product can only be imported if it can be proven that a similar product was not produced in Brazil (Andreoni and Tregenna 2020). In terms of the Law of Similarities, Brazil strengthened their protectionist measures and ensured that the Brazilian government effectively executed the industrial policy strategy. As promising as protectionism may be to the vision of the government that implements it, it has its disadvantages. Although protectionism focuses on growing the domestic economy, it excludes the country's domestic economy from competing in the global economy. Protectionism stagnates technological developments because domestic producers are not under pressure from foreign competitors, so there is no incentive to innovate or invest in new product research and development (R&D) (Corporate Finance Institute 2022). Due to the lack of investment in research and development, the economy will fall behind and struggle to keep up with any innovations created in the global economy. Protectionism prioritises growth in the domestic economy, so it is critical to consider how this will negatively impact the public regarding product prices. There will be an increase in product prices due to the lack of competition. Consumers will consequently witness a price increase in a setting where there have been no significant upgrades or improvements in the products produced (Corporate Finance Institute 2022).

In the late 1950s, the government launched two institutions in the country to promote higher education and provide scholarships to students, namely: CAPES, a ministerial agency for coordination and human capital improvement, and FINEP, an agency set up to finance university studies and various academic projects (Czarnecka-Gallas 2013). In context to this statement, these institutions aimed to develop Brazil socially, politically and economically through the promotion and accessibility of education. In the medium-term to long term, the educational initiative invested in enhancing industrial policy in Brazil. From 1960 to 1980, the government intensified the Law of Similarities within an ISI strategy, which developed and diversified the domestic production system (Andreoni and Tregenna 2020). The goal of the ISI strategy - as a mechanism of protectionism - was to grow the economy independently with little to no reliance on other countries. Behind most policy directions, two elements are always present: the promotion of the competitiveness of firms and the defence of jobs in national economies (Ferraz et al., 2014). In this context, the purpose of the ISI strategy is to protect local enterprises and the domestic market against foreign competition and [simultaneously] enable domestic firms to learn, implement innovations and increase their international competitiveness (Czarnecka-Gallas 2013).

During this protectionist regime, the Brazilian government was responsible for creating state-owned enterprises to further enhance the economy on top of educating (and improving the lives of) the public. According to Andreoni and Tregenna (2020), a number of state-owned enterprises were developed in strategic manufacturing sectors. These companies and organisations serve as Brazil's pillars of the industrial and financial system, namely: the Brazilian Development Bank [BNDES] (1952), Petrobras (1953), Usiminas (1956), Eletrobras (1962)

> Today, Brazil is among the top-performing producers and exporters of orange juice, sugar, coffee, soya beans, beef, pork and chicken, as well as has caught up with the traditional big five grain exporters, namely: the United States of America, Canada, Australia, Argentina and the European Union *(Andreoni and Tregenna, 2018; Andreoni and Tregenna 2020).*

and Embraer (1969). Although these companies are influential to the Brazilian economy, they did not receive enough exposure to the global economy due to the implementation of the ISI strategy. The lack of strategic export-promotion methods did not allow Brazil to link up to global value chains to the same extent as China (Andreoni and Tregenna 2020). On the other hand, import substitution catered for diversification and the significant development of specific local production system linkages, but domestic companies fell behind in keeping pace with technological change (Andreoni and Tregenna 2020).

The case of Embrapa

After the protectionist regime, Brazil looked to take its trade measures and industrial policy strategies to greater heights. However, the economy faced a critical challenge that negatively impacted the government's plans. Andreoni and Tregenna (2018, p.28) state that the debt crisis during the 1980s and 1990s forced the Brazilian government to reduce its industrial policy interventions in favour of structural adjustment programs (SAPs) and macroeconomic stabilisation. Brazil has ascended in the production and trade of goods after the protectionist regime. The onus was on the Brazilian government to recognise what sectors work best in the economy and which firms contribute beneficially to the overall state of the economy.

Today, Brazil is among the top-performing producers and exporters of orange juice, sugar, coffee, soya beans, beef, pork and chicken, as well as has caught up with the traditional big five grain exporters, namely: the United States of America, Canada, Australia, Argentina and the European Union (Andreoni and Tregenna, 2018; Andreoni and Tregenna 2020). Consequently, Brazil began to solidify their status as a global participant over the years and improve the productivity of the aforementioned goods to ensure that its current account balance is in great form. According to Andreoni and Tregenna (2020), a network of intermediate institutes called Embrapa was at the centre of the Brazilian government's transformative policy package. This network fostered technological change and innovation, diversification and upgrading in agricultural farming (Andreoni and Tregenna 2020). The origin of Embrapa is integral to the research because it is considered an influential institution under the scope of industrial policy and institutional innovation. According to Alves (2010), Embrapa is a classic case of successful innovation that has main characteristics in its current form: a public corporation model of organisation, the scale of operation at a national level, spatial decentralisation, specialisation of research units, enhanced training and human resource remuneration, and a vision centred on agriculture, science and technology. Embrapa's structures in enhancing education and the development of distinct industrial sectors are vital because they understand what challenges they face as an institution and as a roleplayer of the Brazilian economy.

One of the core priorities for Embrapa was the modernisation of the agricultural sector and how best to improve it as a significant contributor to the

Brazilian economy. Embrapa, however, focused on environmental sectors that were not just limited to the agricultural sector. During its first decades, Embrapa created a network of national commodity centres and regional centres that focused on major cropping and animal production systems and eco-regional and national themes (Andreoni and Tregenna 2020). When assessing the agricultural sector, it is critical to recognise it as a sector essential to human living because it provides food that serves as a basic need for the public. Food prices were kept artificially low to avoid pressure on urban salaries (Alves and Pastore 1978; Baer 2008; Gremaud et al. 2004; Martha Jr and Alves 2018). Given the fact that Brazil kept food prices low, it meant that the consumers would benefit greatly in satisfying their basic needs. Low food prices also allow consumers to spend money elsewhere other than on food. On the other hand, firms would have to rely on high volumes of consumers buying their food products to ensure they see real profits. The foundation of Embrapa was inspired by the vision of growing the Brazilian economy using a holistic approach.

In the late 1960s, Brazilian policymakers realised that the strategy to increase food supply by expanding cultivated areas and adopting practices of limited technological content should be revised (Martha Jr et al. 2012, p.207). In this case, labour, capital, and land need to have a positive correlation to ensure the growth and efficiency of the sector, and the relevant technologies need to be used to promote productivity amongst the aforementioned factors of production. In 1972, Embrapa was founded as a response to the main weaknesses of the National Agricultural Research and Experiment Department (DNPEA), where the focus was on the main agricultural commodities and regions, experiment stations and existing projects (Andreoni and Tregenna 2018). In essence, addressing these weaknesses opened an opportunity for the government to be more knowledgeable about the agricultural sector, identify gaps in the different factors of production, and provide the necessary research to enhance the sector. This direct approach would lead to a higher total factor productivity for the agricultural sector. Total factor productivity (TFP) measures describe the relationship between output in real terms and the inputs involved in its production (Bureau of Labour Statistics 2022). The TFP is designed to measure the joint influences of technological change, efficiency improvements, returns to scale, reallocation of resources, and other factors on economic growth, allowing for the effects of capital and labour (Bureau of Labour Statistics 2022).

Embrapa's involvement in the agricultural sector provided a developmental approach to growing the economy, thus laying a foundation for the sector to expand its resources and use them to keep up with technological trends within and outside the country. Embrapa realised its growth as an institution with the government's support. According to Alves (2010), in the early years of Embrapa's establishment, the federal government understood the importance of technology for the development of agriculture. The government's relationship with the media was pivotal to Embrapa's success. The media had a crucial role in creating Embrapa's image. The media not only operates on top of achievements but also upon a consistent promise, if it is not for long (Alves 2010). The media's involvement applied indirect pressure on the government to ensure that Embrapa became a success. Since Embrapa focused heavily on agriculture, the organisation prioritised the needs of the farmers. The support from farmers, their different associations, and the media helped Embrapa cultivate a favourable image in the eyes of both the public and the government (Martha Jr and Alves 2018). It is worth noting that the government made a significant investment in Embrapa to realise its objectives and contribution to Brazilian industrial policy. Between 1974 and 1985, the government made considerable investments in infrastructure, operational costs, and personnel training – the enormous investments were around 17.2 billion Brazilian real (Martha Jr and Alves 2018). The government's support in the following decades would be consistent with maintaining the positive relationship between the farmers, the agricultural sector at large, Embrapa and the public. According to Martha Jr and Alves (2018), government support averaged 980 million Brazilian real in the 1970s, 1.9 billion Brazilian real in the 1980s, 2.21 billion Brazilian real in the 1990s, and 2.46 Brazilian real from the first decade of the 2000s. The significant expenditure since the establishment of Embrapa indicates the government's willingness to grow the industrial policy aspect of the economy and to advance technologies within Embrapa.

South Korea Case Study

Korea's history is significant to the research conducted because Korea is a developed country with an advanced economy. The Korean government had a focused analysis of what constitutes industrial policy. Considering this context, Itoh *et al*. (1988) define industrial policy as a set of policies designed to develop selected industries to increase the welfare of the country and achieve dynamic comparative advantages for these industries by using state apparatus in resource allocation. Essentially, the focus is on how sectors compete across countries - for example, the Korean services sector competing with the Chinese services sector. The competition between sectors also encourages growth and promotes industrial development, enhancing the economy domestically and internationally.

Significance of South Korean Case Study

In one specific case, the Korean government incorporated a financial element within the Korean industrial policy, an industrial-financial policy. Akkemik (2008) defines Korean industrial-financial policy as a core model that evaluates the supply-side, demand-side, international sector, and price normalisation. The industrial-financial policy aims to ensure that the optimal performance of sectors is complemented by rigid financial decision-making. The next point of focus is human development. An economy cannot exist without human capital, and its highly educated human capital represents the success of the Korean economy. "Thanks to the strong growth of school enrollments, the educational attainments of the labour force increased remarkably from 1945 to 1960; by the early 1960s, Korea already had a substantial stock of human resources" (Lee 2007, p.6). A vital driving force behind the consistent economic success of Korea is human capital with highly educated backgrounds. Korea's human capital blends in emphatically with its rigid industrial policy and government intervention.

According to Harvie and Lee (2003), the GDP per capita stood at 78 US dollars in 1960; in 1965, the GDP per capita was 105 US dollars; in 1970, it was 248 US dollars; in 1975, 598 US dollars; and in 1979, it was 1,649 US dollars. Based on the GDP per capita growth, it is clear to see the positive impact of

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(Lee 2007, p.6).

industrial policy decisions in Korea. There was also a negative impact on unemployment because it decreased as GDP per capita increased. According to Harvie and Lee (2003), the unemployment rate stood at 11.7 per cent in 1960; in 1965, it was 7.4 per cent; in 1970, it was 4.5 per cent; in 1975, it was 4.1 per cent; and in 1979, it was 3.8 per cent. The GDP per capita and the unemployment rate of the Korean economy are significant reflections of Korean citizens benefiting from the decisions of their government. The significant drop in the unemployment rate meant that human capital became the heart of the economy and that Korean households would be able to live in better conditions due to employment and remuneration.

Formation of chaebol in Korea

The successful industrial policy story of the Korean political economy experienced organisations that looked to benefit from Korea's economic success; these organisations are *chaebols*. A *chaebol* is a group of prominent business enterprises

“*Chaebols* are organisations that contribute to the economy significantly by attracting foreign capital and generating revenue through exports.”

comprising several corporations (Chang, 1988). In Korea, from 1960 onwards, the government promoted large conglomerates named *chaebol* (Akkemik 2008). *Chaebols* are organisations that contribute to the economy significantly by attracting foreign capital and generating revenue through exports. In Korea, production activities in the new high-technology industries were concentrated in the *chaebol*, which had a large production capacity. They were, therefore, the main competitors of American high-technology producers (Akkemik 2008). In context to this statement, chaebols are businesses that generate profits and compete healthily against other businesses around the globe. A prime example of a *chaebol* is Samsung, which produces smartphones and tablets. In sum, *chaebols* pursue their profits and are incentivised to bring foreign capital in and be responsible for a portion of the country's economic growth. The goal of discussing Korean industrial policy was to highlight the approaches to establishing successful industrialisation and a cohesive relationship between large conglomerates and the government.

Historical context of the chaebol

The origin of the *chaebol* is one that was unique to the Korean economy. The *chaebol* is portrayed as an organisation created and managed by the state for national interests, with Korean President Park Chung Hee sitting on top as the Chief Executive Officer (CEO) (Baik *et al*. 2011). The purpose of the *chaebol* was for them to act as businesses and pursue the government's interests as well – this was done through a rigid partnership. Although the *chaebol's* purpose was to generate revenue, the partnership between them and the state was beneficial through the implementation of economic policy. Bearing this in mind, the vision of Korean President Park Chung Hee (henceforth Park) is vital to the study because of his close involvement with the *chaebol* in the political and economic matters of the country. The military coup of 1961 aimed to make the country independent from imports and, consequently, from foreign powers (Schneidewind 2016). In order to achieve these goals, a strong export industry needed to be built up, President Park and his regime depended on the financially strong and powerfully managed *chaebol* (Schneidewind 2016). As long as the *chaebol* accepted the general direction of the economic policy and refrained from getting entangled in partisan politics, President Park let the *chaebol* be the CEOs of Korean economic development (Kim and Park 2011). Consequently, President Park let the *chaebol* be in terms of their operations, but he was vocal and paternalistic in his interventions. Moreover, the *chaebol* would have to operate on his terms and in line with the economic policies that the government outlined. In the early 1960s, President Park's objective was to get the *chaebol* to collaborate on state-formulated industrial projects through an asymmetric exchange of political support and risk-taking between the state and the *chaebol* (Kim and Park 2011). In terms of the chaebol's risk-taking to generate revenue, the onus was on the Korean government to reassure the *chaebol* that they would be supported if the risks failed. In essence, the risks that would fail or not materialise as expected would require some form of monetary support for the *chaebol* to fall back on. According to Baik *et al*. (2011), President Park centralised power in the Economic Planning Board (EPB) and used it to encourage the *chaebol* to take risks in return for his political support.

Under the oversight of President Park, the EPB provided strategies for the government to ensure that the *chaebol* realised their productivity growth and growth as significant economic contributors. According to Kim (1992), the dominance of the EPB arose because the Ministry of Finance managed critical state resources; was internally centralised; occupied a privileged position in personnel recruitment; and had capable state agencies as

allies. Moreover, President Park also nationalised all commercial banks intending to control the sources of capital (Kim and Park 2011).

The nationalisation of commercial banks led to the government taking advantage of achieving industrial policy objectives. Commercial banks would lose the autonomy they would have because the government's decision-making processes largely influence their interests. Consequently, banks became an instrument through which the state could secure business compliance with the goals of industrial policy and macroeconomic planning (Baik *et al*. 2011). The bank nationalisation was significant because President Park could synergise industrial policy objectives with political power. At the heart of economic policymaking in Korea is the central coordination by the Deputy Prime Minister (DPM), who also serves as the Minister of the EPB and the President's top economic advisor (Choi 1987). The EPB gave financial direction in building an economic bureaucracy at the forefront of Korean economic development and policymaking.

The development and growth of the *chaebol*

A key point in the development of the *chaebol* was its partnership with the state and its unwavering support from an institutionally autonomous EPB. However, the success of the *chaebol* extended beyond the state-*chaebol* partnership and the EPB. *Chaebol* groups have been operating on the values of the Korean management system where relationships of family, alumni, region, and the state are critically important (Chang 1988). These core values proved vital when the *chaebol* participated in the global economy. Many Korean *chaebols* adopt specific tactics, such as gaining advantageous new family ties through marriage, to secure their existence and to maintain the family's dominance in management (Lee *et al*. 1991).

The rigid operation of *chaebols* allowed President Park to use them efficiently for improving sectoral performance and manufacturing products that would be sold to the public and exported to the participants of the global economy. The successful generation of rents led to the *chaebol* being able to generate more revenue and expand their businesses further. In the mid-1960s, the *chaebol* lived as exporters in a competitive world of global markets. They remained accountable to President Park as the state-designed vehicles for building a "rich nation, strong army" (Kim and Park 2011). In their role assigned to them as trading companies, the *chaebol* were the government's way of decentralising its administration of export incentives and undertaking the activities needed to strengthen Korea's export marketing capabilities (Westphal 1990). The presence of *chaebols* in the Korean economy motivated exports to increase due to their productive and innovative abilities. Baik *et al*. (2011) assert that the *chaebol* came to be the source of major innovative policy and the construction of special export zones and industrial complexes to launch Japanese-style general trading companies. When assessing major indicators of the Korean economy, a period of consistent growth inspired Korea's rapid industrialisation. According to Harvie and Lee (2003), exports in 1960 were at 33 million US dollars; in 1965, exports were at 175 million US dollars, and exports grew all the way to 4.5 billion US dollars consistently in 1974. The growth of exports reflected positively in the current account and led to enhanced growth of the Korean GDP. The GDP in 1960 stood at 2 billion US dollars; in 1965, GDP stood at 3 billion US dollars, and from there, the GDP grew consistently to 18.8 billion US dollars in 1974 (Harvie and Lee 2003).

The South African Case of Industrial Policy

The emergence of the South African economy represented the growth of a developmental state. The 1868 discovery of diamonds near Kimberley, followed by an 1886 gold boom in the Witwatersrand hills near Johannesburg and the exploitation of the coalfields of Witbank and Vryheid, sparked the birth of South Africa's industrial revolution (Majozi and Veldhuizen 2015). In 1902, the English and the Afrikaners ended the second Anglo-Boer War by signing the Treaty of Vereeniging. "The treaty of Vereeniging brought the war to an end on the 31st of May 1902, when the guns of war became silent; the treaty promised the vanquished Boers civil institutions and ultimately self-government, and it held out the prospect of constitutional reform for the White inhabitants within the two Crown colonies" (Devenish 2011, p.109). The Treaty of Vereeniging opened economic and political opportunities for the English and the Afrikaners.

The creation of economic and political control was at the expense of the native African people. According to Devenish (2011), Africans and other people of colour were left out of constitutional reform based on conciliation between British and Dutch South Africans. In context to the statement made by Devenish, the Treaty of Vereeniging strengthened the English and the Afrikaners' interests. This treaty consolidated the white political and economic elite pursuing their interests. The white people established their supremacy over the native Africans, Indians and Coloureds - however, this only occurred after resistance from the different tribes within the country (Lipton 1986). According to Swirzer (1993), the history of the Ciskei is a microcosm of South African history because the Xhosa resistance against white rule in the Ciskei was a representation of other tribes' resistance to white rule in other regions. The political power of the English and the Afrikaners meant that the rest of the South African population had no effective political representation in Parliament. The South African economy was set to grow based on the English and the Afrikaners working as a collective based on constitutional reform. They worked on establishing different sectors in the new South African state and exercised their political and economic power. The foundation of apartheid originates in legislative and customary measures of all the colonies/republics [the Cape, Natal, Transvaal and the Orange Free State], which formed the Union of South Africa in 1910 (Lipton 1986).

In 1907, representatives of most of the Transvaal coal mines established the Transvaal Coal Owners' Association (TCOA), which agreed on production quotas and a fixed price for coal (Alexander 2007). The establishment of a fixed coal price simply meant that buyers, sellers and investors can meet each other's needs in terms of business regarding coal. After 1910, there was a great increase in the demand for coal by power stations, as industries, mines and households were quick to appreciate the advantages of electricity (Jones and Muller, 2016). The establishments of the Electricity Supply Commission (ESCOM) in 1923 and Iron and Steel Corporation in 1928 were part of South Africa's road to industrialisation. Feinstein (2005) asserts that ESCOM and ISCOR were designed to exploit South Africa's resources of coal and iron ore. The discovery of coal played a pivotal role in the generation of electricity, and it also became the heart of both diamond and gold mining.

> "The 1868 discovery of diamonds near Kimberley, followed by an 1886 gold boom in the Witwatersrand hills near Johannesburg and the exploitation of the coalfields of Witbank and Vryheid, sparked the birth of South Africa's industrial revolution *(Majozi and Veldhuizen 2015).*"

A key highlight of South African industrial policy is the election of the apartheid government in 1948. Ashman and Newman (2013) point out that the election of the Nationalist Party government in 1948 marked the pinnacle of the disjuncture between economic and political power in South Africa. The apartheid government in South Africa had the power to ensure that the economic and political interests of the country are aligned on the condition that they benefit from these interests. The power dynamics of the apartheid government played a pivotal role in governing the native majority of the South African population. Consequently, the onus was on the apartheid government to inspire economic growth in their political position. Apartheid did not enable South Africa to grow more rapidly than countries that did not have similar low-wage, labour-repressive economies, but neither did it prevent a successful performance (Feinstein, 2005).

Coal mining was also a key contributor to the establishment of the South African Coal, Oil and Gas Corporation (SASOL). One of the government's most important projects was its support for SASOL, a major new public corporation formed in 1950 to convert coal into gas, and then gas into petrol, diesel, and other liquid products (Feinstein 2005). SASOL had to make its mark as a new public corporation because it relied on innovation to grow its economy. According to Barnard and Bromfield (2009), SASOL was the only firm using Fischer-Tropsch technology [converting fuel from gas and coal] in South Africa during the 1950s, and there was no need to develop mechanisms to share knowledge within the country. With the successful establishment of SASOL, coal became a critical resource for South Africa's industrial production. While SASOL may have been established as part of the effort to shift industrial development in the country away from its emphasis on the mining industry, its coal mining practices remained firmly rooted (Sparks 2012). In 1957, coal contributed 1.44 million British pounds to South African exports, which is low in comparison to gold [217 million British pounds], diamonds [30.68 million British pounds] and asbestos [10.95 million British pounds] (van Rhijn 1959). The fortunes of coal, however, took a positive turn in 1960 when there was an increase in coal production. In 1960, coal production stood at 38 million metric tons, which represented money sales of 27.5 million British pounds (Jones and Muller 2016).

Post-apartheid analysis of the South African economy and its industrial policy

The 1994 elections marked the start of a new dawn for all South African citizens. Economically, the new democracy did not meet expectations. South Africa has achieved stable economic growth since 1994, accelerating to 5 per cent in 2005 and 2006 (DTI 2007). Unfortunately, economic growth has been destabilised from 2007 onwards, reaching more lows than highs. In 2007, South Africa's economic growth went from 5.4 per cent to 3.2 per cent in 2008. In 2009, SA's economic growth took a further decline to -1.5 per cent and remained in the range of 3 to 0 per cent from 2010 to 2019 (World Bank 2022). In closing, SA's economic growth has shown little promise in the last decade. Consequently, it is pertinent for the research to find the shortcomings of the IPAP and investigate why the economy has not been growing - like how it has grown modestly from 1994 to 2006 - in recent times. The 1994 democratic elections marked the end of the apartheid, which meant that ESKOM had a compulsory duty, as a SOE, to ensure that there was electricity for all people of South Africa. The generation of electricity in South Africa could not have been possible without the abundant supply of coal. With regards to electricity supply, the government signalled from the late 1990s that ESKOM (formerly known as ESCOM) should not invest in new generation capacity as private-sector investment would be facilitated. In the 21st century, ESKOM continued to rely on large coal plants, even as new technologies became both cheaper and more flexible; it allowed the new investors in the coal mines to retain a higher share of the rents (Makgetla 2022).

A key matter to assess in the context of South African industrial policy is the Industrial Policy Action Plan. In essence, the South African government established the Industrial Policy Action Plan (IPAP) to improve the state of South African industrial policy. "South Africa's Industrial Policy Action Plan (IPAP) recognises the country's industrial financing incentive packages needed to be competitive in respect of their accessibility, costs, and conditions, to attract foreign direct investment" (DTI 2018, p.71). The IPAP aims to grow the South African economy on the condition that the plans put on paper are practised. The 2012 IPAP has presented key successes that benefited the South African economy. The manufacturing sector has delivered on most of its objectives within the IPAP. Davies (2021) asserts that the manufacturing sector recorded successes directly from the IPAP programs. These successes include:

1. Investments reached a total of 25.7 billion rands in the automotive sector, supporting around 300,000 jobs, with the APDP to embrace bus bodies, medium and heavy vehicles and minibus taxis.
2. The retention of 67,000 jobs and the creation of 7,000 new jobs in the clothing, textile, footwear and leather industries had lost 45,000 jobs between 2000 and 2010. The Clothing and Textile Competitiveness Programme provided government support to the clothing and textile sector to participate in competitiveness-raising initiatives.

3. Fundamental advances in metals fabrication industries, driven by a combination of infrastructure spending and localisation programs.
4. Significant investments in the agro-processing, household consumer goods, television manufacturing and pharmaceutical sectors, among others.
5. The film rebate programme supports a fourfold increase in the value of film productions.

The following constraints hold back the IPAP: lack of policy coherence and programme alignment, the concentration of ownership and control, high private sector input costs and electricity (DTI 2018). In context to this statement, these constraints must be challenged for industrial policy to flourish. Here, the reader can think of a sector's performance from the IPAP. For example, one can consider the automotive sector's performance based on the 2018 IPAP. In the context of the 2018 IPAP, the automotive sector remains a sector that can influence the economy positively in terms of industrialisation and improving the strength of its GVCs through GVC upgrading. The automotive sector contributes 33 per cent to the manufacturing GDP and about 6 per cent to the overall GDP, and it produces approximately 600,000 vehicles per year, thus creating 113,000 jobs (DTI 2018). As stated earlier, the automotive sector is export oriented. Therefore, the impact of exports plays a role in whether this sector is doing well globally. Exports in this sector (2018) are valued at 171 billion Rand (DTI 2018). The automotive sector has experienced a rapid increase in exports, with its share of manufactured exports increasing from 4.3 per cent in 1995 to over 20 per cent in 2019 (Black 2022). Exports have doubled in this period, which has also seen 45 billion Rands worth of investment by most of the world's leading global vehicle manufacturers – Mercedes-Benz, Toyota, BMW, Ford, and Isuzu, among others (DTI 2018).

Although the automotive sector has grown significantly in exports, the sector has produced high import penetration ratios in the last fifty years. Kennedy and Thirlwall (1979) define an import penetration ratio as a ratio of imports to domestic output. According to Black (2022), the import penetration ratios for motor vehicles stood as follows: 32 per cent in 1972, 24.2 per cent in 1990 and 65.1 per cent in 2016. Consequently, an import penetration ratio of 65.1 per cent means that imports are quite high for motor vehicles and, therefore, pose a threat to South Africa's competitiveness in the global economy. This perspective is also reflected in the manufacturing sector, where the current account is negatively impacted. Although the exports of manufactures have increased at a pedestrian pace, the rapid increase in import penetration coupled with modest export growth has led to the manufacturing sector recording a 300 billion Rand trade deficit in 2017 (Black 2022; DTI 2018). In sum, the automotive sector needs to use its resources better and enhance its GVCs if it wishes to be a mainstay in the list of South Africa's top sectors.

South Africa's manufacturing employs 320,000 fewer people than in 2008; this decline in manufacturing employment arises not only because of the slow growth rate of output but also because the number of jobs per unit of output needs to be higher (Kaplan 2019). The slow growth rate of manufacturing output makes matters challenging for the economy because manufacturing was a significant contributor to the GDP during the twentieth century. In sharp contrast to the IPAP, which envisaged a growing manufacturing share, the manufacturing share of GDP has fallen from 16 per cent to below 12 per cent (Kaplan 2019). The fall of the manufacturing share indicates that the strategies built within IPAP needed to be more stable to ensure manufacturing would prosper. South Africa's manufactured exports have grown far more slowly than its peers, and South Africa's manufactured exports are well below the country's potential (Kaplan 2019). Additionally, manufactured export growth has made it difficult for the manufacturing sector to show any signs of growth. The lack of growth in the manufacturing sector begs the question: why has industrial policy planning failed to counteract manufacturing

"South Africa's manufacturing employs 320,000 fewer people than in 2008..."

performance? The objectives and targets set out in the IPAP do not match the manufacturing sector's performance, so it is safe to conclude that the policy requires a rigorous review.

Premature deindustrialisation and the middle-income trap have become critical defining concepts of South Africa's unequal economy. South Africa has been unable to move out of middle-income status despite the efforts of the IPAP to turn the economy. Thus, the attempt to overcome the middle-income trap has not come to fruition. Structural adjustment programs have been introduced to take middle-income countries to higher heights in economic growth, but they have left the beneficiaries in large amounts of debt. In terms of the middle-income technology trap, South Africa has suffered from three structural challenges that have kept them from preventing premature deindustrialisation: breaking into globally concentrated industrial production; linking up with global value chains while linking back with local production systems; and keeping pace with technological change (Andreoni and Tregenna 2020).

Role of the Fourth Industrial Revolution (4IR) in overcoming the middle-income trap

The role of the Fourth Industrial Revolution (4IR) in overcoming the middle-income trap is crucial for South African industrial policy. The 4IR is the current and developing environment in which changing technologies and trends such as the Internet of Things (IoT) and Artificial Intelligence (AI) are changing the way we live and work (Kayembe and Nel 2019). The 4IR is a confluence of cyber, physical and biological technologies (Marwala 2022). 4IR is viewed as the revolutionary change that takes place when ICT thrives in all industries – primary, secondary, and tertiary (Lee *et al*., 2018). Consequently, the advent of the 4IR promises significant social and economic opportunities and challenges which demand that governments respond appropriately in supporting society transformation (Manda and Ben Dhaou 2019).

The context of South African industrial policy is one that can use 4IR to stimulate sectoral performance in various sectors such as renewable energy, manufacturing, tech manufacturing, power, information and communication technology, and education amongst others. Despite 4IR's capabilities to drive economic growth and foster innovation, there is a fear that 4IR may work against the society in terms of economic opportunities. Marwala (2022) asserts that 4IR will lead to talent shortages because many people do not have the required skills to adapt to the disruptions in industries, mass unemployment, and growing inequality. In the context of this statement, it would be beneficial for people to learn about the capabilities of 4IR and to learn more about IoT and AI to upskill themselves. The upskilling of human capital in the context of 4IR would drive industrial policy to optimal levels but the implementation of 4IR is not limited to people skills. The implementation of 4IR is fundamental for the growth of economic sectors where technology can catalyze productivity and efficiency in various economic sectors. According to Gastrow (2020), the purpose of a 4IR policy that is focused on a nation is to harness the power of new technologies towards the achievement of South Africa's developmental ambitions. 4IR is characterized as a global infrastructure for the information society that is enabling advanced services by interconnecting physical and virtual things based on existing and evolving interoperable information and communication technologies (Lee *et al*. 2018). In 2019, South Africa was ranked 67th out of 140 developing economies, where the manufacturing sector was the 3rd-worst performing sector in the first quarter of 2019 because its GDP share fell to 8.8% after recording performance of 12% in 2015 and 13% in 2016 respectively (Bayode *et al*. 2019). Consequently, South African sectors, such as manufacturing, that can be driven by 4IR-based technology are highly likely to compete with other sectors in global markets.

What can be done differently for South African industrial policy?

The South African government should consider being firm, direct, and detailed in reducing unemployment and poverty or increasing any major indicator (for example, the manufacturing share of the GDP). This approach can include a detailed key action plan or framework that has steps that the government can refer to if the approach is not successfully executed.

The IPAP should be reformulated to have a framework that will address the structural challenges of the middle-income technology trap. The IPAP should have a strategy that discusses how best innovation within the scope of the Fourth Industrial Revolution can be implemented in the South African economy.

References

Akkemik, K. A. (2008). *Industrial development in east asia: a comparative look at japan, korea, taiwan and singapore (With Cd-rom) Vol. 3*. Turkey: World Scientific.

Alexander, P. (1999). Coal, control and class experience in South Africa's Rand revolt of 1922. *Comparative Studies of South Asia, Africa and the Middle East*, 19(1), pp.31-45.

Alves, E.R., and Pastore, A.C. (1978). Import substitution and implicit taxation of agriculture in Brazil. *American Journal of Agricultural Economics*, pp. 865-871.

Alves, E.D.A. (2010). Embrapa: a successful case of institutional innovation. Área de Informação da Sede-Artigo em periódico indexado (ALICE). 19, pp. 64-72.

Andreoni, A. and Tregenna, F. (2018). Stuck in the middle: South Africa in the new global industrial landscape. Industrial Development Think Tank Policy Briefing Paper 11 [online]. Available from: https://www.competition.org.za/ccred-blog-structural-transformation/2020/4/20/stuck-in-the-middle-south-africa-in-the-new-global-industrial-landscape [Accessed: 3 October 2023].

Andreoni, A. and Tregenna, F. (2020). Escaping the middle-income technology trap: A comparative analysis of industrial policies in China, Brazil and South Africa. *Structural Change and Economic Dynamics*, 54, pp.324-340.

Ashman, S. and Newman, S. (2013). Industrial policy and South Africa's economic trajectory: from apartheid to present day., unpublished paper presented at: *UNU-Wider: Conference on learning to compete: Industrial Development and Policy in Africa*. Helsinki, 24-25 June 2013.

Baik, C.J., Domínguez, J.I., Hong, S.G., Im, H.B., Jun, B.J., Kim, E.M., Kim, H.A., Han, Y.S., Kim J.H., Kim T. & Hutchcroft, P.D. (2011). *The Park Chung Hee era: the transformation of South Korea*. Cambridge, Ma: Harvard University Press.

Barnard, H. and Bromfield, T. (2009). The development and management of an intellectual property strategy in a developing country context: The case of Sasol. *The Economics of Intellectual Property in South Africa*, 84.

Bayode, A., Van Der Poll, J.A. and Ramphal, R.R. (2019). 4th industrial revolution: Challenges and opportunities in the South African context. *Conference on Science, Engineering and Waste Management (SETWM-19)*, pp. 174-180.

Black, A. (2022). Industrial policy in South Africa. In: Oqubay, A., Tregenna, F., and Valodia, I., eds. *The Oxford Handbook of the South African Economy*. Oxford Academic.

Bureau of Labour Statistics (2022). Total Factor Productivity - 2021. *Bureau of Labour Statistics* [online]. Available from: https://www.bls.gov/news.release/pdf/prod3.pdf [accessed: 12 November 2022].

Chang, C.S. (1988). Chaebol: The South Korean Conglomerates. *Business Horizons*, 31(2), pp.51-57.

Choi, B.S. (1987). The structure of the economic policy-making institutions in Korea and the strategic role of the Economic Planning Board (EPB). *Korean Journal of Policy Studies.*

Corporate Finance Institute (2022). What is Protectionism?. *Corporate Finance Institute* [online]. Available from: https://corporatefinanceinstitute.com/resources/economics/protectionism/ [accessed: 4 November 2022]

Czarnecka-Gallas, M. (2013). The efficiency of industrial policy in 21st century? The case of Brazil. *Gospodarka Narodowa. The Polish Journal of Economics*, 265(7-8), pp. 5-35.

Davies, R. (2021). *Towards a new deal: A political economy of the times of my life*. Jonathan Ball Publishers.

Devenish, G.E. (2011). The South African Act revisited some constitutional and political reflections on lessons learnt from the centenary of the Union of South Africa in 1910. *Obiter*, 32(1), pp. 108-125.

Department of Trade and Industry and Competition 2007 (2007). *Industrial Policy Action Plan 2007/08-2009/10* [online]. Available from: indpolactionplan3aug20070.pdf [Accessed: 3 October 2023].

Department of Trade and Industry and Competition 2018 (2018). *Industrial Policy Action Plan 2018/19-2020/21* [online]. Available from: publication-IPAP1.pdf [Accessed: 3 October 2023].

Feinstein, C.H. (2005). *An economic history of South Africa: Conquest, discrimination, and development*. Cambridge University Press.

Ferraz, J.C., Kupfer, D. and Marques, F.S. (2014). Industrial policy as an effective development tool: Lessons from Brazil. *Transforming Economies*, pp.291-305.

Francis, D., Habib, A. and Valodia, I. (2022). South Africa's post-apartheid economic development trajectory. *The Oxford Handbook of the South African Economy*, pp.91-110.

Freund, B. (2018). *Twentieth-century South Africa: a developmental history.* Cambridge: Cambridge University Press.

Gastrow, M. (2020). Policy options for the fourth industrial revolution in South Africa. *HSRC*.

Gremaud, A.P., Vasconcellos, M.A.S.D., and Toneto JR, R. (2004). *Economia brasileira contemporânea*. 5th edition, Sao Paulo: Editora Atlas.

Harvie, C., and Lee, H.H. (2003). Export-led industrialisation and growth: Korea's economic miracle, 1962–1989. *Australian Economic History Review*, 43(3), pp. 256-286.

Itoh, M., Kiyono, K., Okuno-Fujiwara, M., and Suzumura, K. (1988). *Sangyou Seisaku no Keizai Bunseki* (Economic Analysis of Industrial Policy), Japan: Tokyo University Press (in Japanese).

Jevons, W. S. (1879). *The theory of political economy*. Macmillan and Company.

Jones, H.S. and Muller, A. (2016). *The South African Economy, 1910–90*. Springer.

Kaplan, D. (2019). South Africa's Industrial Policy: Time for a Review and a Rethink.

Kayembe, C. and Nel, D. (2019). Challenges and opportunities for education in the Fourth Industrial Revolution. *African Journal of Public Affairs,* 11(3), pp. 79-94.

Kennedy, C. and Thirlwall, A. P. (1979). Import Penetration, Export Performance and Harrod's Trade Multiplier. *Oxford Economic Papers*, 31(2), pp. 303–323.

Kharas, H. & Kohli, H. (2011). What is the middle-income trap, why do countries fall into it, and how can it be avoided? *Global Journal of Emerging Market Economies*, 3(3), 281-289.

Kim, E.M. and Park, G.S. (2011). Chapter Nine. The Chaebol. In: Kim, B.Y. and Vogel, E.F. eds. *The Park Chung Hee Era.* Cambridge, Ma: Harvard University Press, pp.265-294.

Lee, J.W. (2007). Economic growth and human development in the Republic of Korea, 1945-1992. *Reconstruction, 1945*, 61.

Lee, S.M., Yoo, S. and Lee, T.M. (1991). Korean chaebols: Corporate values and strategies. *Organizational Dynamics*, 19(4), pp. 36-50.

Lee, M., Yun, J.H.J, Pyka, A., Won, D., Kodama, F., Schiuma, G., Park, H., Jeon, J., Park, K., Jung, K., Yan, M., Lee, S., Zhao, X. (2018). How to respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation*, 4(21), pp.1–24

Lipton, M. (1986). *Capitalism and apartheid: South Africa, 1910-1986.* New Africa Books.

Makgetla, N. (2022). Mining and Minerals in South Africa. *The Oxford Handbook of the South African Economy*, 261.

Manda, M.I., and Ben Dhaou, S. (2019). Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. In: *Proceedings of the 12th international conference on theory and practice of electronic governance 3-5 April, Melbourne,* (pp. 244-253).

Martha JR., B.G. and Alves, E. (2018). Brazil's agricultural modernization and Embrapa. In Amann, E., Azzoni, C.R., and Werner Baer, W. *The Oxford Handbook of the Brazilian Economy*. Oxford University Press, pp. 309-337.

Martha JR, B.G., Contini, E. and Alves, E. (2012). Embrapa: its origins and changes. *The regional impact of national policies: the case of Brazil*, 204.

Schneidewind, D.K. (2016). *Economic miracle market South Korea*. Singapore: Springer.

Sparks, S. (2012). Apartheid Modern: South Africa's oil-from-coal project and the making of a company town' [unpublished]. DPhil dissertation, University of Michigan.

Switzer, L. (1993). *Power and resistance in an African society: The Ciskei Xhosa and the making of South Africa*. University of Wisconsin Press.

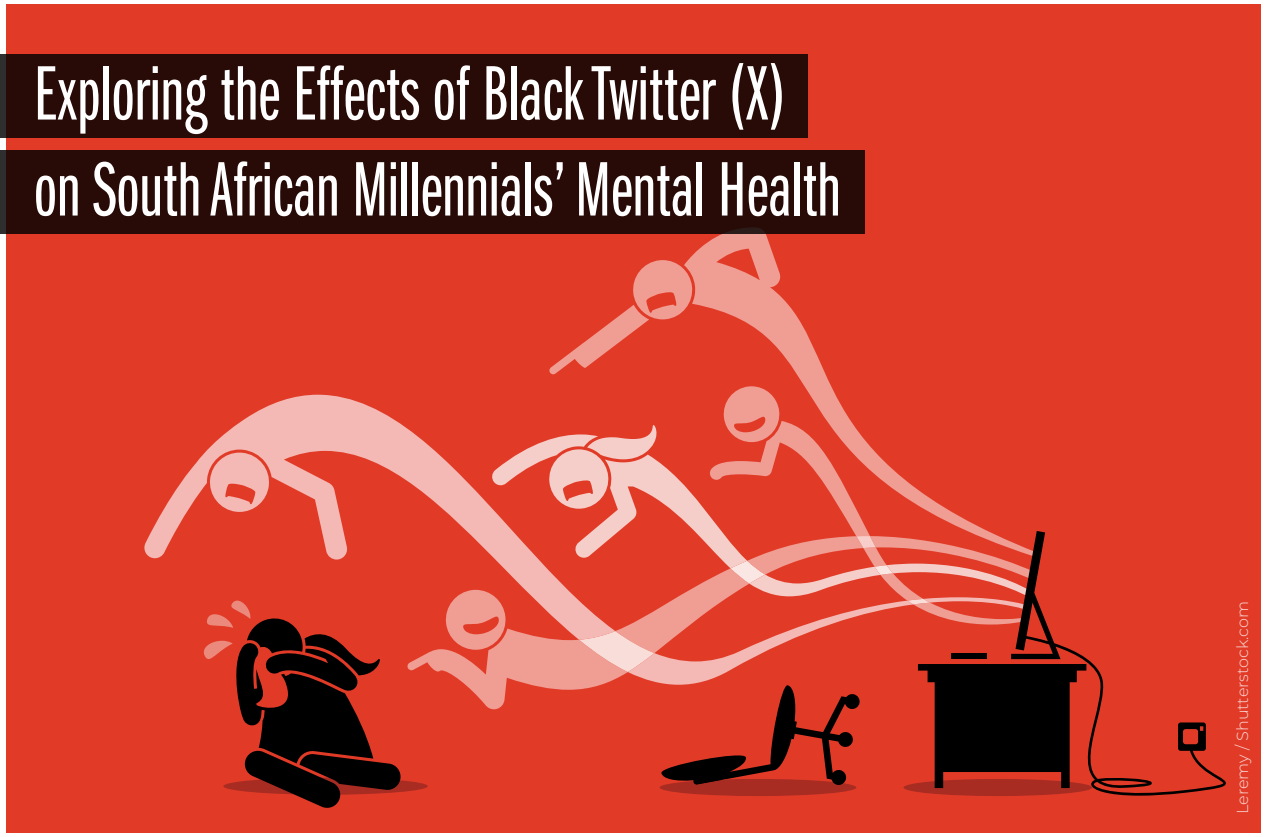
Van Rhijn, A.J.R. (1959). The Importance of the South African Mining Industry. African Affairs, 58(232), pp. 229–237.

Westphal, L.E. (1990). Industrial policy in an export-propelled economy: lessons from South

Korea's experience. *Journal of Economic perspectives*, 4(3), pp.41-59.

World Bank, (2022). South Africa: Economic Indicators. *World Bank Group* [online]. Available from: https://data.worldbank.org/country/south-africa?view=chart [accessed 27 June 2022].

Exploring the Effects of Black Twitter (X) on South African Millennials' Mental Health



By Seriane Morapeli and Tshegofatso Ratale

Abstract

This study qualitatively explored the perceptions of black South African millennials about the effects of Black Twitter (X) on their mental health. In-depth semi-structured interviews were conducted with black South African millennials who actively interact on Black Twitter (X). The data was analysed using thematic analysis. Participants had positive and negative perceptions of the influence of Black Twitter (X) on their mental health. Participants identified Black Twitter (X) as a convenient source of information and a form of escapism but the prevalence of trolling and hateful content causes anxiety and depression. The effect of Black Twitter (X) on black South African millennials' mental health is complex. It can provide a supportive community, inspire activism, and increase awareness of vital issues. However, it does present challenges, such as the possibility of cyberbullying and negative interactions. Recognising these dynamics is essential to maximise advantages and minimise potentially damaging disadvantages.

Introduction

This article aims to explore the effects of Black Twitter (X) on black South African millennials' mental health. In recent years, there has been an increase in recorded suicide deaths as a result of cyberbullying globally (Luxton *et al.* 2012; Schonfeld et al. 2023; Mohd Fadhli *et al.* 2022) however, the increase in such tragedies by black South African millennial celebrities, in 2022, raised concerns about the effect of social media platforms on the mental health of South African users (Mwareya 2022). The subsequent depression caused by cyberbullying was highlighted as a cause of suicide (Luxton et al. 2012), and agreeably the frequency of depression among South Africans has shown an upward trend (Xulu 2022). Studies by Craig et al. (2022), Ardington, and Case (2010) elaborate that anxiety, childhood trauma and

> The subsequent depression caused by cyberbullying was highlighted as a cause of suicide *(Luxton et al. 2012).*

adversity, socioeconomic status, and demographic characteristics affect the mental health of South Africans. However, in addition to these factors, the characteristics of social media platforms, such as 24/7 social connectedness, anonymity, and the far-reach of rich and uncensored content, can enable fake news and cyberbullying (Olweus 2012; Luxton *et al.* 2012), which can affect mental health. Cyberbullying, in particular, has grown dramatically over the past few years, following the COVID-19 pandemic, and it has created many new victims and bullies (Olweus 2012; Kee *et al.* 2022). Whittaker and Kowalski (2014) explain that because of the growing popularity of social media platforms like Twitter (X), cyberbullying has become more widespread and popular among perpetrators. Of concern is that the effects of social media on mental health may be prevalent because social media is ingrained in people's daily lives (Ramalepe 2023), including millennials, who spend a significant portion of their day on one or more social media platforms. Millennials, also known as Generation Y, are aged between 28 and 43 years (Wandhe 2024), they are more active on social media than other generations, including Generation Z (Ramalepe 2023), with Twitter (X) being one of the most preferred social media platforms (Whittaker and Kowalski 2014). A survey by Statista South Africa conducted in 2021, reported that approximately 40.5% of Twitter (X) users were millennials, comprising 23.2% of the population (Nirmala & Fathima, 2019). Black Twitter (X), especially, garners great engagement among South African millennials who are predominantly black Africans (Cowling 2023). The meaning of Black Twitter (X) is a bit ambiguous however, it can be identified as a collective of black identities and voices on Twitter (X) who interact in a collective and culturally-specific dialogue (Cowling 2023). The language patterns, comic phrases, and cultural references found on Black Twitter (X) are well recognized and celebrated for their distinctiveness within black communities globally, creating support communities (Cowling 2023; Goolam 2019). These elements often reflect the lived experiences and perspectives of individuals within the black community (Molefe and Ngcongo 2021). Parham (2021) correctly states that Black Twitter (X) is "both news and analysis, call and response, judge and jury - a comedy showcase, therapy session, and family cookout all in one". The discourse frequently involves using hashtags that are sustained for an extended duration, exerting influence on mass media, public opinion, cultural dynamics, and individuals' mental health. Goolam (2021) elaborates that Black Twitter (X) fosters an environment where no individual is exempt from scrutiny, and no kind of wit is left unfiltered, which makes it rife with negative interactions, online harassment, and cyberbullying. Thus, humiliating, stereotypical, controversial, and divisive memes, hashtags, images, and videos about people, most often celebrities, generate lasting conversations on Black Twitter (X).

Notwithstanding, Black Twitter is used as a tool for activism whereby individuals and groups rally around issues affecting black communities such as #BlackLivesMatter or #UKnowUrBlackWhen (Molefe and Ngcongo 2012; Parham 2021). South African millennials are described by Noah (2018) as advocates for social change who hope to rectify the injustices of the divisive, unequal and oppressive wrongs of the former South African Apartheid regime. Although there is a growing body of research about the influence of social media on mental health globally (Luxton *et al.* 2012; Karim *et al.* 2020; Beyari 2023; Masiphephe network, 2023), most studies focus on children and adolescents. There is a lack of studies exploring the effects of Black Twitter (X) on South African millennials' mental health. Therefore the significance of this study lies in its potential to contribute to the body knowledge about this phenomenon, while also offering recommendations on how to effectively

> “…Black Twitter is used as a tool for activism whereby individuals and groups rally around issues affecting black communities…”

mitigate the adverse effects of Black Twitter (X) on the mental well-being of millennials.

Theoretical Framework: The Social Identity Theory

Theoretically, the social identity theory is a classic social psychological theory proposed in 1970 by Tajfel and Turner. The theory was developed to explain how individuals define their own identities based on social groups they belong to, and that these identifications function to improve and protect the group's identity (Tajfel and Turner 1979). Therefore, the identity of the group becomes more important than the identity of the individual. Turner, Hogg, Oakes, Reicher and Wetherell (1987) further explain that the protection of the group's identity occurs to the extent that there is in-group favouritism and out-group discrimination. The theory aimed to explain the cognitive processes that lead individuals to make in-group and out-group classifications using three key principles: social categorisation, social identification and social comparison.

Social categorisation

The first process explains the process through which individuals are organised in social groups that assist with understanding the social world. In this process, individuals are defined on the basis of the social categories in contrast to their individual features (Islam 2014). Although individuals can belong to different social categories in different situations, there are three main social categories: race, sex and class (Bodenhausen *et al*. 2012). Social categorisation generally occurs when there are similarities between individuals in the same group and differences between individuals in another group (Islam 2014).

Social identification

The second process is identifying as a group member and behaving according to the group norms (Turner et al. 1987). Relational reinforcement and social participation are important for the development of emotional attachment in the group (Paxton and Moody 2003).

Social comparison

The third process involves members of an in-group comparing themselves with members of an out-group based on prestige or social standing (Islam 2014). Thus a positive perception of an individual's in-group compared to an out-group often develops a positive social identity; however, failure of the group to have this outlook, is likely to result in the members abandoning the group for another with prestige (Smith 1999).

Applied to this study, Black Twitter (X) has created a social identity for black identities who have grouped themselves based on race and experiences. Within this online social group, black identities reinforce the group identity by comparison, sharing relational content, and opposing ideas that are unfavourable to the group, often to the extent that groupthink occurs, whereby individuals consent without critical reasoning (Wilkins 2019). Parham (2021) highlights that the black identities on Black Twitter (X) are not one homogenous group based on a similar race and black experience, he notes that black identities group themselves based on countries of origin, tribes and regions. Interactions are thus governed by these factors, whereby for instance, the issues that black South African IsiZulu users promote are often different from those promoted by Northern Sotho users. Thus out-groups are stereotyped and experience what Reynolds, Turner and Haslam (2000) term out-group degradation. However, the degradation is also experienced by in-group members who oppose the dominantly supported content, likely leading to cyberbullying, affecting mental health. In such cases, degrading language is often used to the out-group members to emphasise their exclusion from the in-group, often this is to the extent that the user will delete their Twitter (X) account, or as was the case with South

African celebrities, result in depression or suicide (Bopape 2023; Ndongeni-Ntlebi 2023). However, as previously noted, the perceptions about the effects of Black Twitter (X) on South African millennials have not been explored, hence the significance of this article.

Method

The study was conducted following a phenomenological research methodology, which employed a qualitative research technique. This methodology was most suitable because it enabled the participants to provide in-depth insights about the *what* and *how* of their subjective lived experiences about the effects of Black Twitter (X) on South African millennials' mental health (Teherani *et al.* 2015).

Participant and recruitment sampling

The researcher employed a non-probability purposive sampling technique to carefully select eight South African millennials aged between 28 to 43 years old who avidly interact on Black Twitter and as such are most susceptible to the effects of Black Twitter (X) on their mental health. Ramalepe (2023), Whittaker and Kowalski (2014) and Ramalepe (2023) noted that millennials are more active on social media than other generations, including Generation Z, and Twitter (X) is the most preferred social media platforms. The intentional selection of a limited sample size is a defining feature of qualitative research, since it allows the researcher to collect comprehensive and detailed perspectives from participants who have been purposefully chosen (Showkat 2017). After obtaining ethics permission, the researchers contacted the participants over email. The email included an information sheet that included details about the goal and procedures of the research. Additionally, the participants were asked to provide their informed consent as a means of ensuring ethical protection.

Data collection

The use of semi-structured interviews allowed both the researchers and study participants the opportunity to flexibly delve into the inquiries and responses (DeJonckheere and Vaughn 2019). During the interviews, the researchers probed the research participants about the effects of Black Twitter (X) on their mental health. The researchers videotaped and transcribed the interviews in order to facilitate data analysis.

Ethics

In order to adhere to ethical guidelines, the researcher was obliged to seek first authorisation from the University of Johannesburg, Faculty of Humanities. Following this, the project received ethics approval from the Research Ethics Committee of the Faculty of Humanities at the University of Johannesburg prior to its initiation. The researcher informed the participants that their participation in the study was completely voluntary. The rights of the participants were deliberated about prior to the commencement of the interviews. Each participant provided their consent for the interviews to be recorded. Before conducting the interviews, the researcher underscored the need to maintain anonymity and confidentiality, assuring participants that their personal information would not be identifiable or connected to their responses. In order to preserve the confidentiality of individuals, pseudonyms were used in the transcriptions. Furthermore, the participants were duly informed of their right to discontinue their involvement in the study at any point without facing any adverse consequences, and were assured that their data would be promptly erased. Due to the sensitive nature of the study, exploring mental health, it was made clear in the informed consent form that participants can decline participating in the study or refuse to answer uncomfortable questions (Silverio *et al.* 2022).

> "...Black Twitter (X) has created a social identity for black identities who have grouped themselves based on race and experiences."

Trustworthiness

In order to ensure the correctness and rigour of research findings, it is imperative to establish credibility, transferability, dependability, and confirmability. To enable the inclusion of a diverse and complete range of participants' experiences, the study prioritised the legitimacy of these experiences and their accurate representation (Stahl and King 2017). The researchers engaged in a process of iterative cross-validation, comparing the identified themes with the raw, transcribed data. This ensured that the themes and subthemes accurately represented the replies provided by the participants. Transferability pertains to the extent to which the findings of the present study may be extrapolated to different contexts and populations under investigation (Stahl and King 2017). The researchers provided a comprehensive account of the research methodology and included a description of the study participants to provide a contextual background for the current study, acknowledging the limitations in generalising research findings when using qualitative and interpretive methodologies. The concept of confirmability pertains to the extent to which the findings and interpretations of research accurately represent the experiences and viewpoints of the participants (Adler 2022). The researchers relied on a detailed audit trail to ensure accuracy and avoid researcher misinterpretation.

Data Analysis

The process of examining and interpreting data in order to uncover patterns, relationships, and insights is commonly referred to as data analysis. The findings were interpreted using a thematic analysis approach based on the three-step model proposed by Miles and Huberman (1994), which involves data reduction, data presentation, and conclusion drafting and verification.

Findings 1: Community of Support

The majority of millennials from black communities identified Black Twitter (X) as providing a sense of community and support. They shared that it can be used to connect with others who share similar experiences, obstacles, and passions. *"I want to call it a safe haven; a safe haven for black people"*. Two participants revealed that interacting on Black Twitter (X) reduces the fear of missing out (FOMO) by keeping one up-to-date with the latest news and entertainment that often take time to be shared on mainstream media, or are omitted by mainstream media. Engaging with this community can improve psychological health by reducing feelings of isolation through information sharing. Thus despite the online nature of this community, the opportunity to be part of a community engaging about similar experiences of black identities can establish human connections based on openness and relatability, that are important for mental well-being.

Findings 2: Activism

Black Twitter (X) is renowned for bringing attention to social justice, political and socio-economic issues from the perspective of black communities. One research participant shared that *"I wrote a tweet saying that women complain about men killing them in South Africa but they kill men too. I might be quoting it incorrectly, but then it obviously got more attention than my usual tweets because people are very sensitive"*. Engaging in these discussions can create a sense of social responsibility and activism in millennials, which can be empowering and advantageous to their mental health. However, the amplification of voices can be exclusive, marginalising some groups in black communities. Another research participant shared *"I'm an observer, so I never participate in anything...I've seen what it does to people. So you just avoid it"*.

Findings 3: Cyberbullying

Black Twitter (X) is rife with negative interactions, online harassment and trolling which can greatly harm mental health. The information overload about the opinions and lifestyle choices of others can create feelings of inadequacy in millennials. *"It's a lot of comparisons; people compare themselves to other people and they usually feel like they are not worthy; and that's what kills our mental health"*. Another participant disclosed that *"Black Twitter is a place where people say the meanest things that they can think of; that they would never say in person, but on Twitter they feel like because they are behind the screen, they can get away with it"*. Such interactions can cause distress, anxiety, sadness or lead to suicidal thoughts.

Discussion

Analysis of the semi-structured interviews revealed that Black Twitter (X) has positive and negative effects on the mental health of black South African millennials. The online community of support Black Twitter (X) grants millennials in the black community enables them to share their voices and engage on matters that are often neglected or briefly covered in mainstream media. This sense of freedom is beneficial to the mental health of black South African millennials who feel they can be part of conversations that add meaning or understanding to their lives without the gatekeeping and restrictions of mainstream media. For instance, Parham (2021) noted that to obtain censored videos or in-depth insights about trending topics, Black Twitter (X) in contrast to other social media platforms, provides swift reporting. Moreover, the opportunity to converse in different conversations, affords millennials an opportunity to influence attitudes and behaviour, especially since South African millennials desire to rectify the injustices of the oppressive Apartheid system their parents were part of (Noah 2018). Through the use of hashtags that can become viral and sustained for long periods of time, millennials can become online activists for change, creating an inclusive online community. However, as argued by Dratwa (2023), divisive hashtags pertaining to patriotism and advancing specific goals exclusively beneficial to native millennials can marginalise other black identities in the interactions. The lasting hashtag #PutSouthAfricansFirst, is indicative of the divisive nature of Black Twitter (X) in South Africa. At the core of the hashtag is to promote patriotism in South Africa, and protect the rights and experiences of South Africans (Bezuidenhout 2020) however, the hashtag is often dominated by offensive and marginalising content about other black identities residing in South Africa (Dratwa 2023). Of concern, is that the excluded black identities are from other African countries, excluding African American black identities. This indicates that perceived prestige or association with a high economic status is considered a qualifying factor for an in-group. The out-group discrimination characterised by divisive content creates and sustains stereotypes about other black identities in both the online and offline sphere that affects the mental health of the victims (Tao and Fisher 2022).

This in-group and out-group phenomena highlights that Black Twitter (X) is not as *unified* as displayed because black identities categorise, identify and compare their identities depending on their countries of origin, experiences, tribes, and regions. This questions the true nature of *community* in this online space. In agreement, one participant stated that they engage passively on Black Twitter (X) due to fear of being *politically incorrect*.

Although Twitter (X) has measures in place to reduce hateful content, in the form of reporting, post removals, reducing post visibility, restricting engagement, downgrading post replies, and suspending accounts (X 2024). This appears to be insufficient because online harassment and trolling continue to dominate the online platform.

Furthermore, the obsession to be popular, and part of the trending list on Black Twitter (X), has created an online culture whereby people share content that is hateful and harmful in order to be validated by online communities, aligning with the social comparison principle of the social identity theory. This has negative effects on the mental health of millennials, particularly pertaining to perceptions about achievement (Elsayed 2021), connectedness and integration. This is aggravated by the constant comparison that occurs on social media whereby millennials have reported that they aspire to more affluent, successful characters and lifestyles online (Elsayed 2021). These often distorted perceptions that can be reinforced by challenging lived experiences such as childhood trauma and adversity, socioeconomic status, often experienced by black South African millennials can cause depression (Craig *et al*. 2022; Ardington and Case 2010).

There is a need to have more dialogue about the consequences of interaction on Black Twitter (X), and how it shapes the mental health of millennials. It is through this interaction that solutions can be proposed on how these negative issues can be mitigated, and more reflexive decision-making can be encouraged to actively avoid posting and interacting with hateful content. More especially because even though Twitter (X) has measures to reduce abuse and harassment on the platform, the measures are limited and insufficient to restrict hateful content. Moreover, lessons about digital

literacy, emphasising the respectful use of social media, for children and adolescents can also prove beneficial to avoid the negative effects of social media on mental health.

Conclusion

The findings of the current study suggest that the effect of Black Twitter (X) on the mental health of black South African millennials revealed both positive and negative effects. Black Twitter (X) provides a forum for black millennials to express their concerns, particularly regarding neglected issues in mainstream media, which improves their mental health by granting them the freedom to address injustices. However, divisive hashtags and exclusive objectives can result in the marginalisation of some black identities; and online harassment, resulting in mental health problems for them. In addition, the desire for online notoriety can lead to the dissemination of hateful content and unrealistic aspirations, contributing to negative perceptions of achievement and mental health issues, particularly among black South African millennials who have endured difficult life circumstances. It is thus crucial for online communities to support a variety of voices and promote connectivity and integration. Future research is needed to examine how black South African millennials can engage in inclusive dialogue about the negative effects of Black Twitter (X) on their mental health.

References

Adler, R.H. (2022). Trustworthiness in qualitative research. *Journal of Human Lactation* [online], 38(4), pp. 598-602. Available from: DOI: 10.1177/08903344221116620 [accessed 29 September 2024].

Ardington, C. and Case, A. (2010). Interactions between mental health and socioeconomic status in the South African national income dynamics study. *Tydskr Stud Ekon Ekon* [online], 1;34(3), pp.69-85. Available from: http://hdl.handle.net/10520/EJC21506 [accessed 29 September 2024].

Bezuidenhout, J. (2020). @uLerato_pillay: how the xenophobic network around #putsouthafricafirst was born and then metastasised. *Daily Maverick* [online]. Available from: https://www.dailymaverick.co.za/article/2020-08-18-ulerato_pillay-how-the-xenophobic-network-around-putsouthafricafirst-was-born-and-then-metastasised/ [29 September 2024].

Bodenhausen, G.V., Kang, S.K. and Peery, D. (2012). Social categorization and the perception of social groups. *The Sage Handbook of Social Cognition* [online], pp.318-336. Available from: DOI: 10.4135/9781446247631.n16 [accessed 29 September 2024].

Bopape, O. (2023). Msaki takes a break from the spotlight to focus on herself – 'please release me'. *Soccer News Lifestyle 24* [online]. Available from: https://www.snl24.com/drum/celebs/news/msaki-takes-a-break-from-the-spotlight-to-focus-on-herself-please-release-me-20230123 [accessed 29 September 2024].

Beyari, H. (2023). The relationship between social media and the increase in mental health problems. *International Journal of Environmental Research and Public Health* [online], 29;20(3), pp.2383. Available from: DOI: 10.3390/ijerph20032383 [accessed 29 September 2024].

Cowling, N. (2023). Distribution of Twitter users in South Africa 2021, by age. *Statista* [online]. Available from: https://www.statista.com/statistics/1341547/distribution-of-twitter-users-in-south-africa-by-age/ [accessed 29 September 2024].

Craig, A., Rochat, T., Naicker, S.N., Mapanga, W., Mtintsilana, A., Dlamini, S.N., Ware, L.J., Du Toit, J., Draper, C.E., Richter, L. and Norris, S.A. (2022). The prevalence of probable depression and probable anxiety, and associations with adverse childhood experiences and socio-demographics: A national survey in South Africa. *Frontiers in Public Health*, 28(10), pp. 1-13. Available from: DOI: 10.3389/fpubh.2022.986531 [accessed 29 September 2024].

DeJonckheere, M. and Vaughn, L.M. (2019). Semi-structured interviewing in primary care research: a balance of relationship and rigour. *Family Medicine and Community Health* [online], 7. Available from: DOI: 10.1136/fmch-2018-000057 [accessed 29 September 2024].

Dratwa, B. (2023). 'Put South Africans First': Making sense of an emerging South African xenophobic (online)

community. *Journal of Southern African Studies* [online], 49(1), pp. 85-103. Available from: DOI: 10.1080/03057070.2023.2170126 [accessed 29 September 2024].

Elsayed, W. (2021). The negative effects of social media on the social identity of adolescents from the perspective of social work. *Heliyon*, 21;7(2). Available from: DOI: 10.1016/j.heliyon.2021.e06327 [accessed 29 September 2024].

Goolam, Z. (2019). Hilarity and humanity: Black Twitter in South Africa. *Biz Community* [online]. Available from: https://www.bizcommunity.com/Article/196/669/194517.html [accessed 29 September 2024].

Islam, G. (2014). Social identity theory. In: Teo, T., ed. *Encyclopedia of Critical Psychology* [online]. New York: Springer. Available from: https://doi.org/10.1007/978-1-4614-5583-7_289 [accessed 29 September 2024].

Karim, F., Oyewande, A.A., Abdalla, L.F., Chaudhry Ehsanullah, R. and Khan, S. (2020). Social media use and its connection to mental health: A systematic review. *Cureus* [online], 15;12(6). Available from: DOI: 10.7759/cureus.8627 [accessed 29 September 2024].

Kee, D. M. H., Al-Anesi, M. A. L. and Al-Anesi, S. A. L. (2022). Cyberbullying on social media under the influence of COVID-19. *Global Business and Organizational Excellence* [online], 41(6), pp. 11–22. Available from: https://doi.org/10.1002/joe.22175 [accessed 29 September 2024].

Luxton, D. D., June, J. D., and Fairall, J. M. (2012). Social media and suicide: a public health perspective. *American Journal of Public Health* [online], 102 Suppl 2(Suppl 2):S195-200. Available from:DOI: 10.2105/AJPH.2011.300608 [accessed 29 September 2024].

Masiphephe network. (2023). *The impact of cyberbullying in South Africa. Maiphephe Network* [online]. Available from: https://www.masiphephe.org.za/wp-content/uploads/2023/05/3.-Thematic-paper-cyber-bullying-in-SA_FINAL.pdf [accessed 29 September 2024].

Miles, M. and Huberman, M. (1994). *Qualitative data analysis*. Second Edition. United States of America: Sage Publications.

Mohd Fadhli, S.A., Liew Suet Yan, J., Ab Halim, A.S., Ab Razak, A., and Ab Rahman, A. (2022). Finding the link between cyberbullying and suicidal behaviour among adolescents in Peninsular Malaysia. *Healthcare (Basel, Switzerland)* [online], 10(5), pp. 856. Available from: https://doi.org/10.3390/healthcare10050856 [accessed 29 September 2024].

Parham, J. (2021). A people's history of Black Twitter, part I. *Wired* [online]. Available from: https://www.wired.com/story/black-twitter-oral-history-part-i-coming-together/ [accessed 29 September 2024].

Molefe, M. and Ngcongo, M. (2021). "You don't mess with Black Twitter!": An Ubuntu approach to understanding "militant" Twitter discourse. *Communicatio* [online], 47; 3, pp.26-49. Available from: DOI: 10.1080/02500167.2021.2001553 [accessed 29 September 2024].

Mwareya., R. (2022). South African celebrities are taking their lives over Twitter. *Paste Magazine* [online]. Available from: https://www.pastemagazine.com/tech/twitter/south-africa-twitter-social-media-mental-health [accessed 29 September 2024].

Ndongeni-Ntlebi, V. (2023). Hours after Riky Rick's passing, fans concerned about Black Coffee's 'mental state'. *IOL* [online]. Available from: https://www.iol.co.za/lifestyle/health/mind/hours-after-riky-ricks-passing-fans-concerned-about-black-coffees-mental-state-afc05f69-fc66-4910-b5d3-222ec0cf8942 [accessed 29 September 2024].

Nirmala, M. and Fathima, S. (2019). Preference of social media among millennials. *Think India Journal*, 22 (14), pp. 5736-5744. Available from: https://thinkindiaquarterly.org/index.php/think-india/article/view/14171 [accessed 29 September 2024].

Noah, T. (2018). Trevor Noah: Why millennials give me hope for the future. *Time* [online]. Available from: https://time.com/5087341/trevor-noah-optimist/ [accessed 29 September 2024].

Olweus, D. (2012). Cyberbullying: An overrated phenomenon? *European Journal of Developmental Psychology* [online], 9(5), pp.520–538. Available from: DOI:10.1080/17405629.2012.682358 [accessed 29 September 2024].

Paxton, P., and Moody, J. (2003). Structure and sentiment: explaining emotional attachment to group. *Social Psychology Quarterly*, 66(1), pp. Available from: 34–47. https://doi.org/10.2307/3090139 [accessed 29 September 2024].

Ramalepe, P. (2023). Millennials are more active on social media than Gen Zs and other generations – report. *News24* [online]. Available from: https://www.news24.com/news24/tech-and-trends/news/millennials-are-more-active-on-social-media-than-gen-zs-and-other-generations-report-20230813 [accessed 29 September 2024].

Reynolds, K.J., Turner, J.C., and Haslam, S.A. (2000). When are we better than them and they are worse than us? A closer look at social discrimination in positive and negative domains. *Journal of Personality and Social Psychology* [online], 78(1), pp. 64–80. Available from: DOI: 10.1037//0022-3514.78.1.64 [accessed 29 September 2024].

Schonfeld, A., McNiel, D., Toyoshima, T. and Binder, R. (2023). Cyberbullying and Adolescent Suicide. *Journal of the American Academy of Psychiatry and the Law Online* [online]. 51(1), pp. 1-8. Available from: DOI: 10.29158/JAAPL.220078-22 [accessed 29 September 2024].

Showkat, N. and Parveen, H. (2017). Non-probability and probability sampling. *Open Journal of Business and Management*. 9(4).

Silverio, S.A., Sheen, K.S., Bramante, A., Knighting, K., Koops, T.U.,

Montgomery, E., November, L., Soulsby, L.K., Stevenson, J. H., Watkins, M., Easter, A. and Sandall, J. (2022). Sensitive, challenging, and difficult topics: Experiences and practical considerations for qualitative researchers. *International Journal of Qualitative Methods* [online], 21. Available from: https://doi.org/10.1177/16094069221124739 [accessed 29 September 2024].

Smith, E.R. (1999). Affective and cognitive implications of a group becoming part of the self: New models of prejudice and of the self-concept. In Abrams, D. and Hogg, M.A., eds. *Social identity and social cognition.* Oxford, England: Basil Blackwell, pp.183-196.

Stahl, N. and King, J. (2020). Expanding approaches for research: Understanding and using trustworthiness in qualitative research. *International Journal of Development Education* [online], 44:pp. 26-28. Available from: http://www.jstor.org/stable/45381095 [accessed 29 September 2024].

Tajfel, H., and Turner, J.C. (1979). An integrative theory of inter-group conflict. In Austin, W. G. and Worchel, S., eds. *The social psychology of inter-group relations*. Monterey, CA: Brooks/Cole, pp.33-47.

Tajfel, H. (1978). The achievement of inter-group differentiation. In Tajfel, H., ed. *Differentiation between social groups* London: Academic Press, pp.77-100.

Tao, X. and Fisher, C.B. (2022). Exposure to social media racial discrimination and mental health among adolescents of color. *Journal of Youth and Adolescence* [online], 51(1), pp.30–44. Available from: https://doi.org/10.1007/s10964-021-01514-z [accessed 29 September 2024].

Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A. and Varpio, L. (2015). Choosing a qualitative research approach. *Journal of Graduate Medical Education* [online], 7(4), pp. 669–670. Available from: https://doi.org/10.4300/JGME-D-15-00414.1 [accessed 29 September 2024].

Turner, J.C., Hogg, M.A., Oakes, P. J., Reicher, S.D. and Wetherell, M. S. (1987). *Rediscovering the social group a self-categorization theory*. Basil Blackwell.

Wandhe, P. (2024). The new generation: Understanding millennials and Gen Z. Available from: https://ssrn.com/abstract=4716585 [accessed 29 September 2024].

Whittaker, E. and Kowalski, R.M. (2014). Cyberbullying via social media. *Journal of School Violence* [online], 14(1), pp. 1–29. Available from: DOI:10.1080/15388220.2014.949377 [accessed 29 September 2024].

Wilkins, D. (2019). Ride the wave: social media's effect on groupthink. *Howard University* [online]. Available from: https://hunewsservice.com/groupthink/ [accessed 29 September 2024].

X. (2024). X's policy on hateful conduct. *X* [online]. Available from: https://help.x.com/en/rules-and-policies/hateful-conduct-policy [accessed 29 September 2024].

Xulu, L. (2022). Celebrity suicides turn spotlight on mental health. *News24* [online]. Available from: https://www.news24.com/news24/southafrica/z_archives/local/greytown-gazette/celebrity-suicides-turn-spotlight-on-mental-health-20220315-2 [accessed 29 September 2024].

A Framework for Fourth Industrial Revolution Adoption by Small-Scale Rural Farmers in Sub-Saharan Africa: A Systematic Literature Review

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Abstract

Climate change is witnessed in unpredictable weather conditions that negatively affect human lives, economies, and farming worldwide. This results in severe heat waves and a shift in rainfall patterns. This is a major global threat to agriculture and food security, especially for rural farmers. Small-scale rural-based farmers contribute immensely to local communities' socio-economic well-being and food security. However, most of the small-scale rural farmers are constrained, especially regarding resources. There is a need for the agricultural industry in rural areas to adopt the fourth industrial revolution (4IR) technologies to predict and make well-informed decisions on how to manage existing, often constrained resources efficiently. Government support, in various forms, is equally needed. Furthermore, adopting 4IR by small-scale rural farmers will assist countries in the Sub-Saharan African region in achieving the United Nations Sustainable Development Goal Number 2 on 'Zero Hunger' by achieving food security and promoting smart, sustainable agriculture. However, there is a deficiency in the literature on 4IR adoption frameworks to guide small-scale rural farmers in adopting 4IR tools to manage their resources and promote sustainable agriculture. This study aims to develop a 4IR adoption framework that could guide small-scale rural farmers in adopting 4IR tools for managing their resources and promoting smart agriculture. A systematic literature review approach is employed to identify critical components significant for adopting 4IR in rural farming. Rural farmers may use this framework as a guiding lens when adopting 4IR tools. This study broadens the scope of the scant literature on the best practices for adopting 4IR for smart small-scale rural farming in Sub-Saharan Africa and other developing nations with similar setups. The smart-scale rural farming is mainstreamed within the smart village concept and the greenfield or green economy resilient to harsh climate change conditions.

"The small-scale farmers represent a significant portion of the Sub-Saharan African region's population and play a crucial role in ensuring food security, yet they often face numerous challenges when it comes to the adoption of 4IR technologies *(Kakani et al. 2020; Almadani and Mostafa 2021; Dlamini, Chizema and Van Greunen 2023)*"

Introduction

The literature shows that the Fourth Industrial Revolution (4IR) is emerging as a hot potato in the agricultural sector with a focus on smart agriculture meant to address climate change and population growth (Javaid et al. 2022; Joy et al. 2022; Sharma et al. 2022)with a focus on smart and precision agriculture to maximise benefits in the context of growing populations and climate change. Agriculture 4.0 supports the adoption of intelligent systems in all spheres of farming, harvesting, irrigation, and so on. Though there is enough inclusion of Artificial Intelligence and Internet of Things (IoT. Adding to that, 4IR is upon us, ushering in an era of unprecedented technological advancement and innovation that has the potential to transform agriculture industries, economies and societies worldwide (Joy et al. 2022; Slob and Hurst 2022)with a focus on smart and precision agriculture to maximise benefits in the context of growing populations and climate change. Agriculture 4.0 supports the adoption of intelligent systems in all spheres of farming, harvesting, irrigation, and so on. Though there is enough inclusion of Artificial Intelligence and Internet of Things (IoT. The 4IR presents boundless opportunities for growth and development, particularly for small-scale rural farmers in Africa (Dlamini, Chizema and Van Greunen 2023; Ngongoma, Kabeya and Moloi 2023)which is well developed. Despite the increase of commercial agriculture, the agricultural expansion of smallholders is essential for long-term socioeconomic stability and food security. A smart farming culture is described in the fourth industrial revolution (4IR.

The small-scale farmers represent a significant portion of the Sub-Saharan African region's population and play a crucial role in ensuring food security, yet they often face numerous challenges when it comes to the adoption of 4IR technologies (Kakani et al. 2020; Almadani and Mostafa 2021; Dlamini, Chizema and Van Greunen 2023) which is well developed. Despite the increase of commercial agriculture, the agricultural expansion of smallholders is essential for long-term socioeconomic stability and food security. A smart farming culture is described in the fourth industrial revolution (4IR. They encounter challenges such as a lack of digital infrastructure, technologies, digital literacy, data analytics, and budget, to name a few (Sharma et al. 2022; Talari et al. 2022). Similarly, African small-scale rural farmers face many challenges, including limited access to resources, climate change and market volatility (Winberg 2020; Dlamini, Chizema and Van Greunen 2023)which is well developed. Despite the increase of commercial agriculture, the agricultural expansion of smallholders is essential for long-term socioeconomic stability and food security. A smart farming culture is described in the fourth industrial revolution (4IR.

The adoption of 4IR technologies, such as precision agriculture, Internet of Things (IoT) sensors, artificial intelligence, and blockchain may address some of the pressing issues in small-scaled farms (Noor et al. 2022; Campuzano et al. 2023; Hassoun

et al. 2023)including the dairy industry. Growing literature shows that the adoption of technologies of the fourth industrial revolution (named Industry 4.0. For example, IoT sensors can assist small-scale rural farmers by monitoring soil moisture levels in real-time to enable them to manage and improve water usage while ensuring that the crops achieve the anticipated growth (Campuzano et al. 2023). Similarly, AI-powered predictive analytics may assist rural farmers in predicting weather patterns or pest outbreaks, just to name a few, to enable them to plan for these disastrous events in advance to minimise losses.

These technologies can enhance productivity, increase crop harvests, improve resource management and provide valuable insights into market dynamics that will ultimately improve the livelihoods of rural farming communities (Joy et al. 2022; Noor et al. 2022; Sarkar et al. 2023)with a focus on smart and precision agriculture to maximise benefits in the context of growing populations and climate change. Agriculture 4.0 supports the adoption of intelligent systems in all spheres of farming, harvesting, irrigation, and so on. Though there is enough inclusion of Artificial Intelligence and Internet of Things (IoT. Blockchain technologies could ensure transparent and traceable supply chains, allowing small-scale farmers to gain trust and secure better market prices for their products (Campuzano et al. 2023; Gumbi, Gumbi and Twinomurinzi 2023)including the dairy industry. Growing literature shows that the adoption of technologies of the fourth industrial revolution (named Industry 4.0.

In the literature, there is little research that explores and develops a framework for the fourth industrial revolution adoption by small-scale rural farmers in Sub-Saharan Africa to manage their resources and promote sustainable agriculture (Dlamini, Chizema and Van Greunen 2023; Hassoun et al. 2023; Ngongoma, Kabeya and Moloi 2023) which is well developed. Despite the increase of commercial agriculture, the agricultural expansion of smallholders is essential for long-term socioeconomic stability and food security. A smart farming culture is described in the fourth industrial revolution (4IR. Therefore, this study aims to develop a 4IR adoption framework that could guide small-scale rural farmers to adopt 4IR tools. To achieve this aim, this study employed a systematic literature review (SLR) to critically examine and synthesize the existing literature to develop a framework to assist small-scale farmers in adopting 4IR in Sub-Saharan Africa.

The conceptual framework targets to bridge the gap by offering practical, accessible guidelines that small-scale rural farmers can follow to integrate 4IR technologies into their farming practices. The proposed framework will be specifically developed considering the distinct conditions of rural areas, including their resource limitations. In addition, this framework will offer insights into the critical factors that small-scale rural farmers must address before the implementation of 4IR in the farms. This study will also make a significant contribution to the academic literature by providing a study that will inform future investigations.

The SLR aims to provide a comprehensive overview of the existing body of research on the adoption of 4IR technologies by small-scale rural farmers in Sub-Saharan Africa (Schukat and Heise 2021; Rudrakar and Rughani 2023). It also seeks to identify the key factors that may influence the adoption decisions, assess the impact of 4IR technologies on agricultural practices, and propose a robust framework to facilitate the successful integration of these transformative innovations into the agricultural landscape of the region (Niloofar et al.

“The conceptual framework targets to bridge the gap by offering practical, accessible guidelines that small-scale rural farmers can follow to integrate 4IR technologies into their farming practices.”

2021; Spanaki, Karafili and Despoudi 2021; Abbate, Centobelli and Cerchione 2023).

In the succeeding sections that follow, the study will explore the concept of 4IR, small-scale rural farms and 4IR adoption. This is done to elucidate the challenges and opportunities faced by small-scale rural farmers and propose a robust framework that integrates technological, socioeconomic, and institutional factors to facilitate a sustainable and inclusive transformation of the agriculture sector in the region. Furthermore, the systematic literature review method will be discussed to outline the process that was followed when conducting this study. Finally, this aspires to contribute to the ongoing discourse surrounding the 4IR to potentially revolutionise small-scale rural farms, reduce rural poverty, and secure food production for future generations in Sub-Saharan Africa.

Methodology

This study employed a systematic literature review (SLR) to identify and review literature to develop a framework for 4IR adoption by small-scale rural farmers in Sub-Saharan Africa. The researchers started by searching for the literature from the IEEE Xplorer, ProQuest, ScienceDirect and Web of Science databases. This study is an interdisciplinary field since it cuts through information systems and agriculture. Therefore, multidisciplinary databases that often used in the studies of this nature were chosen (Campuzano et al. 2023; Gumbi, Gumbi and Twinomurinzi 2023; Mashau, Kroeze and Howard 2021). The literature was searched from these databases using the following keywords to extract relevant articles:

- "Fourth Industrial Revolution" AND "Small-Scale Farming"
- "Fourth Industrial Revolution" AND "Farming"
- "Fourth Industrial Revolution AND "Small-Scale Farm"
- "Fourth Industrial Revolution AND "Farm"
- "4IR" AND "Small-Scale Farming"
- "4IR" AND "Farming"
- "4IR" AND "Farm"
- "4IR" AND "Small-Scale Farm"

The literature was searched examining all the metadata. Each search was restricted to articles that were peer-reviewed and written in English between 01/01/2018 and 08/092023. In total, all the searches retrieved 317 articles from the selected databases (see Table 2). Therefore, duplicated articles were identified, and 103 duplicated files were deleted from the review pool. Furthermore, the remaining articles were screened by examining titles and the abstract to verify their relevance. All the sources whose abstracts were relevant and aligned with this study's focus on the adoption of 4IR technologies in rural farming were added to the review pool. One hundred seventy-two (172) articles were deleted from the review pool during this phase because they were not related to the 4IR topic.

Table 2: SLR search results

Databases	Initial search results	Final reviewed results
IEEE Xplorer	52	7
ScienceDirect	183	13
Web of Science	55	15
ProQuest	27	1
Total	317	36

From all the articles that were saved in the review pool, the full text was read, and 6 more articles were deleted from the review pool because it was realised after this close reading that the content was not relevant to the 4IR topic. In total 36 articles that are pertinent to this study were reviewed to develop a framework for 4IR adoption by small-scale rural farmers in Sub-Saharan Africa. To minimise or avoid personal bias and to ensure that all relevant articles are considered, all the authors conducted the search and screening independently and evaluated the articles for inclusion and exclusion based on the PRISMA model. After that, the authors met and discussed their disagreements, looking at the articles' relevance, rigour and value.

Overview of the Fourth Industrial Revolution

The term fourth industrial revolution was coined in 2016 by Klaus Schwab (Effoduh 2016). This term is also known as Industry 4.0 (Guha, Chakrabarti and Chatterjee 2021; Joy et al. 2022). In the literature, scholars define this term differently (see Table 3):

Apart from the definitions highlighted in Table 1, the fourth industrial revolution in farming is also known as Agricultural 4.0. Therefore agricultural 4.0 is seen as the use of intelligent tools such as the Internet of Things, big data, artificial intelligence,

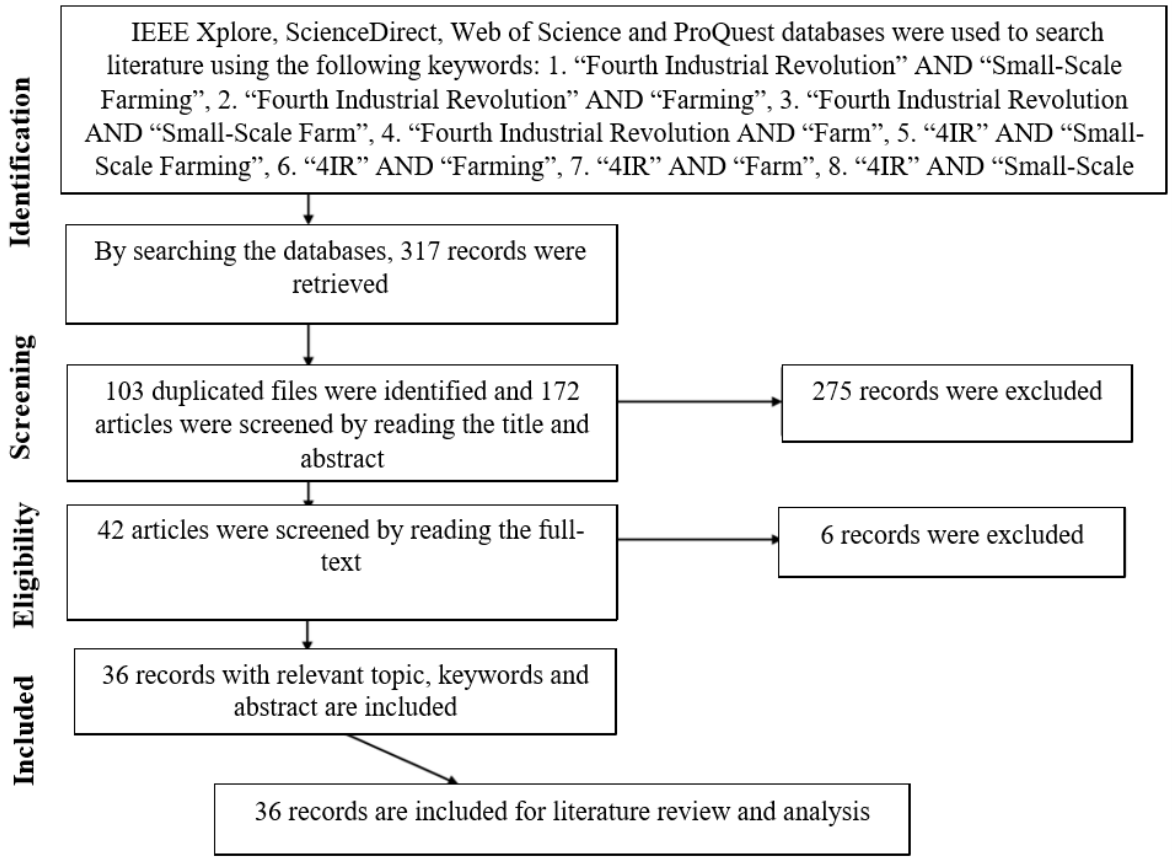


Figure 1: Systematic Literature Review identification diagram

Table 3: Fourth Industrial Revolution definitions

Authors	Definitions
Slob and Hurst (2022)	The 4IR is defined as a combination of innovations in AI, robotics, the IoT, genetic engineering, quantum computing, and other technologies.
Dlamini et al. (2023)	The 4IR is defined as an idea that combines AI and big data to monitor, identify insect pests, detect soil moisture, decide when to harvest, and reduce labour-intensive human monitoring in the farming industry.
Spanaki et al. (2021)	The 4IR is defined as a design of computer-generated products and three-dimensional (3D) printing, which produce solid objects by stacking successive layers of materials.
Abbasi, Martinez, and Ahmad (2022)	The Fourth Industrial Revolution is about more than just technology-driven change that offers the opportunity to help everyone, including leaders, policymakers and people from all income groups and nations, to harness converging technologies to create an inclusive, human-centred future.

and so on in all areas of farming to manage resources effectively and catapult production (Joy et al. 2022; Talari et al. 2022; Polymeni et al. 2023). This study will adopt this version as a definition for this research.

Small-scale rural farms

Small-scale farms, often referred to as smallholder farms, are characterized by their relatively small size and limited land and resource holdings (Almadani and Mostafa 2021; Dlamini, Chizema and Van Greunen 2023). These farms are a fundamental component of global agriculture, contributing significantly to food production, rural livelihoods and local economies (Belaud et al. 2019). Small-scale farms play a crucial role in food production, livelihoods, and local economies. Similarly, small farms are vital contributors to food security, especially in developing countries (Guha et al. 2021). They often prioritise diverse crops,

> literature shows that farms need to analyse data to effectively manage resources such as water, fertiliser, and tractors, just to name a few *(Mabiletsa et al. 2020; Jiménez, Cárdenas and Jiménez 2022).*

contribute to local markets and provide direct employment opportunities to the local citizens (Harfouche et al. 2019; Almadani and Mostafa 2021). Small-scale farming also helps preserve traditional agricultural practices and biodiversity (Liu et al. 2021; Campuzano et al. 2023).

Small-scale farms are essential for rural livelihoods, providing income, employment, and Subsistence for millions of people. Fostering the growth of small-scale farms can contribute to poverty reduction and rural development (Abbate, Centobelli and Cerchione 2023). Small-scale farmers often face challenges such as limited access to land, credit, and modern technology (Joy et al. 2022; Noor et al. 2022). Additional challenges include climate change, market fluctuations and land tenure issues. Addressing these challenges requires targeted policies, concerted effort from all stakeholders and information technology interventions (Joy et al. 2022; Dlamini, Chizema and Van Greunen 2023). Access to appropriate technologies, including mobile apps for market information, improved seeds, and sustainable farming practices, can significantly address challenges encountered by farmers and enhance the productivity and resilience of small farms (Almadani and Mostafa 2021; Abbate, Centobelli and Cerchione 2023; Ngongoma, Kabeya and Moloi 2023).

Furthermore, gender dynamics play a significant role in small-scale farming, with women often contributing remarkably to agricultural activities in rural-based farming (Aznar-Sánchez et al. 2019; Gagliardi, Cosma and Marasco 2022). Empowering women in agriculture with the right knowledge and technical skills is essential for improving farm productivity and rural livelihoods (Büyüközkan, Göçer and Uztürk 2021; Choi and Shin 2023). Kanyane (2021) writes that the smart rural village model would offer the opportunity to ensure that requisite skills and jobs are created and retained for instance, through funded commodity production in agriculture – crop and livestock, energy, water, health, food security, transportation and technology spaces. This is because people with skills tend to move to places with higher wages or work opportunities.

Adoption of the fourth industrial revolution by small-scale rural farmers

In the past, three major technological breakthroughs have ushered in industrial revolutions by enabling mass production, accelerating growth and shifting employment from agriculture to manufacturing and later to services (Staneva and Elliot 2023). The adoption of fourth industrial revolution technologies by small-scale rural farmers has the potential to transform agriculture, manage farm resources, improve livelihoods, and enhance food security globally (Campuzano et al. 2023). These require addressing challenges related to access to innovation, affordability, capacity building, and customization of solutions (Schirpke et al. 2019). Furthermore, this will require collaborative efforts involving government departments, state-owned entities and the private sector to assist small-scale farmers in successfully adopting 4IR in rural areas (Schukat and Heise 2021; Dlamini, Chizema and Van Greunen 2023; Hassoun et al. 2023).

However, the literature postulates that small-scale rural farmers should consider the following to adopt 4IR successfully, namely digital infrastructure, connectivity, data analytics, mobile applications, budget, capacity, training and policies (Schirpke et al. 2019). Different scholars also suggest that access to digital infrastructure, including reliable internet

connectivity should be a prerequisite when adopting 4IR in small-scale rural farm set-ups. Similarly, other scholars have indicated that mobile devices are a significant element in the adoption of 4IR by small-scall farmers to manage and monitor their resources (Campuzano et al. 2023; Hassoun et al. 2023). On the contrary, literature shows that limited access to digital infrastructure and internet connectivity can hinder the successful adoption of 4IR by small-scale farmers (Ranjan et al. 2022; Dlamini, Chizema and Van Greunen 2023).

On the other hand, the literature shows that farms need to analyse data to effectively manage resources such as water, fertiliser, and tractors, just to name a few (Mabiletsa et al. 2020; Jiménez, Cárdenas and Jiménez 2022). For example, this includes collecting and analysing moisture data from a farm may lead to data-driven decision-making to water crops when it is necessary (Noor et al. 2022; Campuzano et al. 2023). Data analytics in this case may help farmers conserve water and other scarce resources (Jiménez, Cárdenas and Jiménez 2022). In addition, small-scale farms may benefit from data analytics by gaining more insights into crop management, pest control, market trends, transport logistics, etc. (Elijah et al. 2021; Debauche et al. 2022).

The literature also suggests that the use of mobile applications may provide small-scale farmers with access to valuable information on weather forecasts, market prices and agronomic advice (Almadani and Mostafa 2021). Furthermore, mobile applications will enable farmers to have control of their farming activities from wherever they are (Liu et al. 2021; Choi and Shin 2023). In addition, farmers my use mobile applications to instruct digital devices to perform their duties like IoT-enabled crop watering (Sharma et al. 2022). However, the use of 4IR technologies requires training to capacitate small-scale farmers because it is crucial for them to understand how to use these tools effectively (Spanaki et al. 2022).

The literature suggests that for small-scale farmers to effectively adopt 4IR, they need to set aside a budget that will help in improving digital infrastructure and acquiring various technologies (Spanaki et al. 2022; Hassoun et al. 2023). Furthermore, capacity building also requires enough budget to send farmers for training and attending workshops. Enough budget may help farmers address barriers that may impede the successful adoption and implementation of 4IR for smart agriculture (Spanaki, Karafili and Despoudi 2021; Gagliardi, Cosma and Marasco 2022; Campuzano et al. 2023).

Results and Discussions

The critical components significant to adopting 4IR by small-scaled rural farms in Sub-Saharan Africa as evidenced in the reviewed articles are discussed next. The reviewed literature underscored the pivotal role played by having sufficient financial budgets in the adoption of 4IR by small-scale rural farmers. Fifteen qualitative, fourteen qualitative analysed articles posit that budget constraints are a prevalent phenomenon across most small-scale farmers in the Sub-Saharan African region (Sharma et al. 2022; Spanaki et al. 2022; Hassoun et al. 2023). Furthermore, sufficient budgets enable small-scale rural-based farmers to engage in meaningful hands-on training, acquire the 4IR tools and efficiently use them for various farming activities. Thus, constrained financial budget is flagged as an area that needs special attention to findings of previous studies on 4IR adoption by small-scale farmers in developing nations (Jellason et al. 2021; Smidt and Jokonya 2022; Gumbi et al. 2023). This finding implies that to effectively adopt 4IR technologies, small-scale rural farmers in developing nations require financial support from the government and other key stakeholders like non-governmental organizations.

Fourth industrial revolution technologies such as the Internet of Things, big and predictive data analytics, artificial intelligence, precision agriculture, sensors collecting data and monitoring fundamental crop health, weather, and soil quality tools come at an exorbitant cost, often beyond the reach of most small-scale rural farmers. The findings of this study establish that the majority of small-scale rural farmers are severely budget-constrained and this poses a huge barrier to effectively adopting and embracing cutting-edge 4IR for agriculture tools (Ranjan et al. 2022; Dlamini, Chizema and Van Greunen 2023). Moreover, the 4IR for agriculture tools requires fast and efficient internet connectivity to effectively work. Yet, the cost of internet connectivity and access in the context

of most developing nations in the Sub-Saharan Africa region is very exorbitant; thus, further exacerbating and constraining the widespread adoption of such innovative technologies. This finding concurs with the findings of previous scholars on 4IR for agriculture who attested that the lack of digital infrastructure poses a severe challenge to the effective adoption of 4IR tools across small to medium-scale agriculture producers (Sutherland 2020; Hassoun et al. 2023; Spanaki et al. 2022). This finding is a wake-up call to all key stakeholders in the government, policymakers and funding organizations working so hard to ensure food security and sustainability to establish mechanisms to assist small-scale rural farmers to embrace 4IR for agriculture hustle-free. This may call for government interventions through subsidizing the cost of these 4IR tools and internet connectivity to cushion and enable small-scale farmers in their adoption efforts.

The reviewed literature further demonstrated that access to 4IR innovative tools is the first and foremost stage in the adoption process. The second phase of possessing the right soft skills to effectively use such technologies for smart farming remains a major obstacle for most small-scale farmers across the Sub-Saharan Africa region. Although most small-scale rural farmers can use smartphones daily for general purposes, the use of 4IR tools like IoT, smart agriculture apps and predictive analytics require some astute configurations, monitoring and manipulations which often pose serious challenges to most rural-based farmers who are not technology savvy. Besides, the literature demonstrated that acquiring such knowledge comes at a huge cost, often beyond the reach of most rural-based small-scale farmers (Schirpke et al. 2019; Campuzano et al. 2023; Gagliardi et al. 2022; Spanaki et al. 2021). Therefore, the United Nations Food and Agriculture Organization (FAO) through its various umbrella regional bodies, in collaboration with NGOs and government entities should intensify its efforts to capacitate and upskill small-scale rural farmers with the relevant 4IR for agriculture skills to catapult smart agriculture and ensure sustainable societies and food security.

A Proposed Framework

A proposed framework for the fourth industrial revolution adoption by small-scale rural farmers in Sub-Saharan Africa – which is an artefact of this study was developed using findings from the systematic review. The critical components

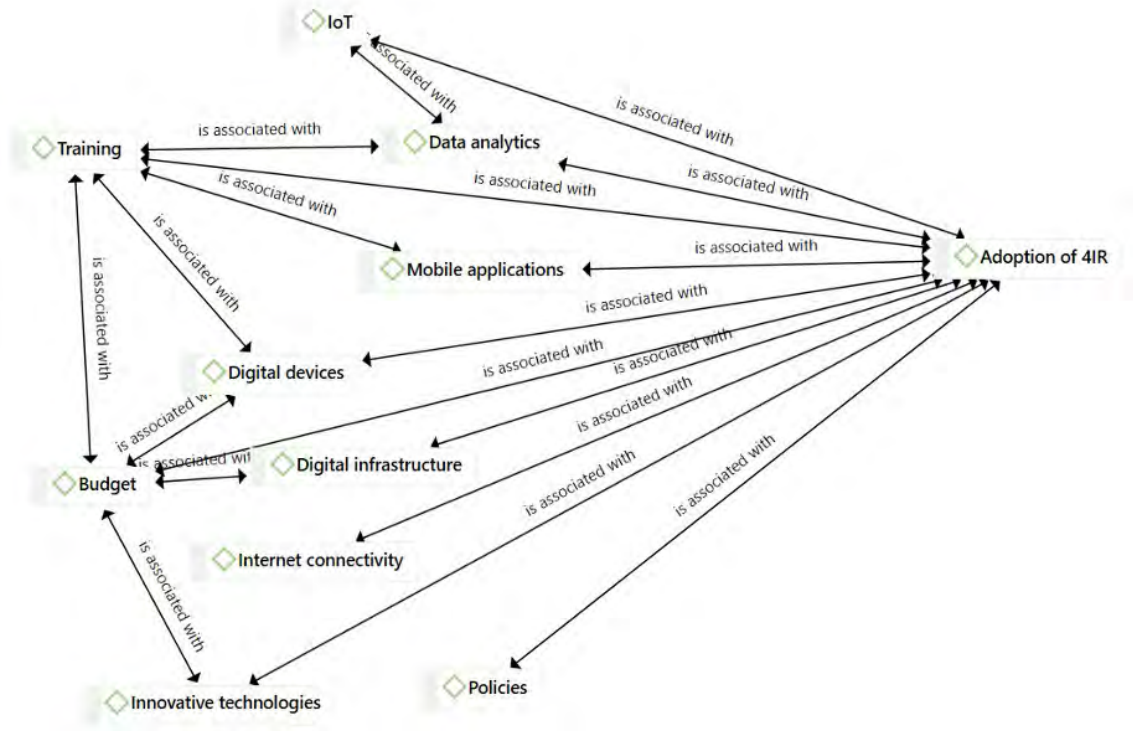


Figure 2: Proposed conceptual framework.

identified to be significant to the adoption of 4IR by small-scale rural farms were integrated to develop a model depicted below (see Figure 2).

The proposed framework (see Figure 2) shows that digital infrastructure, digital devices, budget, policies, training, mobile applications, internet connectivity, IoT, innovative technologies and data analytics are significant for the adoption of 4IR by small-scaled rural farms (Schirpke et al. 2019). Small-scale rural farms should have the budget to buy the required digital infrastructure, digital devices, and internet access (Hassoun et al. 2023; Schirpke et al. 2019). Furthermore, small-scale rural farmers should set aside a budget to train their staff to operate 4IR tools (Gagliardi et al. 2022; Spanaki et al. 2021). The availability of digital infrastructure, digital mobile, internet connectivity and digital literacy for staff may influence the adoption of 4IR (Campuzano et al. 2023; Hassoun et al. 2023; Schirpke et al. 2019).

The model also postulates that policies play a pivotal role in the adoption of 4IR in small-scale farms. This means government policies should be aligned and support the adoption of 4IR technologies by small-scale rural farms (Dlamini et al. 2023). Furthermore, the government should ensure that government policies on smart farming are implemented and monitored to reap the fruits of 4IR for agriculture (Schirpke et al. 2019). On the other hand, small-scale rural farms should implement innovative technologies as a precursor for 4IR adoption to assist in real-time data collection (Jiménez et al. 2022; Elijah et al. 2021). Furthermore, small-scale rural farmers should have intelligent tools that will be used to analyse data in real-time to predict and make well-informed decisions on how to manage existing, often constrained resources efficiently (Joy et al. 2022). Lastly, if these components are disregarded, small-scale rural farms are likely to fail in adopting 4IR for their day-to-day activities.

Conclusion

This study aimed to develop a 4IR adoption framework for small-scale rural farmers to adopt 4IR tools for managing their resources and promoting smart agriculture. To achieve this aim, a systematic literature review approach was employed to identify critical components significant to 4IR adoption for rural farming. To achieve this aim, an initial total of 317 articles were extracted from four major databases, including IEEE Xplorer, ProQuest, ScienceDirect and Web of Science. Key terms like 'Fourth Industrial Revolution' AND 'Small-Scale Farming', '4IR' AND 'Small-Scale Farm' and related terms as alluded to in the methodology section were used to extract the articles for inclusion. After a thorough synthesis and refining, only 36 articles were included in the final analysis for this study. Thereafter, major challenges that affect small-scale rural farmers in adopting 4IR smart technologies were explored, namely the lack of digital infrastructure, internet connectivity, digital literacy, data analytics, and budget constraints. To adopt 4IR effectively and successfully for agriculture, it is essential for small-scale rural farmers and all the key stakeholders like government agencies and NGOs to address these challenges. Constructive alignment between formulated policies on 4IR adoption for small-scale farmers and practical implementation and monitoring is fundamental to the success of such initiatives for sustainable farming and food security for the region.

This study had its limitations. Since the study relied purely on the systematic literature review approach, there is a need to explore a qualitative empirical research strategy using interviews to capture the voices and lived experiences of small-scale rural farmers in the region. This will complement and enrich this research. Similarly, a quantitative method will provide a fertile statistical test of the results and synthesis of the proposed research model. Thus, future studies should explore these avenues to effectively establish viable mechanisms and solutions to overcome the identified challenges confronting small-scale rural farmers in their endeavours to adopt 4IR smart technologies.

References

Abbate, S., Centobelli, P. and Cerchione, R. (2023) The digital and sustainable transition of the agri-food sector. *Technological Forecasting and Social Change*, 187, pp. 1-14.

Almadani, B. and Mostafa, S. M. (2021) IIoT based multimodal communication model for agriculture and agro-industries. *IEEE Access*, 9, pp. 10070-10088.

Aznar-Sánchez, J.A., Piquer-Rodríguez, M., Velasco-Muñoz, J.F. and Manzano-Agugliaro, F. (2019) Worldwide research trends on sustainable land use in agriculture. *Land Use Policy*, 87, pp. 1-15.

Belaud, J.P., Prioux, N., Vialle, C. and Sablayrolles, C. (2019) Big data for agri-food 4.0: Application to sustainability management for by-products supply chain. *Computers in Industry*, 111, pp. 41-50.

Büyüközkan, G., Göçer, F. and Uztürk, D. (2021) A novel pythagorean fuzzy set integrated choquet integral approach for vertical farming technology assessment. *Computers and Industrial Engineering*, 158, pp. 1-14.

Campuzano, L.R., Mahmoudi, S., Manneback, P. and Lebeau, F. (2023) Barriers to the adoption of innovations for sustainable development in the agricultural sector – Systematic literature review (SLR). *Sustainability*, 15(5), pp. 1-23.

Choi, S.W. and Shin, Y.J. (2023) Role of smart farm as a tool for sustainable economic growth of Korean agriculture: Using input–output analysis. Sustainability, 15(4), pp. 1-21.

Debauche, O., Mahmoudi, S., Manneback, P. and Lebeau, F. (2022) Cloud and distributed architectures for data management in agriculture 4.0: Review and future trends. Journal of King Saud University – Computer and Information Sciences, 34, pp. 7494-7514.

Dlamini, P., Chizema, T. and Van Greunen, D. (2023) SMS Connectivity and Information Display in 4IR Projects for Small-Scale Farmers. 2023 IST-Africa Conference, IST-Africa 2023. IST-Africa Institute, pp. 1-8.

Effoduh, J. O. (2016) The fourth industrial revolution by Klaus Schwab. The Transnational Human Rights Review, 3(1), pp. 1-9.

Elijah, O., Rahim, S.K.A., Emmanuel, A. A., Salihu, Y O., Usman, Z.G. and Jimoh, A.M. (2021) Enabling smart agriculture in Nigeria: Application of digital-twin technology. 2021 1st International Conference on Multidisciplinary Engineering and Applied Science, ICMEAS 2021. IEEE, pp. 1-6.

Gagliardi, G., Cosma, A.I.M. and Marasco, F. (2022) A decision support system for sustainable agriculture: The case study of coconut oil extraction process. Agronomy, 12(1), pp. 1-21.

Guha, K., Chakrabarti, A., Paul, K. and Chatterjee, B. (2021) Criticality based reduction of security costs in a FPGA based cloud computing farm. 2021 34th International Conference on VLSI Design and 2021 20th International Conference on Embedded Systems (VLSID), pp. 264-269.

Gumbi, N., Gumbi, L. and Twinomurinzi, H. (2023) Towards Sustainable Digital Agriculture for Smallholder Farmers: A Systematic Literature Review. *Sustainability*, 15(12530), pp. 1-20.

Harfouche, A.L., Jacobson, D.A.,Kainer, D., Romero, J.C., Harfouche, A.H., Scarascia, M.G., Moshelion, M., Tuskan, Gerald A., Keurentjes, J. J. B. and Altman, A. (2019) Accelerating climate resilient plant breeding by applying next-generation artificial intelligence. *Trends in Biotechnology*, 37(11), pp. 1217-1235.

Hassoun, A., Garcia-Garcia, G., Trollman, H., Jagtap, S., Parra-López, C., Cropotova, J., Bhat, Z., Centobelli, P. and Aït-Kaddour, A. (2023) Birth of dairy 4.0: Opportunities and challenges in adoption of fourth industrial revolution technologies in the production of milk and its derivatives. *Current Research in Food Science*, 7, pp. 1-11.

Javaid, M., Javaid, M., Haleem, A., Singh, R.P. and Suman, R. (2022) Enhancing smart farming through the applications of Agriculture 4.0 technologies. *International Journal of Intelligent Networks*, 3, pp. 150-164.

Jiménez, A.F., Cárdenas, P. F. and Jiménez, F. (2022) Intelligent IoT-multiagent precision irrigation approach for improving water use efficiency in irrigation systems at farm and district scales. *Computers and Electronics in Agriculture*, 192(2022), pp. 1-19.

Joy, S.A., Abian, A.I., Iwase, S.C., Rahman, S.I., Juairia, G.T. and Farid, D. M. (2022) Agriculture 4.0 in Bangladesh: Issues and challenges. *2022 14th International Conference on Software, Knowledge, Information Management and Applications (SKIMA)*, pp. 245-250.

Kakani, V., Nguyen, V.H., Kumar, B.P., Kim, H. and Pasupuleti, V.R. (2020) A critical review on computer vision and artificial intelligence in food industry. *Journal of Agriculture and Food Research*, 2, pp. 2666-1543.

Kanyane, M (2021). Fourth industrial revolution and rural development – a catalyst connect between rural and urban development. In Mzo Sirayi, Modimowabarwa Kanyane & Giulio Verdini (eds), *Culture and Rural-Urban Revitalization in South Africa: Indigenous Knowledge, Policies and Planning.* London: Routledge, pp. 209-225.

Liu, Y., Ma, X., Member, S.S., Shu, L., Member, S.S., Hancke, G. P., Member, S. S., Abu-mahfouz, A. M. and Member, S.S. (2021) From industry 4.0 to agriculture 4.0: Current status, enabling technologies, and research challenges. *IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS*, 17(6), pp. 4322-4334.

Mabiletsa, O., Omowunmi, I., Viljoen, S., Farrell, J. and Ngqwemla, L. (2020) Immersive interactive technology: A case study of a wine farm. *Proceedings of 2020 ITU Kaleidoscope: Industry-Driven Digital Transformation, ITU K*, pp. 1-7.

Mashau, N.L., Kroeze, J.H. and Howard, G.R. (2021). An integrated conceptual framework to assess small and rural municipalities' readiness for smart city implementation: A systematic literature

review. *Lecture Notes in Computer Science;* Springer: Cham, Switzerland, p. 262-273.

Ngongoma, M.S.P., Kabeya, M. and Moloi, K. (2023). A review of plant disease detection systems for farming applications. *Applied Sciences*,13(10), pp. 1-28.

Niloofar, P., Francis, D.P., Lazarova-Molnar, S., Vulpe, A., Vochin, M.C., Suciu, G., Balanescu, M., Anestis, V. and Bartzanas, T. (2021) Data-driven decision support in livestock farming for improved animal health, welfare and greenhouse gas emissions: Overview and challenges. *Computers and Electronics in Agriculture*, 190, pp. 1-16.

Noor, N.M., Razali, N.A.M., Malizan, N.A., Ishak, K.K., Wook, M. and Hasbullah, N. A. (2022). Decentralized access control using blockchain technology for application in smart farming. *International Journal of Advanced Computer Science and Applications*, 13(9), pp. 788-802.

Polymeni, S., Polymeni, S., Plastras, S., Skoutas, D.N., Kormentzas, G. and Skianis, C. (2023) The impact of 6G-IoT technologies on the development of agriculture 5.0: A review. *Electronics,* 12(12), pp. 1-24.

Ranjan, S., Kaur, M., Singh, K., Rakesh, N. and Goyal, M.K. (2022) IoT-based rural farming and education infrastructure. *2022 International Conference on 4th Industrial Revolution Based Technology and Practices, ICFIRTP 2022*. IEEE, pp. 303-307.

Rudrakar, S. and Rughani, P. (2023). IoT based agriculture (Ag-IoT): A detailed study on architecture, security and forensics. *Information Processing in Agriculture*, 1(1), pp. 1-26.

Sarkar, S., Ganapathysubramanian, B., Singh, A., Fotouhi, F., Kar, S., Nagasubramanian, K., Chowdhary, G., Das, S.K., Kantor, G., Krishnamurthy, A., Merchant, N and Singh, A.K. (2023). Cyber-agricultural systems for crop breeding and sustainable production. *Trends in Plant Science*, 1(1), pp. 1-20.

Schirpke, U., Altzinger, A., Leitinger, G. and Tasser, E. (2019). Change from agricultural to touristic use: Effects on the aesthetic value of landscapes over the last 150 years. *Landscape and Urban Planning*, 187, pp. 23-35.

Schukat, S. and Heise, H. (2021). Smart products in livestock farming—An empirical study on the attitudes of german farmers. *Animals,* 11(4), pp. 1-18.

Sharma, R., Kamble, S., Mani, V. and Belhadi, A. (2022) An empirical investigation of the influence of industry 4.0 technology capabilities on agriculture supply chain integration and sustainable performance. *IEEE Transactions on Engineering Management*, 1, pp. 1-21.

Slob, N. and Hurst, W. (2022) Digital twins and industry 4.0 technologies for agricultural greenhouses. *Smart Cities*, 5(3), pp. 1179-1192.

Spanaki, K., Sivarajah, U., Fakhimi, M., Despoudi, S. and Irani, Z. (2022) *Disruptive technologies in agricultural operations: a systematic review of AI-driven AgriTech research, Annals of Operations Research.* New York: Springer.

Spanaki, K., Karafili, E. and Despoudi, S. (2021) AI applications of data sharing in agriculture 4.0: A framework for role-based data access control. *International Journal of Information Management*, 59, pp. 1-12.

Staneva, M., and Elliot S. (2023). Measuring the Impact of Artificial Intelligence and Robotics on the Workplace In: Shajek, A., Hartmann, E.A. (eds.) *New Digital Work: Digital Sovereignty at the Workplace*. Switzerland: Springer, pp. 149-160.

Talari, G., Cummins, E., McNamara C. and O'Brien J. (2022). State of the art review of big data and web-based decision support systems (DSS) for food safety risk assessment with respect to climate change. *Trends in Food Science and Technology*, 126, pp. 192-204.

Winberg, S. (2020). Towards incorporating industry 4.0 practices and hybridized jobs within the agricultural sector. *Proceedings of 2020 IEEE 11th International Conference on Mechanical and Intelligent Manufacturing Technologies, ICMIMT 2020*. IEEE, pp. 207-212.

Reflecting on Diversity and Gender Equality in Artificial Intelligence in Africa

By Helen Titilola Olojede

Abstract

Many ethical issues plague the field of AI, and several ethical solutions, mainly from the Global North, have been proposed. Among the issues inherent in ethical AI are bias and lack of diversity. Openair Africa reports, for example, an enormously low participation/visibility of women in today's digital world. World Economic Report states that worldwide, only about 22% of women are in the field of artificial intelligence compared to 78% of men. In the 2022 Cybersecurity Workforce Report, women account for just 24%. The 2020 Gender Equality Index: Digitalisation and Future of Work also indicates that only one out of two women, 54%, perceive robots and AI positively compared to 67% of men. Thus, this paper discusses diversity and gender equality in AI from the African context. How should we safeguard AI systems from rehashing extant inequality? To what extent can we ensure AI eliminates bias and fosters equality? To this end, this paper proposes a *communal* approach to the conception, design, development, and deployment of AI systems to address this abysmal situation towards a gender-smart and truly inclusive AI in Africa.

Introduction

It is a fact that artificial intelligence is revolutionizing our world with far-reaching consequences on various walks of life, such as education, health, industries, art, and a host of others. Given its humongous impacts, various ethical principles have been proposed to guide its development and deployment to enable it to be at the service of humanity. Among the principles proposed are European Union Act (2023), America AI Bill of Rights (2022), UK Ethical Principles for AI in Defence (2022), NATO Principles of Responsible Use of Artificial Intelligence (2021), US DoD Ethical Principles for Artificial Intelligence (2020), OECD AI

Principles (2019), European Union Ethics Guidelines for Trustworthy AI (2019), IEEE Ethically Aligned Design (2019), Microsoft Responsible AI Principles (2018), Asilomar AI Principles (2017). Among the most cited principles include transparency, inclusion, responsibility, impartiality, reliability, security, limits on use, justice and fairness, non-maleficence, privacy, beneficence, freedom and autonomy, and trust. Some of these principles coincide with the 17 most prevalent principles of Correa et al. (2023), who conducted a meta-analysis of two hundred regulations and ethical guidelines to determine if there is an international agreement on the ethical principles to regulate AI.

A close look at these principles reveals fundamental missing ideas on gender and diversity. However, gender is somewhat implicit in principles such as fairness, transparency, accountability and explainability. The principles do not represent world diversity, whether directly or indirectly. Goffi (2023) states that China, where 20 per cent of the world is located, is hardly represented. The same is true for India, whose 1.36 billion population is practically missing. Latin America, the Middle East and Russia struggle to have their voices heard and represented.

Consequently, this paper focuses on the issue of diversity and gender equality (DGE), one of the ethical issues in AI. What is the state of DGI in Africa? How can DGI be enhanced in AI systems? It discusses existing DGE issues such as gender-based violence, health inequalities, gender pay gap, unpaid work, and uneven funding. It further discusses DGE in AI, such as lack of awareness, digitalisation/digital skill gap, and narrow conception of DGE. The paper concludes by advocating for the communal approach to the AI life circle as a veritable means of not just bolstering AI development in Africa but one that takes its place in the scheme of AI discussion globally.

The Scope of Gender Equality

Gender equality is a basic human right sacrosanct to achieving a flourishing and strife-free world. Goal 5 of the United Nations Sustainable Development Goal is germane to realising other SDGs. This is because it is a crucial human right and a significant criterion for a harmonious and enduring universe. This is part of the reason why its place in the discourse of AI cannot be over-emphasised. According to Tschopp (2021), at the heart of gender issues are issues such as gender-based violence, health inequalities, gender pay gap, unpaid work, and uneven funding. Violence against women incorporates not just physical and psychological violence but also threats of violence in addition to femicide. A report from the World Health Organization indicates that 1 out of 3 women suffer physical or sexual violence during their lives, which is instrumental to preventing women from fulfilling their economic, political, and social rights. Nuwabaine et al. (2023) report that 18.7% of women experience sexual violence. At the core of gender-based violence is women's inability to gain the same access as men to power and resources. Women are persistently at the receiving end of offensive oppression, an offshoot of gender stereotypes and inequality (Nuwabaine et al. 2023).

Gender-based access to healthcare inequalities is another way whereby there is a vast difference in how men and women access healthcare. The data collected from men continues to be used for women under the assumption that it equally represents women's data with a flagrant disregard for the law that mandates women's inclusion in biomedical research. Tschopp (2021) thus concluded that to bring about health equity for women, there is a need for more biomedical research on women, top-notch data, and algorithms representative of a diverse population.

> "Given AIs humongous impacts, various ethical principles have been proposed to guide its development and deployment to enable it to be at the service of humanity."

A third area of gender inequality pertains to remuneration differential found in women and men. WEF (2023) reported that the gender pay gap of 31.5% found worldwide is estimated to take nearly a century to bridge. A World Bank report (2022) stated that almost 2.4 million women worldwide lack similar economic rights as men. International Labour Organization (2016) reported that while 40% of women in paid employment are not contributors to social protection internationally, in Africa, 63.2% of women do not contribute to social protection. Sustainable development nonetheless relies on improved gender quality. European Parliament (2020), the Workplace Gender Equality Agency (WGEA) of the Australian workplace reported a reduction of 21.9% in the pay gap in recent years, which is still relatively high. Estonia in the EU records 20.5%, and the lowest being 3.6% in Romania. However, it is essential to note that a decreased pay gap is insufficient to assume an increase in gender equality because it could just be that women are fewer in paid jobs.

Nurturing children and caring for adult children and elderly relatives are areas where unpaid housework is unequally distributed. ILO (2018) revealed that women engage in unpaid care and household chores 2.6. million times more than men. Such unpaid chores are by no means inconsequential as they are estimated to be equal to three days' work per week. This, thus, influences earnings, women's health, and the ability to be a part of the labour market. According to the Global Gender Gap Index (2020), internationally, just 55% of women aged between 15 and 64 are part of the labour force, in contrast to 78% of men.

Crunchbase (2020) further noted unequal funding as another area of gender inequality. This pertains to women not having equal access to loans and equity capital. Just 3% of venture capital is given to companies that women fund, and this is a recurrent problem during each phase of venture capital allocation. New studies indicate that investors usually pose different questions to women and men during idea pitching. Africa Gender Index Report (2019) stated that in Africa, the regional level recorded some noticeable variations in gender gaps. The inequality between men and women in South Africa was less at 61.3%, while the lowest was at 40.3%, 42.1%, and 43.7% for North, Central, and West Africa, respectively. Africa Gender Index Report (2019:14). The National Council to Prevent Discrimination (2023) in Mexico states that in 2018, 51% of females experienced gender discrimination in virtually all places, including academics, politics, and more.

Artificial Intelligence, Diversity, and Gender Equality

Given the above gender inequality, it is essential to ensure that AI systems do not continue replicating these biases as evidence abounds on this (Aquino 2023). DGE is an emerging area within the broad field of AI. The AI and Gender Equality Index (2020) reported a paucity of data on the issue of DGE. Likewise, there is a lack of explicit representation of AI and DGE in the existing AI principles. Despite these, several studies have shown that AI exacerbates existing inequalities in the world. The AI Index Report (2023) reported an overwhelming disparity between the enrolment for a doctorate in AI to be 78.7% male and 21.3% female. Despite that this portrays a 3.2% increase compared to previous reports, it still indicates that gender imbalance continues to increase in higher education with the attendance consequence for gender inequality. Its (2018) report indicated a critically low representation of women in higher education as applicants for AI jobs. It further revealed that 80% of US AI professors in Ivy League universities were men, and just about one-fourth of the undergraduate students in AI classes at Stanford and University of California were women. This idea is corroborated by Susan Leavy's (2018) assertion that the underrepresentation of women in AI design and the overrepresentation of men has the propensity to reverse the advances already recorded in gender equality. Nonetheless, Element AI (2019) reported that just 18% of papers were authored by women at 21 foremost AI conferences. Spain, Singapore, Taiwan, Australia, and China are the countries with different degrees of towering numbers of women authors.

The situation in industries is not much different. Employing adverts and data from online jobs, the AI index uncovered that men were mainly candidates for AI roles in the US in 2017. Similarly, the Global Gender Gap of The World Economic Forum of 2018 noted that a mere 22% of women are found on the AI professionals network on LinkedIn, with no proof of recent development. The report further noted a particular gap where women, on the one hand,

> Gender equality is a basic human right sacrosanct to achieving a flourishing and strife-free world

have more presence in positions like data analysis and information management, and men, on the other hand, occupy the roles of software engineer and senior management positions. The implication of this lacuna in AI gender diversity and research and development (R&D) is that it creates the risk of AI systems worsening traditional professional inequality even when functioning according to intent. A non-diverse R&D team will be one whose awareness level is low or one with less sensitivity to the risks for either social groups as a whole or vulnerable populations.

Africa, Diversity/Gender Equality in AI

Goffi (2023) opines that the AI terrain in Africa is still grossly underdeveloped as the continent lags in discussions about the formulation of policies and ethical principles that reflect the values and ethos of the continent. Kwao et al. (2023) highlighted eight principles fundamental to teaching AI ethics to future African leaders, especially in the Agricultural and health sectors. They argue that these principles would also help address data bias. Less discussed among the principles are those on respect of human rights, society and the environment, and contestability. Olojede (2023) argued for principles of solidarity, subsidiary, human dignity and natural law as African AI ethical principles that resonate with African values. In a similar vein, Kiemde et al. (2022) argue that there is a need for AI ethics education to foster the incorporation of African AI ethical values, engender diversified AI teams, and consequently create responsible AI in Africa. Borokini et al. (2023) decried the disproportion use of chatbots as females in Nigerian commercial banks, the asymmetry of women in the service industry, the negative perception these elicit in the minds of users, and the reinforcement of prevalent social stereotypes regarding abilities, which could bother on cognitive capabilities of different genders. Ruttkamp-Bloem (2023) leverages the dynamic nature of AI technologies, the unfortunate situation of Africa as an ethical refuse for big technology companies, the import of authentic AI ethics and the necessity for an epistemically fair AI ethics system where Africa participates and leads the discussion opines that epistemic fairness ought to be the basis for regulations to achieve responsible AI ethics in Africa.

Part of what accounts for Africa's backward embrace of AI is the many problems bedevilling the continent, which range from poverty, bad leadership and insecurity. A more directly relevant reason militating against the spread of AI technology is the lack of either electricity, internet, or low bandwidth digitalisation. Amane et al (2020) further highlighted a dissimilar in internet use on the continent, with southern Africa taking the lead with 55%, 12% in central Africa with 149% of the population in southern Africa using mobile subscriptions, 102% in northern Africa and only 50% in central Africa.

These problems, thus, make it impossible for diversity and gender equality in AI to occupy the front burner in Africa, which in turn has made policy formulation impossible. For instance, Research ICT (2023) revealed minimal awareness of AI and DGE as people are more aware of AI's goods and benefits, which tend to overshadow any form of critical attitude. In addition to the report, in my professional relation, many tend to be puzzled regarding the relevance of gender equality and diversity in AI discourse. Some go as far as criticising the move as a mere attention-seeking feminist venture. They are thus oblivious that when a data set is not inclusive, that is, if it does not include a comprehensive amount of data on a diverse population, the resulting algorithm cannot just perpetuate existing gender biases but create new ones as well.

Beyond the lack of awareness of AI vis, vis DGE in Africa, there is also the inadequate conception of

gender along mere binary lines of female and male or sometimes women and girl child. Gender and diversity, however, transcend binary lines. While the issue of intersectionality regarding gender fluidity may not be an issue for serious consideration in Africa, DGE in Africa ought to include people living with disability, minority groups, and vulnerable populations whose voices would otherwise not be heard. By this, DGE is thus not limited or narrowly defined or conceived as the inclusion of women and children; it could thus be the inclusion of men and boys who are differently ordered. Inclusion equally entails a consideration of African languages, cultures, and ethos. More importantly, inclusion further implies that Africa is actively engaged in the discussions of AI internationally and is not merely leaving the lead to the West.

Regarding digitalisation and the digital skill gap in Africa, the Africa Growth Initiative (2023) report, which sampled an average of 21 African countries and 18 G20 countries, indicated Africa is behind G20 countries in thematic areas of digital infrastructure, digital entrepreneurship, digital finance, digital public participation, digital skills indicator. There is thus, an urgent need for Africa to step up in digitalisation and the formulation of AI principles and policy that will not just reflect her collective values and cultural tradition but equally important one that takes cognisance of DGE.

Communal approach to DGE in AI in Africa

This communal approach involves community-based participation and multi-stakeholder engagement, focusing on consultation with varied members. It differs from them because it draws on Africa's values of solidarity and human dignity as fundamental drivers of the approach. The communal approach is not the same as communalism, as the latter springs up the agelong contentious debate regarding collectivism and individualism, which is an unwanted distraction in the AI discourse (Ikuenobe 2018; Olúfémi 2016). It, however, has a close affinity with the principle of common good. It differs from the common good as the Thomistic common good, being referred to, calls on everyone to contribute to the common good (CBCE and W 1996). Whereas the communal approach actively brings relevant parties to the table, it seeks everyone's input; it does not merely encourage the populace to work conscientiously

> "Part of what accounts for Africa's backward embrace of AI is the many problems bedevilling the continent, which range from poverty, bad leadership and insecurity."

as the common good does. Another difference between the duo is that the common good incorporates more cognate ideals like the principle of subsidiarity and natural law than the communal approach encompasses.

The Ubuntu philosophy inspires the communal approach. The term Ubuntu is a derivative of the aphorism Umuntu ngumuntu ngabantu, which translates as the personhood of a person is based on others; that is, an individual is only one because of or through the individuality of others. Desmond Tutu argues that no one was born into the world ready-made; we all learn basic human behaviours. Thus, we need one another to be fully human (Tutu 2004). Ubuntu presents African culture as possessing the capacity to convey empathy, worth, mutuality, give-back, and humanity out of the desire to create and maintain just and reciprocal caring communities. Ubuntu philosophy, wherever applied, enhances an African organisation's aboriginal setting. Endemic in the Ubuntu philosophy is the belief in group solidarity, which plays a pivotal role in the continuity of African communities.

Former President Nelson Mandela extols the value and truth of Ubuntu as a universal worldview foundational to an open society (Mandela 2006). The Ubuntu philosophy, sometimes misunderstood, does not imply that people should not seek solutions to their problems. It means they should examine

whether their actions foster improvements in their community. Another implication of the Ubuntu philosophy is that when people are well-treated, it will likely translate to better performance. Ubuntu underpins African cultural life. It demonstrates mutuality, reciprocity, interconnectedness, common humanity and the responsibility of individuals to one another (Koster 1996).

The communal approach is thus conceived as an engagement where various stakeholders and the end users of AI systems are involved in designing, developing, and deploying AI systems. It incorporates two fundamental values: solidarity and human dignity. The communal approach entails responsible participation and action where it is essential, for instance, for different regional governments or various groups such as academic, non-profit organisations, governments, policymakers, practitioners, developers, data scientists, feminist organisations and other various interest groups to share their perspectives, contribute ideas and create recommendations that can be implemented broadly across the AI lifecycle. Communal, from its etymology, has the feature of fostering a sense of belonging and being owned collectively. It is a co-creation, co-ownership approach. It involves more active collaboration and shuns silos. The communal approach to DGE calls us to look out for one another and not inadvertently fall into the shortfall we want to correct. If the AI system, through its algorithms, undermines diversity and gender equality, our collective humanity and dignity are undermined. AI system that is devoid of DGE does not represent our lived experience. It also does not mirror the profundity of human experience. A consideration of DGE is both a philosophical and moral imperative.

Conclusion

This paper has discussed the various traditional issues that constitute gender inequality. Topics such as gender-based violence, health inequalities, gender pay gap, unpaid work, and uneven funding. It further analyses the AI, diversity and gender equality climate in Africa with the myriad of challenges militating against it – a lack of electricity, lack of internet or low bandwidth, and absence of digitalisation. This section also reveals the various proposals on AI ethics and AI education in Africa, gender stereotypes in banks and the need for Africa to lead the discourse beyond being a mere onlooker. The paper then proposes the communal approach, which hinges on concrete engagements with society and incorporates two fundamental values, solidarity and human dignity, as a framework for building a gender-smart AI system in Africa.

References

African Gender Index. (2019). African Development Bank and United Nations Economic

Commission for Africa. *Africa Gender Index Report*. Available from: https://www.afdb.org/sites/default/files/documents/publications/africa_gender_index_report_2019_-_analytical_report.pdf [accessed on 20/10/23].

Bhorat, H, Signé, L, Asmal, Z and Monnakgotla, J and Rooney, C. (2023). Digitalization and digital skills gaps in Africa: An empirical profile. Available at: https://www.brookings.edu/wp-content/uploads/2023/05/Bhorat-et.-al-May-2023-Digitalization-and-digital-skills-in-Africa-2.pdf [accessed on 24/11/24].

Borokini F, Wakunuma K, Akintoye S. (2023). The use of gendered chatbots in Nigeria:

Critical perspectives. In Eke, D.O., Wakunuma, k., Akintoye S. (eds) *Responsible AI in Africa.* Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-08215-3_6 pp. 119-139. [accessed on 5/6/23].

Bourbonnière, Caroline. (2019). *Element AI Global Talent AI Report*. Available from: https://www.businesswire.com/news/home/20190402005239/en/Element-AI-Announces-2019-Global-AI-Talent-Report. [accessed on 19/09/23].

Crunchbase. (2020). *A Decade in Review: Funding to the Female Founders*. Available from: https://about.crunchbase.com/female-founder-report-2020/#. [Accessed on 5-6-2023].

Correa, N., Galvao, C., Santos, J., Pino, C., Pinto, E., Barbosa, C., Massmann, D., Mambrini, R., Galvao, L., Terem, E., Oliveira, N. (2023). Worldwide AI ethics: A review of 200 guidelines and recommendations for AI governance. *Patterns*. 4(10). https://doi.org/10.1016/j.patter.2023.100857. [accessed on 20/6/24].

Dannouni A, Maher H, and Gildemeister J et al. (2020). The race for digital advantage in Africa. *Boston Consulting Group.* Available from: https://www.bcg.com/publications/2020/race-digital-advantage-in-africa [accessed on 20/6/24].

European Parliament (2023) Understanding the gender pay gap definition and causes. Available from: https://www.europarl.europa.eu/news/en/headlines/society/20200109STO69925/understanding-the-gender-pay-gap-definition-and-causes. [accessed on 20/6/23].

European Parliament. (2003). European Union Act on AI. Available from: https://www.europarl.europa.eu/doceo/document/TA-9-2023-0236_EN.html. [accessed on 20/6/23].

Future of Life Institute. (2017). *Asilomar AI Principles*. Available from: https://www.fhi.ox.ac.uk/asilomar-ai-principles-announced/ [accessed on 18/10/2023].

Goffi E., (2023). Teaching Ethics Applied to AI from a Cultural Standpoint: What African "AI Ethics" for Africa? In Caitlin Corrigan, Simon Asakipaam, Jerry Kponyo and Christoph Luetge (eds) *AI Ethics in Higher Education: Insights from Africa and Beyond.* Springer.

World Economic Forum. (2020). Global Gender Gap Index. Available from: https://www3.weforum.org/docs/WEF_GGGR_2020.pdf. [accessed on 20/6/23].

Ikuenobe P., (2018). Human rights, personhood, dignity, and African communalism. *Journal of Human Rights*, 17(5), pp. 589-604.

International Labour Organization. (2016). *Addressing Gender Gaps in Africa's Labour Market*. Available from: https://www.ilo.org/africa/media-centre/pr/WCMS_458102/lang--en/index.htm [accessed on 16/7/23].

Kiemde SMA. (2022). Towards an ethics of AI in Africa: rule of education. *AI and Ethics.* 2. Available from: https://doi.org/10.1007/s43681-021-00106-8. [accessed on 16/7/23].

Kwao PK, Kanubala DD, Sonna B. (2023). AI ethics education for future African leaders. In C. C. Corrigan et al. (eds.) *AI Ethics in Higher Education: Insights from Africa and Beyond*. Springer Briefs in Ethics, pp 87–101.

Koster JD., (1996). Managing the transformation. In K. Bekker (Ed.) *Citizen participation in local government*. Pretoria: Van Schaik, pp. 100-115.

Leavy S., (2018). Gender Bias in Artificial Intelligence: The Need for Diversity and Gender. Theory in Machine Learning. *History Studies International Journal of History.* 10(7). https://ieeexplore.ieee.org/document/8452744

Mandela N., (2006). Foreword. In R. J. Khoza (Ed.) *Let Africa lead: African transformational leadership for 21st Century business*. Johannesburg: Vezubuntu.

Microsoft. (2018). *Putting Principles into Practice: How we approach responsible AI at Microsoft.* Available from: https://www.microsoft.com/cms/api/am/binary/RE4pKH5 [accessed on 24/11/24].

Ministry of Defense, UK (2022). *Ambitious, safe, responsible: Our approach to delivery of AI-enabled capability in Defense.* Available from: https://www.gov.uk/government/publications/ambitious-safe-responsible-our-approach-to-the-delivery-of-ai-enabled-capability-in-defence/ambitious-safe-responsible-our-approach-to-the-delivery-of-ai-enabled-capability-in-defence [accessed on 24/11/24].

National Council for the Prevention of Discrimination. Available from: https://eulacfoundation.org/en/national-council-prevention-discrimination-conapred [accessed on 18/8/23].

NATO. (2021). *Summary of the NATO Artificial Intelligence AI Strategy*. Available from: https://www.nato.int/cps/en/natohq/official_texts_187617.htm [accessed on 24/11/24].

Nuwabaine L et al. (2023). Sexual violence and associated factors among women of reproductive age in Rwanda: a 2020 nationwide cross-sectional survey. *Archives of Public Health*, 81(112).

OECD AI Principles. (2019). Available from: https://oecd.ai/en/ai-principles. [accessed on 17/5/23].

Olojede H.T. (2023). Towards an Africa Artificial Intelligence Ethical Principles. *IEEE.* Available from: https://doi.org/10.1109/AAIAC60008.2023.10465379 [accessed on 15/3/24].

Shoham, Y., Perrault, R., Brynjolfsson, E., Clark, J., Manyika, J., Niebles, J., Lyons, T., Etchemendy, J., Grosz, B. and Bauer, Z. (2018). The AI Index 2018 Annual Report, AI Index Steering Committee, Human-Centered AI Initiative, Stanford University, Stanford, CA, Available at: https://hai.stanford.edu/sites/default/files/2020-10/AI_Index_2018_Annual_Report.pdf [accessed on 24/11/24].

Research ICT Africa. (2019). *Gender and Artificial Intelligence Readiness in Africa*. Available from: https://researchictafrica.net/wp/wp-content/uploads/2020/11/RANITP2019-4-AI-Gender.pdf [accessed on 24/11/24].

Ruttkamp-Bloem E. (2023). Epistemic Just and Dynamic AI Ethics. In Eke, D.O.,

Wakunuma, k., Akintoye S. (eds). *Responsible AI in Africa.* London: Palgrave Macmillan, pp. 13-34. https://doi.org/10.1007/978-3-031-08215-3_2. [accessed on 22/5/2023].

Shamira A. (2021). A gender perspective on the use of AI in the African Fintech

Ecosystem: case studies from South Africa, Kenya, Nigeria and Ghana. https://ideas.repec.org/p/zbw/itsb21/238002.html. [accessed on 22/5/2023].

Stathoulopoulos K, Mateos-Garcia J (2019). *Gender Diversity in AI Research*. Available from: https://media.nesta.org.uk/documents/Gender_Diversity_in_AI_Research.pdf [accessed on 24/11/24].

Táíwò O. (2016). Against African Communalism. *Journal of French and Francophone Philosophy*. 24 (1), pp.81-100. [accessed on 8/8/2024].

The White House. (2022). *Blueprint for an AI Bill of Rights: Making Automated Systems Work for The American People.* Available from: https://www.whitehouse.gov/wp-content/uploads/2022/10/Blueprint-for-an-AI-Bill-of-Rights.pdf [accessed on 7/7/23].

Tutu D. (2004). *God has a dream: A vision of hope for our future*. London: Rider.

The AI Index Report. (2023). *Diversity*. Available from: https://aiindex.stanford.edu/wp-content/uploads/2023/04/HAI_AI-Index-Report-2023_CHAPTER_7.pdf. [accessed on 1/10/24].

The Common Good and the Catholic Church's Social Teaching.

A Statement by the Catholic Bishop's Conference of England and Wales. Available from: https://www.cbcew.org.uk/content/download/34882/259028/file/common-good-1996.pdf [accessed on 24/11/24].

The World Bank. (2022). *Nearly 2.4 billion Women Globally Don't Have Same Economic Rights as Men.* Available from: https://www.worldbank.org/en/news/press-release/2022/03/01/nearly-2-4-billion-women-globally-don-t-have-same-economic-rights-as-men [accessed on 24/11/24].

Tschopp M. (2021). *AI for Gender Equality*. Available from: https://www.researchgate.net/publication/349376382_AI_FOR_GENDER_EQUALITY [accessed on 24/11/24].

U.S. Department of Defense. (2020). *DoD Adopts 5 Principles of Artificial Intelligence Ethics*. Available from: https://www.defense.gov/News/News-Stories/article/article/2094085/dod-adopts-5-principles-of-artificial-intelligence-ethics/ [accessed on 24/11/24].

UNESCO. (2020). Artificial intelligence and gender equality: key findings of UNESCO's Global Dialogue. *Artificial Intelligence and Gender Equality.* Available from: https://unesdoc.unesco.org/ark:/48223/pf0000374174. [accessed on 20/10/2023].

Workplace Gender Equality Agency. *Annual Report 2021-2022.* Available from: https://www.wgea.gov.au/sites/default/files/documents/Attachment%20A%20-%20WGEA%20annual_report_21%2022.pdf [accessed on 24/11/24].

World Economic Forum. (2023). *Global Gender Gap Report*. Available from: https://www3.weforum.org/docs/WEF_GGGR_2023.pdf [accessed on 24/11/24].

Challenges and Prospects of Deploying AI and Machine Learning for Clinical Diagnosis in African Healthcare

by Edmund Terem Ugar

Abstract

The integration of artificial intelligence (AI), machine learning (ML), and robotics into clinical diagnosis has become prevalent. For example, ML-driven image recognition has demonstrated remarkable efficacy, prompting clinicians to rely increasingly on these technologies for "accurate" medical diagnoses and prognoses of diseases. Although these advancements have exhibited their relevance and effectiveness in medically advanced regions of the Global North and selected areas in the Global South, the question arises as to their viability within the healthcare landscape of Africa, given contextual variations. In this paper, I delve into the potential efficiency of deploying these technologies within African healthcare, aiming to address these contextual concerns. Employing a phenomenological methodology, I demonstrate that the deployment of these technologies might inadvertently introduce biases and discrimination against Africans. This stems from the inherent nature of the data used to develop these technologies, primarily sourced from healthcare experiences in designing nations, coupled with the pervasive algorithmic biases prevalent in contemporary ML systems. I call for a paradigm shift in AI and ML development. I propose that African nations should proactively engage in the design of healthcare AI and ML technologies that are attuned to distinct African conditions, prevalent medical conditions, and prognostic methodologies. Key prerequisites include the establishment of robust infrastructure for efficient data collection and storage of electronic healthcare records and capturing the intricacies of day-to-day healthcare encounters across the African continent. Furthermore, I underscore the importance of contextual sensitivity in applying AI and ML within African healthcare.

> "I propose that African nations should proactively engage in the design of healthcare AI and ML technologies that are attuned to distinct African conditions, prevalent medical conditions, and prognostic methodologies."

Introduction

What are the ethics of designing context-sensitive AI and medical ML technologies within Sub-Saharan African healthcare? Are current ML technologies trustworthy, and can they effectively carry out complex medical diagnoses in Sub-Saharan Africa? In this paper, I argue that to design effective, trustworthy and ethical ML for Africa, these designs ought to centre on African agency, that is, attuned to the African experiences, values, and healthcare norms, on the one hand. On the other hand, a context-sensitive design of medical MLs in Sub-Saharan Africa will be a technology that understands the factual and value-laden judgement on what is considered as health and diseases in the region. Furthermore, it is imperative that medical AI and ML technologies are designed using healthcare datasets from Sub-Saharan African healthcare systems rather than externally sourced from elsewhere. My claim that healthcare datasets must be sourced within Sub-Saharan Africa should not be understood as a homogenous data-gathering process, leading to a generic design of medical AI and ML technologies. If this is done, it defeats the aim of this paper, as a homogenous/generic design of medical AI and ML for Africans implies that Africans have the same healthcare values and norms captured in their datasets. I engage with this point later on in this paper.

My above-prized approach is necessary for designing ethical, trustworthy, and value-sensitive AI and medical ML technologies in Sub-Saharan Africa because of the disruptive nature (which I will clearly explain later) of these technologies. AI encompasses "a broad set of sophisticated computer-based statistical tools" (Ranka et al. 2021:26) and may be defined as "an area of computer science devoted to developing systems that can be taught or learn to make decisions and predictions within specific contexts" (Smith and Neupane 2018:10). AI systems "display intelligent behaviour by analysing their environment and taking actions — with some degree of autonomy — to achieve specific goals" (EC 2018: n.p.). AI algorithms are particularly useful because they "can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments" (OECD 2019b:7).

Given the capacity of AI, the technology has become prevalent in healthcare and/or medical decision-making. It is worth noting that the application of AI in healthcare is not a recent innovation. Early uses occurred in the 1970s when early forms of AI were used to diagnose and treat pathologies such as glaucoma and other infectious diseases by implementing Bayesian approaches (Owoyemi et al. 2020). However, with the growing application of ML techniques, a subfield of AI, in the second decade of the present century, AI has become more significant in medicine and, increasingly, in public health. Image recognition, in particular, has become highly effective, and clinicians increasingly rely on ML technologies for clinical diagnosis and prognosis of medical conditions (Grote and Berens 2019).

While the use of ML techniques has been applied to the diagnosis of neurodegenerating diseases such as Parkinson's, Alzheimer's, mild cognitive impairment (Myszczynska et al. 2020), cardiovascular diseases (Ranka et al. 2021), or skin diseases such as skin cancers (Esteva et al. 2017), to mention a few, the technology generally suffers from algorithmic bias, misrecognition, and discrimination against specific demographics of the human population, especially along racial lines. ML algorithmic bias

is a result of the technology's poor track record in recognising people of certain populations, such as Asians and those categorised as Black Africans (Angwin et al. 2016; Aquino 2017; Barocas and Selbst 2016; Buolamwini and Gebru 2018; Castro et al. 2023; Forrest 2021; Greene 2023; Hellman 2020; Holm 2023; McCullom 2017; Sloane 2022).

The problems mentioned above stem from the misrepresentation and/or poor representation of the aforementioned population in the ML designing dataset. In healthcare, the problem of misrepresentation and/or poor representation of some populations in ML designing datasets stems from healthcare/medical decision-making and distribution of healthcare/medical resources due to socioeconomic inequalities (Braveman et al. 2010; Cavallero 2019; Ekmekci and Arda 2015; Marmot et al. 1991; Wilkinson 1996; Wilkinson 2003). However, in this paper, focusing on the African AI ecosystem, I claim that most ML technologies are not developed within the African continent; hence, the less inclusivity of data that captures African daily lived experiences in the designing dataset of AIs and MLs results in algorithmic bias and discrimination against Africans.

To solve the problem of algorithmic bias and discrimination in AI and ML technologies in healthcare, I make the following new Submissions. First, the technologies should be designed in Africa and encoded with the necessary features to understand the African experiences. Second, the majority of the designing datasets for these technologies must be sourced from African healthcare systems, as this is necessary for the efficient design of medical AI and ML technologies for African healthcare that are trustworthy. Third, the African Union must make pragmatic efforts to ensure that the primary data collection techniques and storage systems are provided in healthcare systems across the continent for efficient data collection and storage for the research and design of ethically efficient and trustworthy AI and ML technologies. Finally, to achieve value-sensitivity in the design of medical AI and ML for healthcare in Africa, the designing ethical guidelines and frameworks must be centred around dominant African values, cultures, and norms.

This chapter has three sections. In the first section, I outline the promises of AI and ML technologies in healthcare. Furthermore, I expose some of the implications and challenges of ML techniques in healthcare. In the second section, I engage with the technological landscape and ecosystem in Africa. The aim here is to see Africa's readiness to engage with the designs of medical AIs and MLs. Additionally, I show the necessity for an African design of AI and ML for Africans. Finally, I make some novel pragmatic recommendations for a way forward on how Sub-Saharan Africa can advance and upskill its technology research and design, especially within the healthcare domain.

> "…the technologies should be designed in Africa and encoded with the necessary features to understand the African experiences…"

The Promises of Artificial Intelligence and Machine Learning Technologies

The development, deployment, and application of AI in different industries are increasing rapidly (Borenstein and Howard 2021). With this rapid increase, AI is now occupying a transformative space in our societies as it continues to affect lives, experiences, and the social, political, and economic landscapes (Luan et al. 2020). To understand what AI means, many theorists have theorised this technology in different ways while bearing in mind the positive and adverse effects of the technology (EC 2018; Smith and Neupane 2018; Tremblay 2017; Ugar 2022; Van de Poel 2020).

The definition of AI has progressed or has been conceptualised according to the different social milieu and the effects of AI within each milieu. For instance, between the 1950s to 1980s, AI was understood solely to be a branch of science

responsible for developing intelligent systems (Brey and Soraker 2009; Hayes and Ford 1995; Luxton 2016). This conception of AI stems from Alan Turin's (1950) exposition of AI in Turin's famous argument, "Can machines think?" Since Turin introduced the notion of AI, other definitions of AI technology have sufficed. AI is sometimes conceptualised as a technology designed to perform activities requiring intelligence (Flowers 2019). In the last two decades, the definition of AI has transcended beyond the mere conceptualisation of the technology as just a machine. AI is now conceived as a technology meant to mimic the intricacies of human interactions, comprehension, sensing, actions, and intelligence (Hamet and Tremblay 2017; Smith and Shum 2018). Given these qualities of AI, it is said to change different aspects of our society, such as how we do business, public health, foster innovations, increased productivity and service delivery, and agriculture (Borenstein and Howard 2021).

In the current social milieu, the definition that best captures the current role AI plays in society and how the technology is viewed is provided by the theorist Ibo van de Poel (2020). Van de Poel defines AI as a sociotechnical system made of "technical hardware, human behaviours, and social institution" (2020:391). For AI to function properly, the system relies on certain portfolios or Subfields, such as machine and deep learning, natural language processing, and computer vision (Esteva et al. 2019). ML, a Subfield of AI, enables the sociotechnical system to learn from the pool of data that has been made available to the system to allow it to make predictions and decisions for users (Norgeot et al. 2019; Ranka et al. 2021). Additionally, deep learning, as a Subfield of machine learning technology, using large datasets has enabled ML algorithms to interact with data and other aspects of machine learning systems such as image recognition, language and speech recognition and processing to carry out tasks (Esteva et al. 2019; LeCun et al. 2015). These AI tools are essential in public health and medicine to carry out diagnosis, as I will show in the preceding paragraphs.

ML technology has become an important aspect of public health and medicine, especially for diagnosing and treating diseases. This technology has the potential to transform healthcare. Given the potential of ML, there has been a recent interest to further introduce the technology in medical and healthcare decision-making (Esteva et al. 2019; Grote and Berens 2019; Myszczynska et al. 2020). This is on the basis that the techniques have demonstrated expertise and accuracy in diagnosing diseases such as neurodegenerating diseases, skin lesions, skin cancer, and fundus images (Esteva et al. 2017; Grote and Behrens 2019; Topol 2019). With the accuracy of machine learning algorithms in clinical diagnosis and expertise in predictive abilities, clinicians will benefit immensely from the assistance the technology will provide them in assessing patients' risks individually on complex datasets.

Machine learning technologies are expected to move from curing diseases to preventing diseases in the near future (Myszczynska et al. 2020). For example, a significant number of the global population is ageing, and the risk of neurodegenerating diseases is increasing. Age is a significant explanans of neurodegenerative diseases like Parkinson's, Alzheimer's, mild cognitive impairment, and motor neuron diseases. With the high cost of treating these diseases, the call for using ML technology for early clinical diagnosis and prognosis is imperative.

While machine learning technologies have great promises in public health and/or medicine, there are some significant ethical concerns that these technologies raise. One is the issue of algorithmic bias, misrecognition, and discrimination due to an imbalance in datasets used to train AI algorithms (Angwin et al. 2016; Buolamwini and Gebru 2018; Castro et al. 2023; Forrest 2021; Greene 2023; Hellman 2020; Holm 2023; McCullom 2017).

For example, evidence shows that facial recognition (FRT) and recidivism software have higher accuracy among Caucasians than African Americans, Africans, and Asians (Buolamwini and Gebru 2018; McCullom 2017). In some instances, FRT has lower accuracy for darker skin colours than lighter skin (Buolamwini and Gebru 2018). This raises a severe problem for clinical diagnosis of people of colour, such as African Americans, Africans, and Asian people, given the current biases and the low accuracy of the representation of these populations in machine learning software. This problem may seem like a practical problem. However, I argue that bias in machine learning technologies results from conceptual, methodological, and ethical issues that require some philosophical skills to resolve.

> "Van de Poel defines AI as a sociotechnical system made of "technical hardware, human behaviours, and social institution" *(2020:391)*."

For example, with the current designs of machine learning algorithms, there is a challenge that people of 'minority identities', such as race (blacks, Asians and others), may find it challenging to access proper healthcare services due to the poor representation of these populations in datasets used in designing these technologies. However, issues of poor representation of 'minority populations' in datasets result from the basic structures of societies and the unfair distribution of societal goods across different demographics in society (Ugar 2023). Issues of these kinds have not been sufficiently dealt with due to the shortcomings of the current guiding principles for the distribution of social goods in society. However, I will leave the above problem for another project. In this paper, I narrow my concern to the impact of structural biases and discrimination in algorithms within the context of Sub-Saharan Africa. I contend that it is a prerequisite for Africans to begin producing their medical machine learning technologies to circumvent the abovementioned problems of machine learning technologies. This is because ML technologies, especially those in healthcare, are designed using healthcare datasets from the context where they are designed to achieve efficiency. If these technologies are not currently designed here in Sub-Saharan Africa, it means the datasets, which capture the worldviews of Sub-Saharan Africans are not present in the design to create efficiency.

However, the pragmatic question to ask is: Can Sub-Saharan Africans design their medical technologies? Since the data used in designing medical technologies are produced from medical and/or healthcare judgments, such as treatment judgments of clinicians over a period of time, I ask whether Sub-Saharan African healthcare systems have the requisite technologies needed for the extraction of healthcare data for research and designs of medical technology. My answer is not in the affirmative. However, Africans producing their technology is the best alternative to mitigate structural biases and discriminations in algorithms used in the continent to tackle healthcare challenges.

It is imperative for Africans to resist the proclivity to deploy technologies elsewhere to deal with their healthcare challenges. According to my intuition, technologies designed elsewhere are not produced with African agency in mind, such as values, ethics, lived experiences, and worldviews, given that the data used in designing these systems do not dominantly come from Africa. Furthermore, given the problem of structural biases and discrimination that people of colour and black people have experienced, deployed technologies are less trustworthy. As a result, this paper calls for the design of medical technologies within Africa which considers the contextual healthcare experiences of Africans. For the above to be realistic, Africans must look inward towards their indigenous knowledge systems, values, and lived experiences to enable them to design context-sensitive machine learning technologies for their healthcare systems. Designing these technologies in Africa can be made possible by capturing data from Africa that emanates from the continent, as well as capturing their lived experiences, especially within the healthcare domain.

However, while the above is ideal, I am not oblivious to some of the contextual challenges that may impede an African design of medical machine learning technologies. As a result, in the next section, I show some challenges Africans might face in designing their healthcare machine learning technologies. However, I also provide motivations and rationale for dealing with these challenges to

create a sustainable and efficient technological ecosystem in Africa that can see to the design of efficient ML technologies.

Technological Landscape and Ecosystem in Africa

There have been several conversations regarding the design of AI in Africa, which has been championed by the African Union (AU). The goal of the AU has been intended to protect African interests from disruptive technologies as well as ensure that the continent is prepared to welcome this technological revolution, construed broadly as the Fourth Industrial Revolution (4IR), which comprises the Internet of Things (IoT), robotics, AI, genetic engineering, and others. The AU has ensured that from the regulatory side of this discourse, Africans are protected. The AU has also ensured that there is a template which could enable Africans to take advantage of this technological revolution.

> “…evidence shows that facial recognition (FRT) and recidivism software have higher accuracy among Caucasians than African Americans, Africans, and Asians *(Buolamwini and Gebru 2018; McCullom 2017)*”

For instance, the AU’s panel, the African Union High-Level Panel on Emerging Technologies, which was instituted in 2016 consisting of expert groups, was set to ensure that it provides expert guidance to the AU on matters of technology and how to harness these emerging technologies for the benefits of Africans (AUDA-NEPAD 2016). Given that the AU is very interested in the responsible use of social technologies, the expert group is designed to ensure Africa’s readiness to engage with emerging technologies. Furthermore, the AU also instituted the African Union Working Group to oversee the development of AI in 2019 (African Union 2019). The working group’s focus is to ensure there is development and acquisition of technical skills, efficient data infrastructure growth across member states, and support for interstate research on AI (Ministry of Communication and Information Technology 2019). Other groups like the African Commission on Human and People’s Rights (ACHPR) are also tasked to undertake multidisciplinary studies to grasp how AI impacts the continent. The group is also ensuring that it develops effective frameworks that will ensure effective AI governance and encourage the responsible use of AI in the continent (ACHPR 2021).

Before I go further, it is important that I clarify my use of the term ‘Africa’ or ‘Sub-Saharan Africa’ to encompass all the countries in this region. My use of the term ‘Africa’ as a group should not be understood as blindly labelling the narrative of the entire continent from a monolithic lens, as this is a common practice. One of the unconscious things that is usually done in the discourse on AI, especially in the narratives of the technology ecosystem in Africa, is the assignment of geographical labelling, which is problematic. Geographical labelling here is the assumption that people are the same or monolithic in a particular geographical area. For instance, Africa is mostly considered monolithic in anthropological scholarship, and researchers from this domain tend to conceive Africans with the “myth of unanimity” (Segun 2014).

The “myth of unanimity,” in simple terms, is conceived as the erroneous notion that individuals within or from a certain region tend to think alike, and their beliefs and perceptions of reality are intertwined (Segun 2014). This sort of thinking ascribes homogeneity to Africans by circumventing the reality that the continent has 54 political states

with inhabitants with different features, cultures, and ethical values and ethos. In this sense, when the myth of unanimity is carried out, people within that context, in this case, Africans, are stripped of their individuality and collective belief is assigned to them (Hountondji 1983:60). An example of the myth of unanimity here is to conceive Africans as having a homogenous approach to healthcare, a value-laden judgment of diseases, and approach to mitigating health challenges. However, the assumptions above are not always accurate but merely an uncritical form of geographical labelling.

However, exposing what geographical labelling means allows me to use the label 'Africa' or 'Sub-Saharan Africa' without falling into the myth of unanimity. I use geographical labelling similarly to how Thaddeus Metz (2015) uses the term. Here, Metz conceives geographical labelling as the method of picking out salient features that are recurrent within a particular geography and not in other geographical regions. As Metz claims, such a method should not be considered a form of essentialising these features. By essentialising, I mean creating an impression that the features of a particular geography are not found elsewhere. Geographical labelling only deals with recurrent features (Metz 2015:1176; Segun 2020). A recurrent feature is a feature that is dominant within a particular environment. For example, one can say that Kangaroos are more prevalent in Australia than anywhere else. This claim does not imply that there are no Kangaroos in other parts of the world; instead, it means that there are more Kangaroos in Australia than in other parts of the world. Another example, patterning to the AI ecosystem, could be that there are more AI industries in China, the US, and India than in Africa. Again, the claim is not that Africa does not have AI infrastructures but that the presence of these infrastructures is not dominant in Africa compared to the abovementioned countries.

My use of geographical labelling ought to be understood strictly along the above lines, highlighting those dominant features in a particular domain rather than assigning a collectivist notion of those places. Africa has salient features unique to the continent due to some socioeconomic and historical features that countries within this political region share. As a result, it is in line with these thoughts that I use Africa/Sub-Saharan Africa as a reference in making my case for the design of medical AI infrastructure in Africa. Furthermore, I think that Africans, mainly Sub-Saharan Africans, share a similar approach to remedial medicine. There are similarities between Africans addressing health challenges through traditional medicine like herbs, roots and others. Additionally, Africans share similar challenges in healthcare across the different countries within the continents, that is, challenging infrastructures, access to vaccines, and other socioeconomic and political factors. These factors justify my usage of the label 'Africa' or 'Sub-Saharan Africa' to make my case.

On the above account, it is worth mentioning that Africa is getting in line with the design of AI and setting infrastructures in place for an efficient and effective AI ecosystem within the continent. This narrative is vital to point out, given the depiction of Africa by the media to the rest of the world as a region that is incapacitated to develop itself. Furthermore, I seek to make a case that Africans can develop their technologies, especially medical machine learning technologies, that mirror African lived experiences given the number of emerging experts within the continent.

Why is it very necessary for Africans to develop technologies that mirror African lived experiences? There are several reasons, that form the yardstick for my proposition that Africans should develop their medical machine learning technologies, some of which I have clearly espoused (structural discriminations and biases) in the previous section. A further reason is based on the view that

"it is worth mentioning that Africa is getting in line with the design of AI and setting infrastructures in place for an efficient and effective AI ecosystem within the continent."

technologies are not innocuous; when adopted, they influence users' behaviours in many ways (Ihde 1993; Rajagopal 2014; Ugar 2023b). This includes changing how the users begin to lead their lives, visualise the world, and engage with one another while carrying out their day-to-day tasks/businesses. Furthermore, as espoused in the previous section of this paper, current machine learning technologies are guilty of structural biases and discriminations, given their designing datasets. However, in the following paragraphs, I would like to stick to the value influences technologies have on their users to make a case for the need for value-sensitive design (which can only stem from Africa for Africa) of medical technologies that emerge from Africa.

New emerging technologies influence their users more because of their social nature. It is the reason why many researchers have termed emerging technologies as "sociotechnical artefacts" (Ananny 2016; Reider et al. 2021; Van de Poel 2020). For example, Ibo van de Poel (2020) contends that sociotechnical artefacts like AI and machine learning are designed to comply with specific values, mostly the values of their designers. These designers integrate their institutional values into these systems in order to ensure that the values of the social institutions align with the values of the systems they design. As a result, these technologies are not value-neutral but value-laden instruments, such that when they are transferred from one locale into another, they come with the values of their designers (Ugar 2023b). This view has been expatiated by Don Ihde. Ihde argues that technology transfer has to do with the "introduction of some set of material artefacts out of their original context of human praxes or techniques, into some other cultural context" (1993:32). When technology transfer occurs, value transfer also takes place, leading to the disruption of the values of the receivers of this technology. As a result, given their social nature, medical AI technologies tend to be disruptive. This conception of disruption is similar to Hopster's (2021) conception of the term. Here, Hopster conceives social disruptive technologies as those that tend to disrupt our values, current traditional norms, and how we perceive the world through their unpredictability (2021:2-3; Ugar 2023a).

Given that technology, like AI or machine learning, is designed based on their designers' institutional values and norms, it is crucial to understand the contextual influences of their designers on the sociotechnical artefacts. It is prima facie that values and norms are not universally construed, given that each society has some important values and norms that shape them; what is essential to one society might not be important to another. This is precisely why Africans ought to be at the centre of their design and coding important values into their technologies for clinical diagnosis. Furthermore, as I have argued elsewhere (Ugar 2023b), the transfer of technologies from elsewhere may lead to what I conceived as technological colonialism, a kind of colonialism which is common in our current digital milieu. Additionally, designing our technologies within Africa will make the technology more trustworthy. When users in Africa know that their technologies are designed in Africa, they may have moral, emotive, and psychological motivations to trust the technologies. This is because they may feel that the designers understand their needs, cultures, lived experiences, values, and morals and have encoded these in the systems. Furthermore, because of current structural biases and discrimination and past histories of colonialism and neo-colonialism, AI and machine learning designs from Africa will be more trustworthy by Africans than technologies that are deployed elsewhere. I will not go further into this discussion, as the discourse on trustworthiness in AI and colonial history is broad and cannot be fully captured here. However, moving forward, I will show some of the developments in AI within Africa in the last decade.

Some African countries are ensuring that they foster regulatory and economic readiness for AI design and usage. These countries are proactive in implementing regulations to meet the desire to leverage the prospects of AI for economic development in their countries. Some countries within the African continent are putting in place the infrastructures and other strategies like education. However, even though these countries have been proactive in ensuring the above, the African region still ranks very poorly in the AI government readiness index, scoring on average at around 31.61 (Nettel et al. 2021:44). An explanans of these could be based on the poor performance given the continent's poor data infrastructure, an

"With a growing young population, of which two-thirds are ages 14-19, Africa has the potential for growing global internet users."

essential requirement for efficient AI ecosystem. I will return to this point shortly, as it is part of the basis for my argument in this chapter.

According to a Government AI Readiness Index (2021) created by Oxford Insights, Mauritius, ranking 58th out of 160 countries, is leading Africa's government AI readiness index. Other countries like Egypt (65th), South Africa (68th), Seychelles (70th), and Kenya (78th) are also making progress (Shearer et al. 2020). We can learn from these rankings that most African countries are still not ready compared to countries in South Asia, Europe, and America, which have successfully implemented a national strategy for AI. The hope is that the AU Working Group on AI can develop a consistent template to ensure that the strategy for AI cuts across all African countries while considering their contextual needs and differences (Gilbert 2020).

Despite not ranking in the top 50 countries in terms of the Government AI Readiness Index in the 2020 report – which groups countries based on the measures they have put into place like infrastructures – "African countries are relatively prepared in the Data and Infrastructure pillar, followed by the Government pillar and then the Technology Sector pillar" (Shearer et al. 2020). One could see some positive lights in this regard. However, the growth in the AI ecosystem in Africa results from some knock-on effects of technological globalisation in Africa on account.

The notion of technological globalisation here implies the distribution of technologies globally, but mostly from the Global North to the South. This aspect of the AI narrative boils down to the point I have made earlier and on which my argument is centred. In the sense that technological globalisation, as construed above, has shaped the African technological ecosystem in different directions. The private sector has spearheaded this sector. It has formed the substructure upon which African countries have experienced the rapid growth of technology based on the advancement of telecommunication networks like the Internet. Undoubtedly, telecommunication plays an essential role in fostering the development of AI products. With an internet rate of 46.2% in the 1.3 billion people in 2021, a total number of 634,863,323 Africans have access to the internet (Internet World Stats 2021). With a growing young population, of which two-thirds are ages 14-19, Africa has the potential for growing global internet users. As such, there is a growing and rapid investment within the technology sector within the continent.

However, this development has centred largely on technology transfer, which I discussed earlier. For instance, during the uprising of COVID-19, the United Nations Development Programme provided robots to some African countries to assist frontline healthcare workers. These robots were designed by a Belgian robotic company called "Zora Bots," and the deployed robots were given African names. However, the appearances of the robots reflected the appearances of their designers, that is, white bodies with blue eyes (Botha 2021:124). In as much as there are no prima facie problems with such designs, the underlying challenge that I am trying to point out here is that technologies are designed to mirror and replicate the consciousness (values, social norms, and morals) of their designers.

As mentioned earlier, the problem of technology transfer is that most of the work done is less representative of African ethos, values, tenets, worldviews, realities, and modes of perceiving the world. As a result, these technologies are conceived to be an imposition of the institutional values of their emerging locale on the African locale. Furthermore, different designs of AI have shown bias and discrimination towards Africans along the lines of race, which shows the less representation of Africans, their cultures, and values in the design of AI. Given this, some researchers have called this techno-colonialism or digital colonialism and called for the decolonisation of AI (Abeba 2020; Ugar 2023b). However, in this current study, rather

than decolonisation, I recommend that Africans get actively involved in the design of AI, especially medical AI and machine learning technologies that capture their lived experiences and perceptions of health and diseases. It is my view that to decolonise is to ask that technologies should account for African realities. However, that is too much to ask, considering that we do not fund these projects. Instead, I prescribe that Africans begin to fund their AI projects to ensure that they have the agency, given their financial role in the design of the technologies, to include features necessary to ensure an effective design of these technologies that capture their realities. To ensure the feasibility of the above, I make the following pragmatic recommendations in the final section of this paper.

Pragmatic Recommendations for the Design of Medical Technologies within Africa

The internal design of medical machine learning technologies within Africa is important for the African AI ecosystem based on the reasons I have mentioned in the previous sections. Nevertheless, most importantly, designs stemming from Africa will give Africans the kind of agency and spike trustworthy use of the technologies. Over a period of time, structural adverse like biases and discrimination in machine learning algorithms may be reduced. However, given the current AI ecosystem in Africa and its reliance on machine learning technologies designed elsewhere, especially those in healthcare, it does not seem feasible that Africans are at the forefront of the technological revolution with the requisite skills and infrastructure to design their technologies. However, with some efficient policies in place, I contend that in the near future, Africans will be capable of designing their medical machine learning technologies and machine learning technologies for other domains. To contribute to setting efficient policies in Africa, I make the following prescriptive recommendations.

Efficient Healthcare Infrastructure for Data Availability: As pointed out earlier, data is the most critical component for designing efficient medical machine learning technologies. Given the complexity of clinical diagnosis, it is imperative that we design medical machine-learning technologies with accurate datasets. The best way we can achieve this in Africa is to strengthen our healthcare system with state-of-the-art techniques to collect healthcare data ranging from consultations to treatments of patients. From my intuition, given my experiences with several healthcare facilities in Nigeria and South Africa, data are still recorded manually in most healthcare facilities across the continent, especially in more prominent public hospitals. Sometimes, these manual files are misplaced or destroyed (unintentionally). Given some of the contingencies of manual collection of data, it is crucial that African governments invest in computerised data collection methods for efficiency and robustness. Furthermore, African governments should ensure that more focus and efforts are channelled into public healthcare services, given that they accommodate most of the population in every country. This can lead to more data production as well as diverse datasets.

Robust Investment in Building Machine Learning Infrastructures on the Continent: As I have shown earlier, the technology infrastructures in Africa are still very poor and less encouraging. The AU should invest more in building efficient infrastructures within the continent. These infrastructures should be funded by the AU or request for partnerships and investments elsewhere, of which the AU should have the power for most of the decision-making on how and what technology and skills are necessary. There are different machine learning initiatives in Africa, like DeepLearningNdaba and others. However, more must be done in this area to equip Africans with the necessary skills. Furthermore, while there have been incentives for Africans to engage in STEM disciplines, there should also be incentives for Africans to pay attention to disciplines that critically engage with the effects and implications of machine learning technologies in societies. The technical and social inquiries of technologies must go concomitantly.

Practical and Robust Data Policy in Africa: The AU should also ensure that it puts in place robust data policies within the continent, similar to the EU data laws and regulations. This will ensure that data generated from Africa are kept in Africa and do not leave the continent. This can be an added advantage for the continent to develop patent and intellectual properties of their unique innovations.

Conclusion

In this paper, I have highlighted some of the significant prospects and challenges of deploying machine learning technologies for clinical diagnosis in Africa. However, I argued that for Africans to have agency and trustworthiness in their medical technologies, the technologies must be designed within the continent using data that captures the healthcare and lived experiences, values, and worldviews of their context. As clearly argued, the above is imperative because of structural biases and discrimination of current algorithms due to poor datasets and how this might be problematic in Africa due to technology transfer. However, as exposed in section two of this chapter, I am not oblivious to the challenges designing technologies for clinical diagnosis in Africa might face. As a result, I made some pragmatic recommendations in the last section of this chapter. The significance of my paper is that it draws from the issues of structural biases in AI to provide practical ways AI can be designed in Africa for clinical diagnosis to strengthen trustworthiness in these technologies. However, the limitation of my paper is that it does not rely 'so much' on making empirical claims but is based broadly on conceptual analysis. I leave the empirical aspect of this study to empirical social scientists to conduct further research on.

References

African Commission on Human and Peoples' Rights. (2021). *Resolution on the need to undertake a Study on human and peoples' rights and artificial intelligence (AI), robotics and other new and emerging technologies in Africa - ACHPR/Res. 473 (EXT.OS/ XXXI) 2021* [Press release]. Available from: https://www.achpr.org/sessions/resolutions?id=504 [accessed on 24/11/24].

African Union. (2019). *African Digital Transformation Strategy and African Union Communication and Advocacy Strategy among major AU initiatives in final declaration of STCCICT3* [Press release]. Available from: https://au.int/en/pressreleases/20191026/african-digital-transformation-strategy-and-african-union-communication-and [accessed on 24/11/24].

Ananny, M. (2016). Toward an ethics of algorithms: Convening, observation, probability, and timeliness. *Science, Technology, & Human Values*, 41(1), pp. 93–117.

Angwin, J., Larson, J., Mattu, S., and Kirchner, L. (2016). Machine bias. *ProPublica.* Available from: https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing [accessed on 24/11/24].

AUDA-NEPAD (2016) *African Union High-Level Panel on Emerging Technologies (APET)*. Available from: https://www.nepad.org/microsite/african-union-high-level-panel-emerging-technologies-apet [accessed on 24/11/24].

Aquino, Y. (2017). Big eye surgery: The ethics of medicalising Asian features. *Theoretical Medicine and Bioethics*, 38(3), pp. 213–225.

Barocas, S. and Selbst, A. (2016). Big data's disparate impact. *California Law Review,* 104(671), pp. 671.

Botha, C. (2021). Gender and humanoid robot: A somaesthetic analysis. *Filosofia Theorectica: Journal of African Philosophy, Culture and Religions,* 10(3), pp. 119-130.

Buolamwimi, J. and Gebru, T. (2018). Gender shades: Intersectional accuracy disparities in commercial gender classification. *Proceedings of Machine Learning Research*, 81(2018), pp. 1-15.

Braveman, P., Cubbin, C., Egerter, S., Williams, D. and Pamuk, E. (2010). Socioeconomic disparities in health in the United States: What the patterns tell us. *American Journal of Public Health*, 100 Suppl, 1(Suppl1), S186-S196.

Brey, P. and Søraker, H. (2009). Philosophy of computing and information technology. *Philosophy of Technology and Engineering Sciences,* Elsevier, pp. 1341–1407.

Cavallero, E. (2019). Opportunity and responsibility for health. *The Journal of Ethics*, 23(4), pp. 369-386.

Ekmekci, P. and Arda, B. (2016). Enhancing John Rawls's theory of justice to cover health and social determinants of health. *Acta Bioeth*, 21(2), pp. 227-236.

Esteva, A., Kuprel, B., Novoa, R., Ko, J., Swetter, S., Blau, H. and Thrun, S. (2017). Dermatologist-Level classification of skin cancer with deep neural networks. *Nature,* 342(7639), pp. 115–118.

Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., Cui, C., Corrado, G., Thrun, S. & Dean, J. (2019). A guide to deep learning in healthcare. *Nature Medicine*, 25(2019), pp. 24-29.

European Commission. (2018). *Artificial intelligence for Europe*. Available from: https://www.europeansources.info/record/communication-artificial-intelligence-for-Europe/ [accessed on 24/11/24].

Flowers, C. (2019). Strong and weak AI: Deweyan considerations. *AAAI Spring Symposium: Towards Conscious AI Systems.* Available from: https://ceur-ws.org/Vol-2287/paper34.pdf [accessed on 24/11/24].

Forrest, K. (2021). *When machines can be judge, jury, and executioner: Justice in the age of artificial intelligence.* Hackensack, NJ: World Scientific Publishing Co. Pte. Ltd.

Gilbert, P. (2020). Mauritius, Egypt and SA are Africa's most AI ready. *Connecting Africa*. Available from http://www.connectingafrica.com/author.asp?section_id=761&doc_id=765789 [accessed on 24/11/24].

Greene, C. (2023). AI and the social science: Why all variables are not created equal. *Res Publica*, 29(2023), pp. 303-319.

Grote, T. and Berens, P. (2019). On the ethics of algorithm decision-making in healthcare. *Journal of Medical Ethics*, 46(2019), pp. 205-211.

Hamet, P. and Tremblay, J. (2017). Artificial intelligence in medicine. *Metabolism* 69(2017), pp. 36-40.

Hayes, P. and Ford, K. (1995). Turing test considered harmful. *Proceedings of the International Joint Conference on Artificial Intelligence, Monreal*, 1(1995), pp. 972-977.

Hellman, D. (2020). Measuring algorithmic fairness. *Virginia Law Review*, 106(4), pp. 811-866.

Holm, S. (2023). The fairness in algorithm fairness. *Res Publica*, 29 (2023), pp. 265-281.

Hopster, J. (2021). What are socially disruptive technologies? *Technology in Society*, Vol. 67(2021), pp. 1-8.

Hountondji, P. J. (1996). African philosophy: Myth and reality. Bloomington: Indiana University Press.

Ihde, D. (1993). Technology as cultural instrument. In: Ihde, D., ed. *Postphenomenology: Essays in the postmodern context*. Illinois: Northwestern University Press, 207-215.

Internet World Stats (2021). *Africa.* Available from https://www.internetworldstats.com/africa.htm [accessed on 24/11/24].

LeCun, Y., Bengio, Y. & Hinton, G. (2015). Deep learning. *Nature,* 521(2015), pp. 436–444.

Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S.J., Ogata, H., Baltes, J., Guerra, R., Li, P., and Tsai, C.C. (2020). Challenges and future directions of big data and artificial intelligence in education. Frontiers in Psychology, 11(580820), pp. 2748.

Luxton, D. (2016). An introduction to artificial intelligence in behavioural and mental health care. *Artificial Intelligence in Behavioural and Mental Health Care*, ***Elsevier***, pp. 1–26.

Marmot, M., Smith, G., Stansfeld, S., Patel, C., North, F., Head, J., White, I., Brunner, E. and Feeney, A. 1991. Health inequalities among British civil servants: The Whitehall II Study. *Lancet (London, England),* 337(8754), pp. 1387-1393.

McCullom, R. (2017). Facial Recognition Technology is both Biased and Understudied. Available from: https://undark.org/2017/05/17/facial-recognition-technology-biased-understudied/?msclkid=b913148dd10911ec932962fbfdac1591 [accessed on 24/11/24].

Metz, T. (2015). How the West was one: The Western as individualist, the African as communitarian. *Education, Philosophy, and Theory,* 47(11), pp. 1175-1184.

Myszczynska, M., Ojamies, P., Lacoste, A., Neil, D., Saffaris, A., Mead, R., Hautbergue, G., Holbrook, J., & Ferraiuolo, L. (2020). Applications of machine learning to diagnosis and treatment of neurodegenerative diseases. *Nature Review/Neurology*. Available from: https://doi.org/10.1038/s41582-020-0377-8 [accessed on 24/11/24].

Nettel, P.F., Rogerson, A., Westgarth, T., Iida, K., Mbayo, H., Finotto, A., Rahim, S., and Petheram, A. (2021). *Government AI Readiness Index 2021*. Oxford Insights.

Norgeot, B., Glicksberg, B., Butte, A. (2019). A Call for deep-learning healthcare. *Nature Medicine*, 25(2019), pp. 14-18.

OECD. (2019). Recommendation of the Council on Artificial Intelligence. OECD Legal Instruments. Available from: https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449 [accessed on 24/11/24].

Owoyemi, A., Owoyemi, J., Osiyemi, A., & Boyd, A. (2020). Artificial intelligence in Africa. *Front. Digit. Health*, 2(6), pp. 2-5.

Rajagopal and Rajagopal. (2014). Disruptive innovations and technologies. In: Rajagopal, ed. *Architecting Enterprise*. London: Palgrave Macmillan, 200-222.

Ranka, S., Reddy, M. and Noheria, A. (2021). Artificial intelligence in cardiovascular medicine. *Curr Opin Cardiol*, 36(1), pp. 26–35.

Rieder, G, Simon, J and Wong, P (2020). Mapping the Stony Road toward Trustworthy AI: Expectations, Problems, Conundrums. In: Marcello, P. and Teresa S. eds. Machines We Trust: Perspectives on Dependable AI. Cambridge, MA: MIT Press, pp. 1-14.

Segun, S. (2014). The prefix African and its implication for philosophy in Africa. *Filosofia Theoretica: Journal of African Philosophy, Culture and Religions*, 3(2), pp. 106-123.

Segun, S. (2020). Critically Engaging the Ethics of AI for a Global Audience. *Ethics and Information Technology*. Available from: https://doi.org/10.1007/s10676-020-09570-y [accessed on 24/11/24].

Shearer, E., Stirling, R., Pasquarelli, W., Chung, Y., Cussins, J., Salem, F., Sey, A., Martinho-Truswell, E., Castets-Renard, C., Pichu, R., and Scrollini, F. (2020). *Government AI Readiness Index 2020*. Oxford Insights. Available from:

https://static1.squarespace.com/static/58b2e92c1e5b6c828058484e/t/5f7747f29ca3c20ecb598f7c/1601653137399/AI+Readiness+Report.pdf [accessed on 24/11/24].

Sloane, M. (2022). AI-driven biometry and the infrastructure of everyday life. Available from: https://www.adalovelaceinstitute.org/blog/biometry-and-infrastructures/ [accessed on 24/11/24].

Smith, L. & Neupane, S. (2018). *Artificial intelligence and human development: Toward a research agenda.* White Paper. International Development Research Centre (IDRC). Available from: https://idl-bnc-idrc.dspacedirect.org/handle/10625/56949 [accessed on 24/11/24].

Smith, B. & Shum, H. (2018). *The Future Computed.* Washington: Microsoft.

Topol, E. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nat Med*, 25(2019), pp. 44–56.

Ugar, E. (2022). Artificial intelligence and African normative accounts of personhood. In: De Oliveira, Tauchen, and Castanheira,N (eds.) *Bioethics, neuroethics, & AI ethics in a post-pandemic world*. Porto Alegre: Editora Fundação Fenix, pp. 87-112.

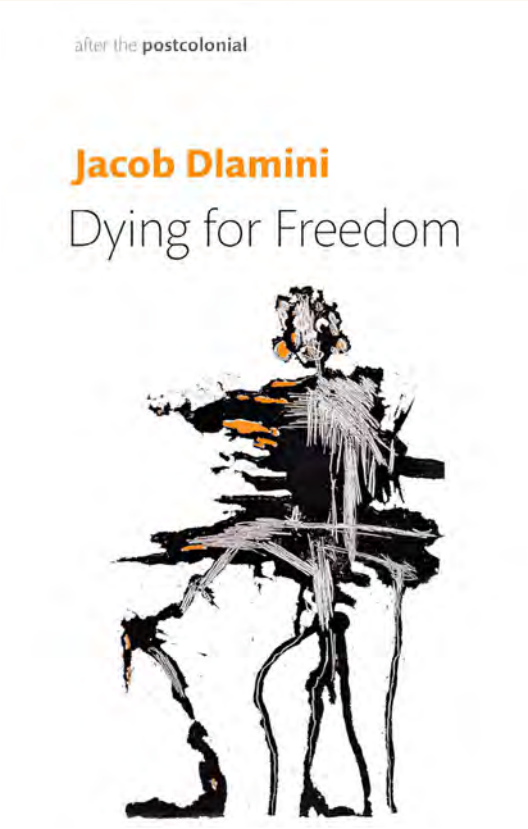
Ugar, E. (2023a). Rethinking remote work, automated technologies, meaningful work, and the future of work: Making a case for relationality. *Philosophy and Technology,* 36(32), pp. 1-21.

Ugar, E. (2023b). The fourth industrial revolution, techno-colonialism, and the Sub-Saharan Africa response. Filosofia Theoretica: *Journal of African Philosophy, Culture and Religion,* 12(1), pp. 33-48.

Van De Poel, Ibo. (2020). Embedding values in artificial intelligence (AI) systems. *Minds and Machines,* 30(2020), pp. 385-409.

Wilkinson, R. (1996). *Unhealthy societies: The afflictions of inequality*. London: Routledge.

Wilkinson, R. (2003). Social determinants of health: The solid facts. Geneva: *World Health Organization Regional Office for Europe*.



A Review of *Dying for Freedom: Political Martyrdom in South Africa* by Jacob Dlamini (Polity Press, 2024).

By Taurayi Munemo

Dlamini's latest book delivers an incisive review of necropolitics in the history of South Africa's political life. According to Achille Mbembe (Necropolitics 2019), necropolitics is the use of both political and social power to dictate how one must live and how one must die. The history of South African politics evinces how dying for freedom was considered the pinnacle of heroism. Championed by the ideas of political activists like Nelson Mandela and Steve Biko, political deaths during apartheid were interpreted as one's passport to a heroic legacy, an experience one had to look forward to. Following this, it is clear why Dlamini decides to explore necropolitics through the notion of political martyrdom in critiquing South Africa's racialised perspective of the sacrifices made by most South Africans during apartheid. In the light of the failure of most South Africans to follow the ways in which they were expected to live and to die, they found themselves stripped of their heroic legacy and some stifled into oblivion as discussed in Dlamini's book.

In addition, Dlamini exposes the 'masculine aspect' that informed how political deaths were to be acknowledged during and after apartheid. In other words, he exposes how, besides the masses, some political activists fought to satisfy their male egos, which resulted in a lack of recognition towards the contributions made by female activists. As a result, the idea of a notable political death has led to the erasure of certain apartheid victims, particularly women, who also sacrificed their lives for South African freedom. For example, the book discusses the unpopularising of Phila Portia Ndwandwe's martyrdom, who, as a female comrade died at the hands of the apartheid security police. Dlamini offers insight on a racialised masculinisation of death through the lack of acknowledgment as a member of the Ndwandwe family and for the role she played in the struggle, which emphasizes how measures of dignity of one's liberation sacrifices are made in gendered terms. Also, the book explores how concealing the names of some comrades elevates them to the position of unmournable bodies, alongside those who were accused of being accomplices to the oppressive system, such as double agents or apartheid informants. Overall, Dlamini argues that such omissions stifle the spirit of the struggle by revoking the very dignity for which the marginalized fought and died.

Drawing from the book of 'Revelations' in the Bible, chapter one portrays martyrdom as an act of witnessing, and Dlamini uses this definition to establish a stunning relation between Mandela's martyrdom and masculinity. In short, Dlamini debunks opinions that Mandela and Biko became witnesses for the anti-apartheid movement out of a desire for the restoration of their manhood and dignity, and that death was the ultimate proof of their masculinity. Yet Dlamini also exposes how Mandela was one of the earliest culprits to politicise death by instrumentalizing death as a negotiating tool in return for the restoration of South Africans' dignity. Dlamini argues that Mandela's attitude attached value to death, prompting a reconsideration of how people died as a measure of the dignity gained through their deaths. The following chapter turns its attention to Steve Biko's attitude toward death, and Dlamini reveals a masculine, aggressive and intellectual response to racial strife. The chapter accentuates how Biko's courageous philosophy enabled him to strip oppressors of the powers of life and death. In one of the interviews noted in the book, Biko actually challenged a security guard 'to kill him or fight him like a man'. Though his attitude eventually led to his death, it established standards upon which political martyrdom would be evaluated in South African politics.

Concomitantly, the discussion of Justice Mafa Ngidi, an ANC leader who escaped from police custody in July 1984, exposes the flaws in the ANC's politicisation of what the dignity of martyrdom entails. For the ANC, martyrdom –not one's life – becomes the pinnacle of political accomplishment. Ngidi's unwillingness to die for the cause, and his so-called lack of masculine dignity fueled the ANC's belief that he was a double agent and sparked a manhunt. Chapter four further expatiates on how the ANC's standardising and politicising of martyrdom resulted in the non-acknowledgement of other deaths, making some deaths more mournable than others. Here Dlamini unpacks the complex case of The Sharpville Mayor, Khuzwayo Jacob Dlamini. Serving as a major of an apartheid state not only made him unpopular in life, but also led to an unacknowledged legacy in death. Dlamini argues that one's collaboration with apartheid did not mean they were agents of the state but should also be acknowledged as political dissidents.

Dying for Freedom proposes a new approach to South African martyrdom and the notion of sacrifice by emphasising the importance of all lives lost during the struggle. According to Dlamini, all black South Africans, whether activists or non-activists and, even those that were labeled double agents, suffered the harshness of apartheid. Therefore, it is for this reason that their suffering should be acknowledged as a sacrifice of their well-being. The book unveils how all lives should be viewed as important and deserving of mourning. In many ways it dethrones the ANC's politicisation of deaths by celebrating all lives that were given and taken during apartheid. The book propounds a more humane approach towards the families and friends of those who sacrificed their lives during apartheid, by advocating for the restoration of their dignity and the kind of acknowledgment that all lives deserve.