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A Glimpse into Botswana's AI Readiness Landscape

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Abstract: This study seeks to provide insights into Botswana's AI readiness landscape. It was achieved by analysing secondary data from the Oxford Insights 2022- Government AI Readiness Index (AIRI). According to the AIRI, Botswana is in position 98, out of 181 countries surveyed. The major drawbacks to successful AI adoption were; a lack of AI strategy, limited capacity to support change, an immature technology sector incapable of supporting innovation, inadequate skills to support AI development, insufficient technological infrastructure to support AI, insufficient data to train AI models, and there are few use cases identified in the public sector. Despite these hurdles, the country is putting in efforts to transform digitally and there are opportunities for improvement. The country is faring similarly, or even better than, regional peers but is lagging behind global peers in the upper middle-income group. Consequently, it is recommended that the government should start by developing an AI strategy to set the vision for AI adoption.

Keywords: Artificial Intelligence, AI Readiness, Botswana, Digital Transformation, Maturity Level

1. Introduction

The emergence of the Covid-19 pandemic has fuelled digital transformation (DT) exercises in both the private and public sectors. The need to improve customer service delivery, increase effectiveness and efficiency, reduce operational costs, increase organizational productivity and, enhance accountability and transparency has also forced governments to undergo Business Process Re-engineering (BPR) through the adoption of digital innovations, such as artificial intelligence (AI) technology. According to Accenture (2023, para 1) AI "is a constellation of many different

technologies working together to enable machines to sense, comprehend, act, and learn with human-like levels of intelligence." It can also be defined as "a computer's ability to recognize patterns and take actions based on available data and statistical models" (Hassani et al., 2020, p.145). AI offers transformational potential across sectors (Collins et al., 2021) and has become the foundation for building smart governments. It is no secret that AI is revolutionizing the public sector. For example; prediction models are being used to generate information, used by policymakers for decision-making. AI has become a key component in the digital strategies of many businesses and governments. It can be viewed as an enabler of digital transformation in the Fourth Industrial Revolution (4IR) era (Ribeiro, 2020). Yet, most organizations fail to understand the foundations desirable for an organization or government to be in a position to assimilate AI technology into its digital transformation strategy (Rogerson, et al., 2022). Based on the above premise, it is vital to explore factors that constitute government AI readiness. This will raise awareness of AI implementation, progress, and readiness factors. Hence, this study focuses on AI readiness at the government level. More specifically, the study focuses on Botswana as a case study. This study aims to provide insights into Botswana's AI readiness landscape. This will be achieved by exploring Botswana's AI readiness from different viewpoints. The specific objectives of this paper are:

1) To expound the findings by Oxford Insights (2022) regarding Botswana's AI readiness;
2) To provide evidence of AI application case studies in Botswana;
3) To make recommendations that will help Botswana get ready for AI deployment.

2. AI Research in the Public Sector

Numerous researches on AI, in the public sector, have been conducted and it is evident that some governments are warming up to the idea of AI adoption (Najdawi, 2020); whilst others are already testing the waters and others are working on enhancing their capabilities in AI usage. For instance, Halaweh (2018) revealed that the United Arab Emirates (UAE) is intentional about AI adoption as it was the first country in the world to launch the Ministry of Artificial Intelligence (AI). Sousa, et al., (2019) also conducted a systematic literature review, to establish what has been published about AI in the public sector and the benefits being generated. The study revealed that the majority of research focused on countries, such as India, the United States (US), Canada and China. Thus, creating a knowledge gap for African countries. Similarly, Susar and Aquaro (2019) discussed the opportunities and challenges related to the use of AI in government. The study also articulated examples of how AI is being applied in various governments, such as Singapore, Kazakhstan, Japan, and Argentina. In addition, the latter study emphasized; (1) the potential of AI to accelerate development and enable developing countries to leapfrog over some traditional obstacles, and (2) that AI brings with it challenges, such as ethical implications and the need to overhaul the education curriculum required for capacity building in preparing the next generation for AI deployment (Susar & Aquaro, 2019). Zhang et al. (2021) also articulated the factors influencing the use of artificial intelligence in government, from the perspective of China.

Although several empirical studies have been carried out on the subject, there is still a shortage of AI readiness studies, specifically addressing African economies. Despite the technological advances in AI, most African governments still provide public services mainly via conventional or non-digital methods and processes. For instance, these traditional services often rely on manual, paper-based systems and face-to-face interactions, which are time-consuming and inefficient. African nations that are undergoing digital transformation still face numerous challenges such, as inadequate budgets, lack of policies and ethical principles, digital divides (both gender and socioeconomic inequality) and inadequate infrastructure (Mutsagondo, 2017; Keakopa, 2022); just to mention a few. Nevertheless, amidst these existing problems, African economies cannot afford to ignore the potential benefits of AI on the society and economy, as a whole. Therefore, governments must assess their readiness to adopt AI technologies before embarking on the implementation exercise.

3. Research Methods

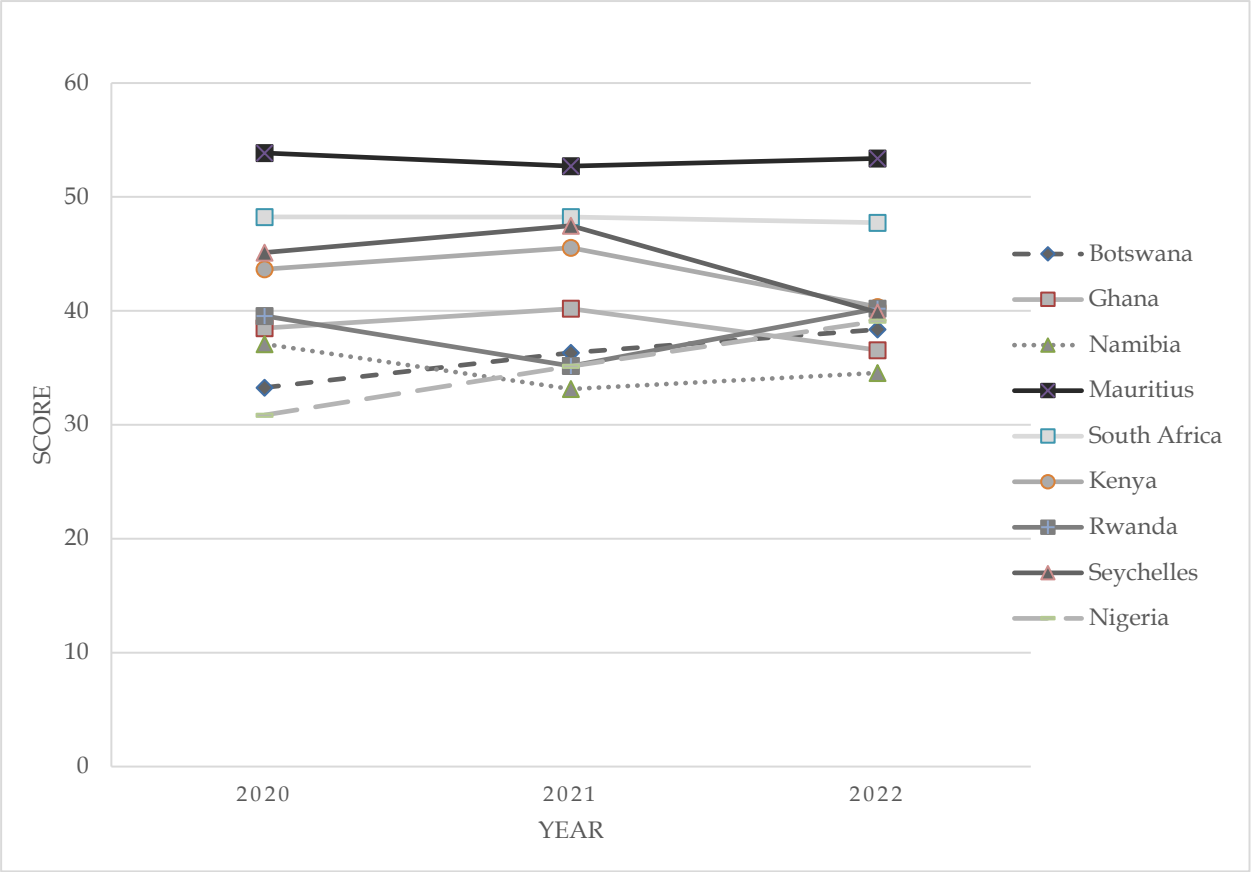
This study mainly adopts a desktop research approach to compiling data required to provide insights into Botswana's digital transformation and AI readiness landscape. Various databases, such as; the University of Botswana Research, Innovation and Scholarship Archive (UBRISA), Botswana International University of Science and Technology Repository (BIUSTRE), Web of Science (WoS), and Google Scholar were used to retrieve journal articles and conference proceedings. This comprehensive literature review serves as the foundation for explicating the AI readiness landscape. In addition to utilizing secondary data sources, the researchers leveraged their personal knowledge and experiences about Botswana's socio-cultural, economic and technological landscape. Also, in some areas, certain data was confirmed via informal conversations with colleagues from parastatals and private organizations. This allowed the researchers to interpret the obtained data within the appropriate context and provide meaningful insights specific to Botswana's AI readiness landscape.

This is primarily a quantitative study based on secondary data. The data set from Oxford Insights is employed. This dataset was originally compiled by Rogerson et al. (2022) when developing the Government AI Readiness Index (AIRI). The latest index was published on 12 December 2022. This index measures 39 indicators across 10 dimensions (vision, governance and ethics, digital capacity, adaptability, size, innovation capacity, human capital, infrastructure, data availability, and data representativeness), which are categorized into three pillars: Government, Technology Sector, and Data and infrastructure. The main goal of this AIRI is to answer the question of how governments can position themselves to take advantage of this AI-powered transformation in the delivery of public services (Okot, et al., 2021). This index was chosen over others due to its inclusivity, in terms of the number of countries surveyed and also, the availability of data set for re-use. Unlike Tortoise and HolonIQ, whose data were limited to less than 70 countries which didn't include Botswana. A clear explanation of how the index scores were calculated is found on page 51 of their report. Data specific to Sub-Saharan countries and Botswana was extracted from the large data set and analysed using Microsoft Excel and presented the scores (percentages) in the form of charts. Thus, the following section will provide findings on the AI readiness status in Botswana.

4. Results from Oxford Insight

This section presents empirical evidence based on the AIRI dataset. According to the 2022 AIRI results, the United States of America, Singapore, and the United Kingdom made the top three consecutively. None of the African countries made it into the top 20 ranks of AIRI. Therefore, the need to look deeper into the scores of African countries and expand the results. This section expounds on the results of Botswana. Botswana sits at position 98 out of 181 countries surveyed globally. Figure 1, presents the government AI readiness scores for Botswana and selected countries in Sub-Saharan Africa

Figure 1: Trends in government AI readiness for Botswana and selected countries in Sub-Saharan Africa. Data adapted from Oxford Insights (2022)



Based on Figure 1, it is evident that Botswana's government AI readiness score has shown an increase between 2020 and 2022. As of 2022, Botswana ranks number 7 out of 46 countries in the Sub-Saharan region. The country has improved its previous year's ranking by just one place with a total score of 38. 36. When comparing Botswana to its peers, particularly Mauritius, a country renowned for its strong governance practices in Africa, just like Botswana, Botswana falls behind in terms of government AI readiness. The disparity is evident across all the pillars, with the most significant difference observed in the government pillar. In 2022, Mauritius achieved a score of 68.66 in the government pillar, whereas Botswana scored 33.42, highlighting a considerable gap between the two countries. In fact, Mauritius generally outperforms most countries in Sub-Saharan Africa, including

the leading economies, in the government pillar of the AIRI. Mauritius has made notable progress in governance and has implemented effective policies and regulations specifically aimed at AI adoption within the government sector. These efforts have contributed to its relatively stronger performance in the government pillar, compared to its peers in the region.

When comparing Botswana to other leading economies in Africa, such as South Africa, Kenya, and Nigeria, Botswana falls behind in terms of government AI readiness. South Africa, in particular, demonstrates higher scores in all the pillars compared to Botswana in 2022. The greatest difference is observed in the data infrastructure and technology pillars. South Africa's investment in developing a robust technological infrastructure, including high-speed internet connectivity and digital platforms, is a contributing factor to its higher scores. This infrastructure is essential for the effective implementation of AI initiatives in government services and operations. Consequently, the disparity in scores suggests that South Africa is more advanced and prepared in terms of government AI adoption than Botswana. However, it is worth noting that Botswana's government AI readiness based on Figure 1 is on par with Nigeria, indicating a comparable level of readiness between the two countries.

A breakdown of Botswana's government AIRI by pillar revealed that the average scores for each pillar are as follows: the Government pillar (33.42), the Technology sector pillar (26.61), and the Data and Infrastructure pillar (55.05). Notably, the technology sector pillar appears to have the lowest score among the three pillars. The relatively lower score indicates that while there have been some advancements in the technology sector, there remains room for further investment and development to fully harness the potential of AI technologies. Enhancing the technological capabilities, fostering innovation, and encouraging investments in the technology sector could contribute to improving Botswana's overall government AI readiness. The following section will further present the findings under each pillar in relation to the ten dimensions and associated 39 AI indicators.

4.1. Government Pillar

According to Oxford Insights (2022, p.6), "a government should have a strategic vision for how it develops and manages AI, supported by appropriate regulation and attention to ethical problems (governance & ethics). Moreover, it needs to have a strong internal digital capacity, including the skills and practices that support its adaptability in the face of new technologies." Based on this premise, this section will attempt to establish Botswana's AI readiness from the AI governance and capability perspective. The government pillar has four dimensions. Governance and ethics (50.02) had the highest score, followed by adaptability (46.21) and digital capacity (37.46). Sadly, the vision dimension did not receive any score. The rest of this section will present the scores of the AI indicators across the four dimensions.

4.1.1. Vision

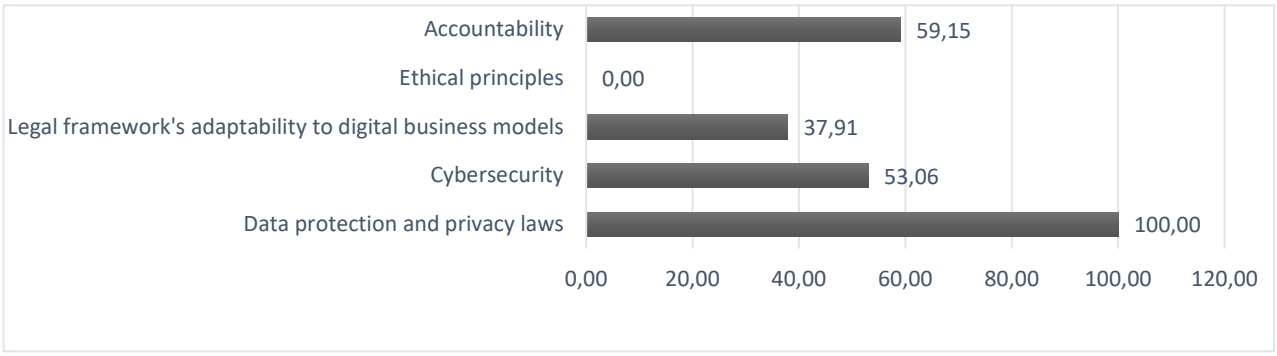
An attempt to establish the presence of a national AI strategy in Botswana did not yield any results. Similar findings were established by Effoduh (2020) and HolonIQ in their 2020 report on the AI strategy landscape. Additionally, the national and international AI strategies map by Yelizarova

(2021) and The Organisation for Economic Co-operation and Development (OECD) AI policy observatory (OECD.AI, 2021) also established that Botswana has no AI strategy in place. Therefore, these findings confirm the score of 0.00 generated by the AIRI (Rogerson, et al., 2022). This is contrary to other African countries that have launched AI strategies or at least have drafts; Benin, Cameroon, Congo, Egypt, Eswatini, Gambia, Ghana, Madagascar, Mauritius, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Uganda, Zambia and Zimbabwe (Adams, 2022; Balancing Act, 2022; Sibal et al., 2021; The Future Society, 2022). Reports have also indicated that the development, and use of AI are a priority, as per the national development plans of Botswana (Sibal et al., 2021). However, this is contrary to findings by ALT Advisory (2022). Having a national AI-specific strategy shows dedication by the government towards making AI a cornerstone of its next development model. The AI strategy; (1) provides a roadmap for AI implementation at all levels, (2) enables AI applications to increase access to goods and services, close gaps, and support Sustainable Development Goals (SDGs), and (3) mitigates risks. As alluded to by Sedola et al. (2021), a national AI strategy is a critical step to outline the vision and the course of action. Moreover, a study by Mittal (2020), revealed that the overall readiness index scores of countries with established AI strategies were higher than countries with no AI strategies. Therefore, a country attempting to implement AI without a strategy is bound to face challenges in its digital transformation journey.

4.1.2. Governance and Ethics

Five indicators as presented in Figure 2, are used to determine whether the right AI regulations and ethical frameworks are in place. The first indicator relates to the availability of data protection and privacy laws. It is praiseworthy that Botswana scored 100%. These findings corroborate with data published on the United Nations Conference on Trade and Development (UNCTAD) website. Though the country does not have an AI-specific regulation, Botswana has accelerated the adoption of digitalization and e-commerce-related regulations, such as the Electronic Communications and Transactions Act (2014), the Electronic Records Act (2014), Customs Act (2018), the Consumer Protection Act (2018), the Cybercrime and Computer Related Crimes Act (2018), Industrial Property Act, (2010), the Data Protection Act (2018) and the Competition Act (2018). In addition, the Civil Aviation Authority of Botswana (CAAB) has implemented regulatory laws for flying drones in the country (Earth of Drones, 2022). Based on these findings, it is praiseworthy that Botswana has set in place foundational laws for technology usage and consequently for responsible AI. However, Botswana faces implementation challenges just like other countries in the region. For instance, there are problems with siloed implementation approaches and the regulatory landscape is struggling to keep pace with technological advances (The World Bank Group, 2022). For example, the Botswana Communications Regulatory Authority (BOCRA) has not yet established the regulations, structures, or enforcement arrangements required to implement the Data Protection Act (2018) (The World Bank Group, 2022).

Figure 2: Governance and Ethics Dimension. Data adapted from Oxford Insights (2022)



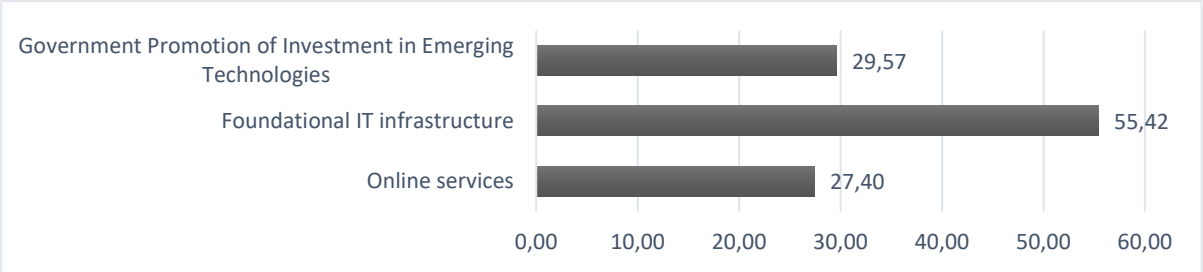
With regards to the cybersecurity indicator; Botswana scored 53.06 with position 88 out of 182 countries on the Global Cybersecurity Index of 2020. Whereas, in Africa, it ranked at position 12 out of 43 countries, with relative strengths under legal measures (International Telecommunication Union, 2021). These findings are in order. As mentioned above, Botswana has implemented the cybercrime act and the National Cybersecurity Strategy. Regarding the legal framework's adaptability to digital business models; Botswana ranked 94/141 countries (World Economic Forum, 2019), with an average score of 37.9 (Figure 2). These results indicate that there is a gap in the regulatory framework which prevents Botswana's digital business models from achieving a maximum competitive edge. This is further evidenced by the lack of AI ethics principles (AI Ethics Lab, 2020; Jobin, et al., 2019). Despite Botswana being among the 193 Member States that adopted the recommendation on the ethics of AI at the United Nations Educational, Scientific and Cultural Organization's (UNESCO) general conference in November 2021, it still has not yet assimilated these recommendations and developed AI ethics for the economy's digital transformation strategy. These findings also imply that, to some extent, Botswana is lagging in responding effectively to technological changes, as evidenced by a lack of AI representativeness in the current regulatory laws and ethical principles.

Accordingly, UNESCO (2022) established that AI technologies are increasingly being adopted across Africa. But, there is a limited regulatory framework to guide safe AI development, implementation, use of AI tech and protection of human rights. The case is true for Botswana as attested by Mubangizi, (2022) and Mudongo (2021). More specifically, Mudongo (2021, p.27), revealed that in Botswana "there is no code of practice in place for the operationalization of closed-circuit television (CCTV) surveillance in public space. Facial recognition technology is being deployed without guidelines reconciling the imperatives of public safety and protection with the fundamental rights to personal privacy." Therefore, there is an urgent need for the government to review the legal framework and align it to enable effective adaptation to digital business models (e.g. e-commerce, sharing economy, fintech, etc.). In addition, the Public Procurement and Asset Disposal Board (PPADB) presentation by Raesima (2021) identified a lack of security and safety on the Internet as an obstacle to the adoption and usage of the Integrated Procurement Management System (IPMS) by citizens. Thus, such a gap in the regulatory framework and Information and communication technology (ICT) platform adversely affects the effective adoption of AI. Protecting human rights and data privacy in digital business models is fundamental.

4.1.3. Digital Capacity

As shown in Figure 3, three indicators are used to measure the digital capacity of the Botswana government. Results shown in Figure 3 indicate that Botswana is not doing well in the area of promoting investment in emerging technologies (29.57) and providing online services (27.40). On a positive note, the government scored above average on having foundational IT infrastructure (55.42). Evidence from the E-Government Development Index (EGDI) 2022, shows that Botswana was amongst the 73 countries that had high EGDI values of 0.50 to 0.75 (The UN-Department of Economic and Social Affairs, 2022). More specifically, Botswana scored 54.95 EGDI, slightly higher than the value (53.83) attained in 2020. This shows Botswana stands a chance to improve its digital capacity to adopt AI technology if done right.

Figure 3: Digital Capacity Dimension. Data adapted from Oxford Insights (2022)



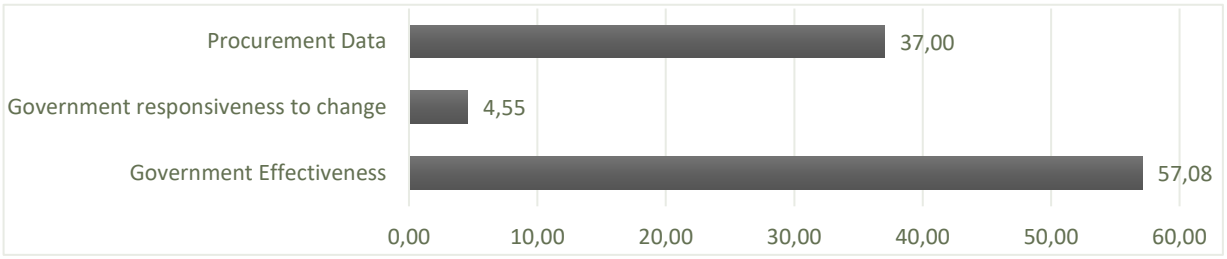
On the other hand, the Online Services Index (OSI) scored 27.40, putting Botswana in the middle OSI group (according to the EGDI 2022). While on the Global Innovation Index; online services ranked 116 out of 132 countries with a score of 36.5 (World Intellectual Property Organization, 2022). Similarly, Botswana scored low on the e-participation index (0.1705) (The UN-Department of Economic and Social Affairs, 2022). Similar results were previously established on the 2019 Global Competitive Index 4.0, which established that e-participation ranked position 130 out of 141 countries (World Economic Forum, 2019). Thus, these findings indicate that the government's efforts to actively engage citizens in collaborative governance are limited. The low score attained for online services and e-participation may be attributed to challenges, such as; lack of a digital identity (ID) system, weak implementation of data protection standards, poor network connectivity, lack of an all-encompassing enterprise architecture guiding services, weak digital payment systems, limited interoperability across platforms and applications (The World Bank Group, 2022). Poor online services or digital platforms affect e-participation. For example; the E-Participation Index assesses the quality, relevance, and usefulness of government websites (The UN Department of Economic and Social Affairs, 2022). If a citizen comes across a poorly designed and less interactive digital platform their e-participation is likely to reduce. For instance; the Botswana government website contains inadequate or limited content, outdated content (e.g., the vacancy section), a search tool that returns no results for important government information, unattended email addresses, and unavailability of chatbots for e-consultation. This depicts a weakness in the government's capability to promote citizen participation on digital platforms. Consequently, a lack of e-participation may indirectly affect the government's digital capacity for successful and effective AI technology adoption and usage. However, on a positive note, the researcher acknowledges that the current Botswana government

website has improved considerably from the previous one. For instance, the current website is satisfactorily user-friendly, well-organized, and has minimal broken links as experienced with the former website.

4.1.4. Adaptability

The adaptability dimension seeks to establish the ability of governments to change and innovate effectively. The findings shown in Figure 4 reveal that Botswana is not doing so well concerning government responsiveness to change (4.55) and availability of procurement data (37.00). However, on government effectiveness (57.08), Botswana scored slightly above average. Similar findings were established on the Global Innovation Index, where Botswana ranked position 56 out of 132 countries with a score of 55.2 (World Intellectual Property Organization, 2022). While on the Worldwide Governance Indicators, the government scored 64.42 (Kaufmann & Kraay, 2021). Thus, based on this; there is hope for Botswana to effectively implement AI technology. These unsatisfying scores on government effectiveness might be due to the lack of an AI strategy. As averred by Mittal, (2020) government effectiveness is affected by the availability of AI strategy. More specifically, it was established that the effectiveness of government with an AI strategy (mean score 79.88) was much higher than countries with no AI strategy (mean score 53.24).

Figure 4: Adaptability Dimension. Data adapted from Oxford Insights (2022)



On the other hand, further evidence of Botswana's lack of responsiveness to change was attained from the 2019 Global Competitive Index 4.0. The index ranked Botswana at position 72 out of 142 countries with a low score of 3.7 (on a scale of 1-7). These findings depict the likelihood of Botswana not being able to effectively handle a disruptive technology, such as AI. The findings regarding less availability of procurement data in Botswana present challenges to the government's ability to adapt to AI changes. According to the Global Data Barometer (2022, para 1), the availability of procurement data helps to support "national public procurement agencies, oversight authorities, anti-corruption agencies, central public administration authorities (ministries of finance in particular), national audit institutions/courts of audit, local public administration authorities, civil society organizations implementing" innovative initiatives, such as AI. Thus, the lack of procurement data for innovations implementation teams will present delays or challenges in the procurement process of AI technology in Botswana. Consequently, this also reduces the adaptability capability of the Botswana government to implement AI.

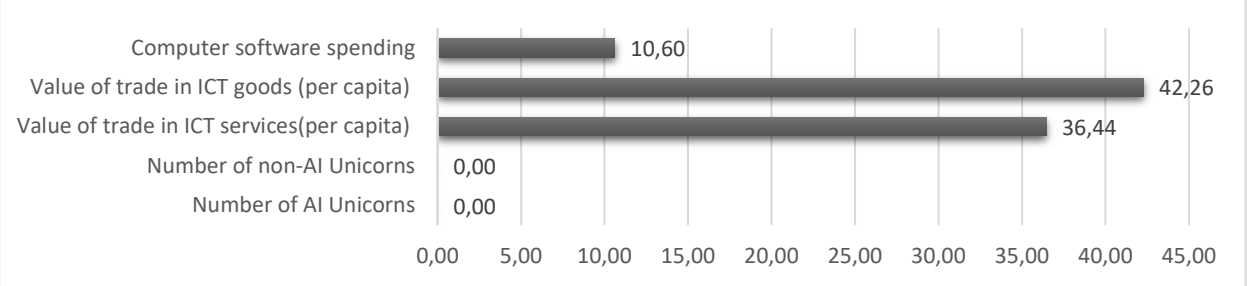
4.2. Technology Sector Pillar

According to Oxford Insights (2022, p.6), "a government depends on a good supply of AI tools from the country's technology sector, which needs to be mature enough to supply the government. The sector should have high innovation capacity, underpinned by a business environment that supports entrepreneurship and a good flow of research and development spending. Good levels of human capital— the skills and education of the people working in this sector—are also crucial." Based on this premise, this section will attempt to establish Botswana's AI readiness based on three dimensions. The leading dimension in this pillar is human capital (35.09), followed by innovation capacity (26.89), and lastly maturity (17.86). The rest of this section will further present the scores of the AI indicators across the three dimensions.

4.2.1. Maturity

Five indicators were measured (Figure 5) to assess whether the government has a technology sector capable of supplying AI solutions. Study findings as shown in Figure 5, indicate that Botswana has no AI unicorns and non-AI unicorns. According to CBInsights (2022), a unicorn establishment refers to a private company with a valuation of over $1 billion. Among 1,200 unicorns around the world established by CB Insights; as of October 2022, none emerged from Botswana. This depicts a low investment capability in AI technology. Nevertheless, there are few AI start-up companies and those involved in developing AI solutions in Botswana. These include Digital Natives (Pty) Ltd, Spectrum Analytics, and Seriti Insights. The latter is a company termed to be the first B2B Machine Learning and AI firm in Botswana. The most commonly known product of Seriti Insights is the digital listening tool called Seipone.ai.

Figure 5: Maturity Dimension. Data adapted from Oxford Insights (2022)



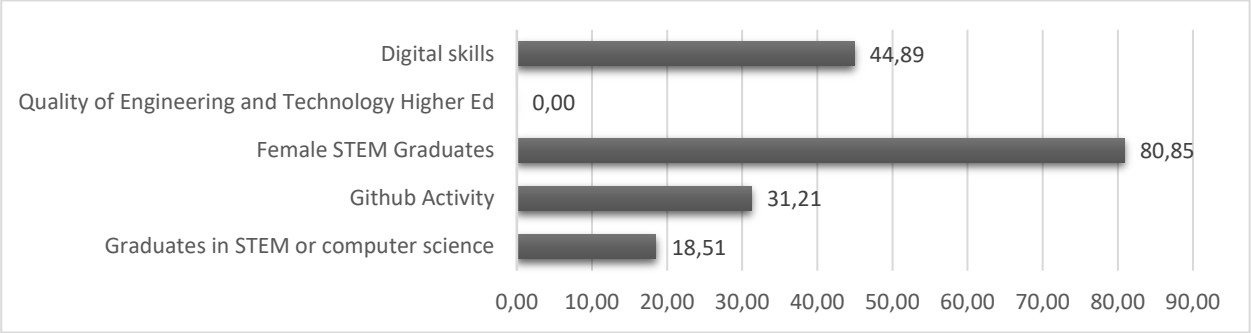
The results in Figure 5, show that Botswana is weak in technology maturity as evidenced by insufficient computer software spending (10.60). This depicts the possibility that the Botswana government does not have the financial capability to invest in AI technology. Based on the scores presented above it is evident that Botswana's technology sector is not yet mature enough to supply the government with AI solutions.

4.2.2. Human Capital

To establish whether there are the right skills in the population to support the technology sector; five indicators were assessed. Results as presented in Figure 6, show that Botswana is weak in the

following areas; quality of engineering and technology in higher education is poor (0.0), few graduates in science, technology, engineering, and mathematics (STEM) or computer science (18.51), insufficient activity in GitHub repository (31.21) and lack of digital skills (44.89). Findings on the Network Readiness Index of 2022, concurred that Botswana has less activity on GitHub as it scored 1.20 and ranked position 106 out of131 countries. The only strength Botswana has is that it has been able to close the gender gap in STEM participation by scoring higher (80.85) in having female STEM graduates. Moreover, Botswana established an initiative termed 'Digital Business Package for Women Entrepreneurs'- the initiative aims at enabling women working in the informal sector to engage in the digital economy (Africa RISE, n.d.). Thus, the SmartBots strategy is intentional about supporting women in technology. Mudongo, (2021b) also averred that even though the ICT industry is male-dominated, the number of women participating in this sector is on the rise. More evidence of such women is seen on the BW TechZone. Gender inclusivity is key for attaining equality in society and increasing the chances of augmented innovation output in the economy.

Figure 6: Human Capital Dimension. Data adapted from Oxford Insights (2022)



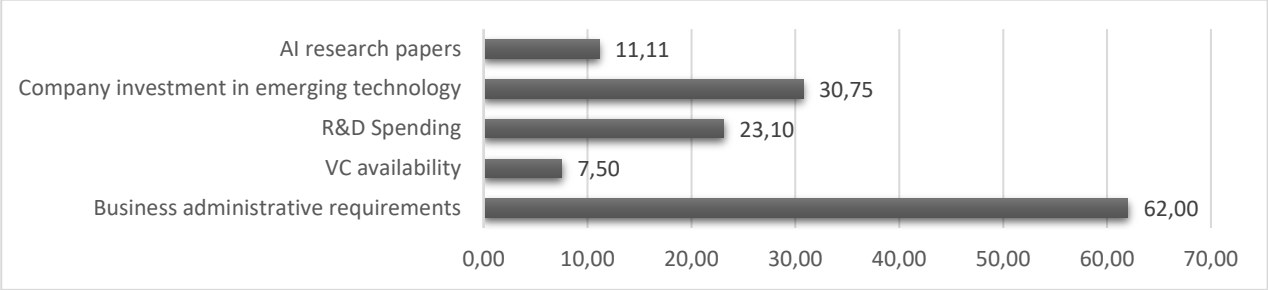
On the other hand, the total score for STEM graduates regardless of gender is very low (18.51). Consequently, this negatively impacts the digital skills required for AI technology development. The findings in this section indicate that there is a challenge with human capital in Botswana. In support of this, a study by Uleanya (2022) averred that the achievement of the 4IR practices is founded on the availability of human capital. However, in Botswana, there are several challenges, such as a shortage of qualified personnel, a lack of funds, limited equipment, and non-alignment of the curricula of schools with the demand for the 4IR (Uleanya, 2022). A low level of computer literacy was also attested to by Raesima (2021), and this is affecting the uptake and usage of government e-systems. With regards to digital skills, a digital economy diagnostics report emphasized that Botswana has various education and training policies designed to support digital skills development and ICT in education, however, these are implemented in siloed approaches. As a result, a significant proportion of Botswana's children and youth lack the digital skills required to excel in an increasingly digitized economy (The World Bank Group, 2022). As a result, Orange Botswana has implemented a digital re-centre initiative where young people are trained freely in digital technology (BW TechZone, 2022). Additionally, the World Bank Group (2022), also noted that there is a scarcity of certified cybersecurity specialists in Botswana. Yet, there are Botswana natives who are expert cybersecurity specialists operating outside Botswana. For instance, the founder and Chief Executive Officer (CEO) of Aiculus company is a Motswana who got a scholarship from Debswana to study Software Engineering in Australia. Currently, Aiculus is an AI-based cybersecurity company with

representation in Singapore and Australia but no trace in Botswana. One may wonder if this absence is related to the disadvantages of a smaller population and poor ICT infrastructure, therefore, reducing the number of firms adopting high-tech. Consequently, reducing the market demand.

4.2.3. Innovation Capacity

As shown in Figure 7, five indicators were measured to assess if the technology sector has the right conditions to support innovation. Results reveal that to some extent; Botswana has adequate conditions to support AI innovation when it comes to the availability of business administrative requirements (62.0). However, the government is weak in terms of venture capital (VC) availability (7.50), AI research output (11.11), Research and Development spending (23.10), and low company investment in emerging technology (30.75). With regards to VC, no data about Botswana was found on the live data from OECD.AI partners. Nevertheless, findings by Cuvellier and Bayen (2023), established that Botswana startups raised only $100,000 in venture funding in 2022. Which is a pittance as compared to neighbouring countries such as; South Africa ($555m), Zambia ($14m), and Namibia ($15m). The Botswana VC status may be attributed to the current market which is not big enough to attract funding for local start-ups. Thus, low venture capital can be seen as a cause of concern for the country's tech innovation industry (BW TechZone, 2023).

Figure 7: Innovation Capacity Dimension. Data adapted from Oxford Insights (2022)



Pertaining to AI research output, Botswana attained an 11.11 h-index on Scimago Journal and Country ranking as of 2021, with only 3 documents associated with the key term "Artificial intelligence". Which is the score used by Oxford Insights when generating AIRI 2022. Contrary to the findings established by SJR, the Technology Readiness Index 2022 ranked Botswana at position 70 out of 131 countries with a total score of 37.60 in AI scientific publications. Therefore, it is important to note that the above findings (Figure 7) are misrepresenting Botswana, as the Scimago has a tendency to omit some information (especially due to the inability to search using synonyms). As a result, SJR's transparency, reliability, and suitability for evaluative purposes in its current form becomes questionable (Mañana-Rodríguez, 2014). Hence, a need to triangulate these findings with data from other sources. Based on the findings in Table 1[1], there is a glimpse of hope that there will be an increase in the AI knowledge base and innovation capacity, as there is evidence of AI research activity in Botswana.

[1] Document search conducted between 31 Dec 2022 and 07 Jan 2023.

Table 1: Search Results on Different Platforms

Source	Results
Web of Science (WoS)	69
Google Scholar	15,800 NB: topic and abstract analysis revealed that from the first 100 articles listed on Google Scholar, only 41 articles were relevant. Also, some articles were duplicated more than three times. Thus, the total search output is exaggerated.
BIUST Repository	281
ResearchGate	8
OECD.AI Policy Observatory	103 NB: Search by = AI research, filtered by country
UBRISA	95

Search query used to retrieve documents on both Table 1 and Table 2: Botswana AND "artificial intelligence" OR "machine learning" OR "robotics" OR "expert system*" OR "knowledge engineering" OR "neural network*" OR "natural language process*" OR "intelligent retrieval" NOT "artificial insemination"

Table 2: Leading Institutions Affiliated with AI Publications in Botswana. Data retrieved from Web of Science Core Collection on 07 January 2023

Author Affiliation	No. of Documents
University of Botswana (UB)	18
Botswana International University of Science and Technology (BIUST)	7
Botho University (BU)	1
Botswana-UPenn Partnership	2
Botswana Predator Conservation Trust	1
Botswana University of Agriculture and Natural Resources (BUAN)	1
Botswana-Harvard AIDS Institute Partnership (BHP)	1

Further scrutiny of the results retrieved on WoS, revealed that the University of Botswana (UB) (18 documents) and the Botswana International University of Science and Technology (BIUST) (7 documents) are the leading institutions with authors engaging in AI research (see Table 2). However, most of the authors were identified not to be Botswana natives. Therefore, the likelihood of a high knowledge gap in the future is very eminent; as these researchers may return to their home countries or migrate elsewhere. Consequently, reducing both human capital and innovation capacity in Botswana. In addition, BIUST was the only institution cited to have provided research funding. Thus, verifying the findings in Figure 7, there is less effort on Research and Development spending in Botswana. Mosweunyane et al. (2018), conducted a 'survey of undergraduate project topics in computer science at the University of Botswana.' The findings revealed that students were not engaging in core Computer Science areas, such as algorithms, machine learning and security (Mosweunyane et al., 2018). This depicts a gap in the Botswana Computer Science curriculum, as students' choice of topic heavily depends on what the curriculum offers, in terms of the diversity of course content and techniques taught. Thus, the curriculum plays a foundational role in research output in the AI field and innovation capacity.

Overall, the results in Figure 7, imply that the Botswana government does not have sufficient conditions to support AI innovation. This corroborates with findings from the Global Innovation Index (GII) which established that Botswana performed better in innovation inputs than innovation outputs in 2022 (World Intellectual Property Organization, 2022). Similarly, findings by UNESCO (2022) established that there are fewer AI initiatives deployed in the public sector. More specifically, for Botswana and Lesotho, no AI use cases were identified in the public sector. This outcome could be due to the lack of online presence by the Botswana government. For instance, the government website does not publish progress reports on digital transformation initiatives and policies. Thus, leaving researchers and international platforms, with no access to accurate information regarding DT initiatives. The researcher attempted to enumerate some examples of AI applications and use cases in Botswana (Table 3). However, due to a lack of readily available content on Botswana government platforms not much was retrieved. The findings in Table 3, demonstrate the efforts made so far, to build e-government capabilities and improve innovation capacity. It is evident that AI algorithms are being utilized more in research but fewer products are being implemented.

Table 3: Application of AI in Botswana

AI Category	Application/Description	Source
Evidence from Empirical Research		
Prediction Models	The use of the artificial neural network (ANN) to predict air blast that is induced by blasting in a diamond mine. Blasting datasets are used to develop and train the ANN models.	(Gaopale, et al., 2019)
	This research developed gravel road performance models using the Feed Forward Neural Networks (FFNN) modelling technique that is increasingly being used as an alternative to traditional model-based techniques to predict gravel loss (GVL) for the first time within a district in Botswana.	(Oladele, 2013)
	An ANN approach was applied to analyse antiretroviral therapy (ART) coverage in Botswana.	(Nyoni & Nyoni, 2021a;

	An ANN approach was applied to analyse the infant mortality rate in Botswana.	Nyoni & Nyoni, 2021b)
	-Capital Markets Prediction: the stock price prediction model was built using social data sentiments to predict the stock market. -Predicting Botswana Stock Exchange using supervised machine learning	(Kelebeng & Hlomani, 2017a;2017b)
	Land change intensities were examined at the time interval, category, and transition levels using Intensity Analysis. A combination of multi-layer perceptron neural network and Markov chain analysis was used to project LULC to 2028 and investigate future changes.	(Akinyemi & Mashame, 2018)
	To optimize the vaccination roll-out strategy, AI was used to identify the population groups in need of more vaccines due to insufficient supply.	(Mathaha, et al., 2022)
	To facilitate agricultural planning, crop yield projections have been made using artificial neural network (ANN) models. This information is useful in agricultural planning and hence strengthens farmers' strategies in mitigating the impacts of climate variability and change in semiarid areas.	(Byakatonda, et al., 2018)
Image recognition	Use of Google's TensorFlow to create an image recognizer trained for Southern African mammals. The recognizer was embedded in an Android mobile app and could then assist tourists at smaller reserves where no rangers were available.	(Butgereit & Martinus, 2018)
AI Initiatives proposed		
Type	**Example**	**Source**
Health information systems	Expert System for HIV and Aids Information: an expert system that will provide general information on HIV and AIDS to the public of Botswana	(Masizana-Katongo, et al., 2010)
Data collection system	The software design is modelled to integrate machine learning technology through AI module devices, BDA applications, and digital smart meters to automate the process of data collection from individual domestic household water meter readings. This study of designing an AI and data analytic software model to address high domestic water billing crises in Botswana's urban areas has raised a high hope for small sampled household communities.	(Gaboalapswe, 2019)
Trash collector VEX Clawbot	The proposed robot allows waste collection to be done with minimal health hazards and safety risks to humans. The robot is battery-operated and can be charged wirelessly using a solar energy power source, making the system eco-friendly.	(Nagayo, et al., 2019)
AI Initiatives Implemented in the Public Sector		
Computer vision Protection services	"Safe City" CCTV project: Botswana's Public Closed-Circuit Television (CCTV) surveillance network implemented in Gaborone and Francistown. The program is driven by the government of Botswana in partnership with Huawei and ICT Dynamics. The aim is to improve the reliability of the response systems, as well as speed up the prosecution and prevention of crime.	(Mudongo, 2021a)

AI Initiatives Implemented in the Private Sector		
Seipone.ai	This solution utilizes natural language processing to mimic the human brain. Seipone.ai is a multi-lingual bot that understands the way African consumers speak about their experiences with brands, services, and products.	Seriti Insights
Chatbots/Virtual Assistants	Dynamic Facebook and Web Virtual Assistants (AI/chatbots) that respond to page queries, set appointments, drive sales, post comments, and handle follow-ups.	Digital Natives (Pty) Ltd
Banking sector	An AI chatbot called 'Abby' is used by ABSA Bank. Abby is designed to be a 24/7 digital personal banker. Stanbic Bank ChatBot 'Thuso'	ABSA Bank Stanbic Bank

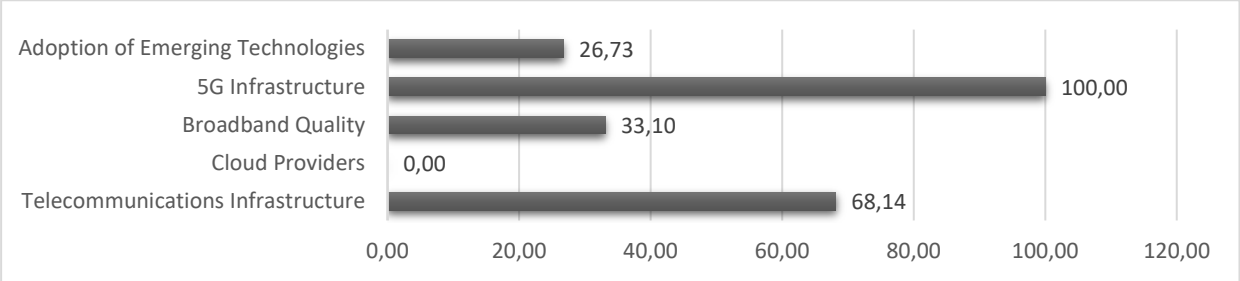
4.3. Data and Infrastructure Pillar

As explained by Oxford Insights (2022, p.6) "AI tools need lots of high-quality data (data availability) which, to avoid bias and error, should also be representative of the citizens in a given country (data representativeness). Finally, this data's potential cannot be realized without the infrastructure necessary to power AI tools and deliver them to citizens." Based on this premise, this section will attempt to establish Botswana's AI readiness from the perspective of ICT infrastructure, data availability, and representativeness. As mentioned earlier, the data and infrastructure pillars have higher scores than the other two pillars. The leading dimension under this pillar is data representativeness (75.40), followed by infrastructure (45.59) and data availability (44.17). The rest of this section will further present the scores of the AI indicators across the three dimensions.

4.3.1. Infrastructure

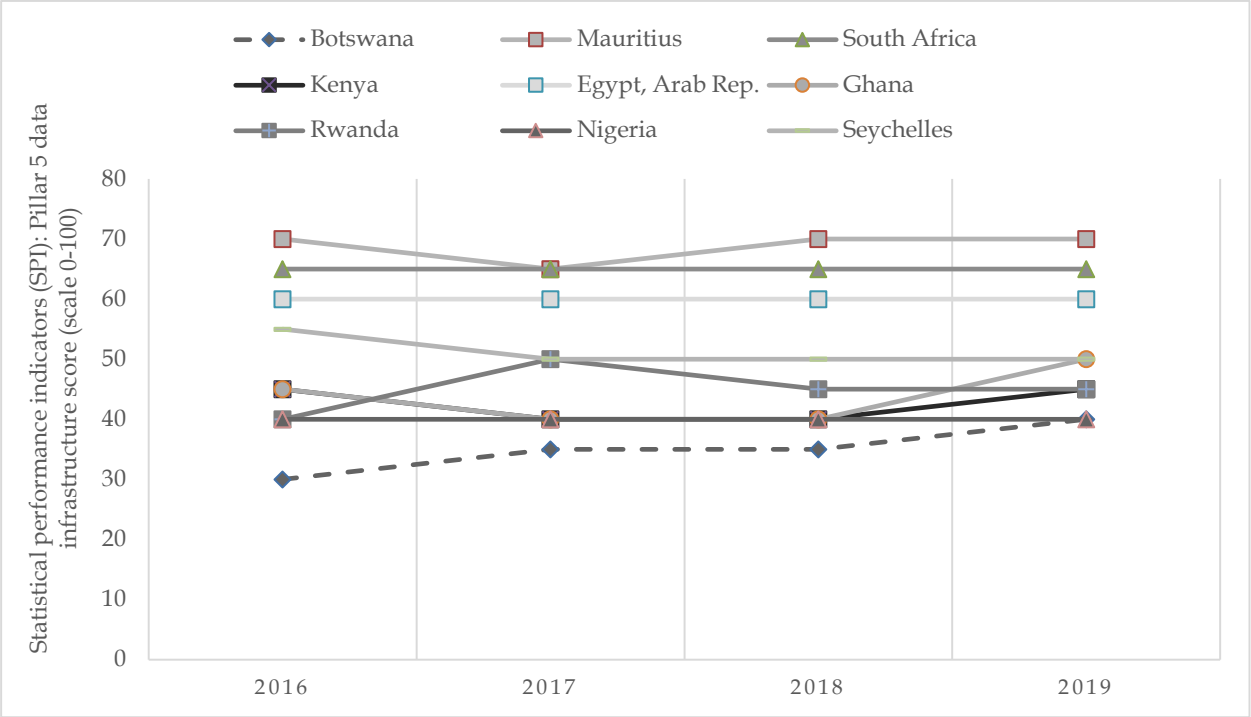
To establish whether the country has the technological infrastructure to support AI, five indicators are assessed. The findings in Figure 8, revealed that Botswana has strengths in the availability of 5G infrastructure (100) and Telecommunication Infrastructure (68.14). Regarding the availability of 5G infrastructure, the Ookla 5G Map and the World Bank Group (2022), do not have any record on Botswana; yet the country has 5G commercial networks, such as Orange and Mascom mobile network providers. However, the Orange 5G network is only deployed in Gaborone and Francistown cities. The GSM Association (2022) concurs with the availability of a commercial 5G network in Botswana. Moreover, plans are underway for future deployment, for instance, as of November 2022, Botswana Telecommunications Corporation Limited (BTCL) went into partnership with Infovista in preparation for its upgrade from 4.5G / LTE-Advanced network to 5G network infrastructure.

Figure 8: Infrastructure Dimension. Data adapted from Oxford Insights (2022)



With regards to the availability of telecommunications infrastructure; Botswana is doing well, as established by the E-Government Development Index 2022 which categorized Botswana in the high Telecommunications Infrastructure Index (TII) group, with 64% of individuals using the internet and (2) 95% mobile-broadband subscriptions per 100 inhabitants. Botswana had the highest TII value (68.14) but the lowest online service index value (27.40) among the landlocked developing countries (LLDCs). Accordingly, compared to its counterparts in the region, it can be concluded that Botswana has made a tremendous effort to lay an acceptable infrastructure considering that; (1) it is a landlocked nation with no natural access to sub-marine cables and international digital infrastructure, and (2) has dispersed population which creates high structural barriers (The World Bank Group, 2022). According to the data presented in Figure 9, Botswana's government AI readiness lags behind several leading countries in Africa. The comparison reveals that Botswana consistently receives lower scores than the top-performing economies in terms of government AI readiness. Notably, even Nigeria, which is considered on par with Botswana in terms of government AI readiness, fares better in the rankings.

Figure 9: Data infrastructure score (scale 0-100) of selected countries in Africa, Based on Word Bank Indicators



Botswana depends on neighbouring countries, such as South Africa for access to undersea cable capacity. Therefore, associated transit costs are passed on to consumers. This places constraints on network availability and service affordability, especially for higher-capacity data packages. Consequently, the digital divide continues to exist. To boost the telecommunication infrastructure, the government implemented a National Broadband Strategy to address these constraints; and established Botswana Fibre Networks (BoFiNet), which maintains a national backbone network connecting cities, major towns, and villages. To achieve this, BoFiNet recently contracted Ribbon Communications Inc. so that it can provide the company with a multi-terabit optical network that utilizes advanced technology (Light Reading, 2022). In addition, the Republic of Botswana recently signed a Memorandum of Agreement with E-Space. E-Space is a global space company focused on bridging Earth and space with the most sustainable low earth orbit (LEO) network (E-Space, 2022). Thus, Botswana believes that this is an opportunity to leverage NewSpace and AI; more specifically in agriculture. This shows the effort by the government to improve the telecommunications infrastructure to enable connectivity that will drive socioeconomic digital transformation.

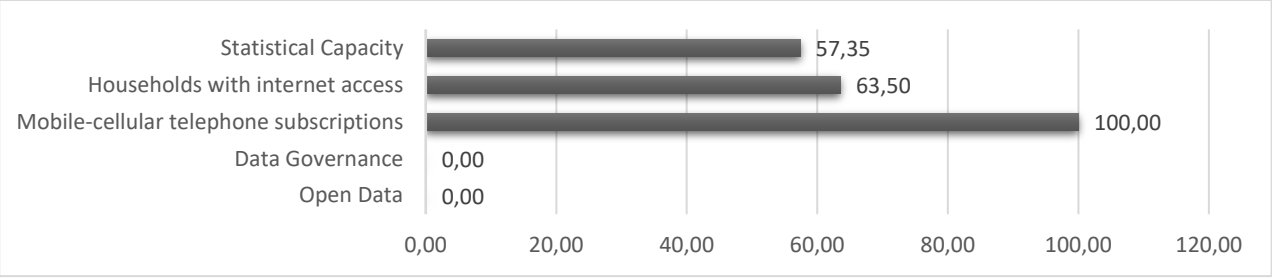
Results in Figure 8, also show that the government does not have cloud providers (no score attained), there is poor broadband quality (33.10), and low capacity to adopt emerging technologies (26.73). Similarly, in their digital economy diagnostic report; The World Bank Group (2022) attested that the quality of connectivity offered is generally only suitable for basic applications. Thus, negatively impacts productive uses of the internet and reduces usage chances of AI solutions. As averred by UNESCO (2022) and UNCTAD, 2021b a poor digital infrastructure limits the market share of new entrants such as AI and the technological expertise needed to maintain or deliver quality services.

Pertaining to the availability of cloud providers in Botswana, the findings in Figure 8 contradict what is on the ground as there is evidence of data centres available to support cloud services. For example; (1) Botswana Fibre Networks (BoFiNet)/BTCL, hosting Facebook, Netflix, Google Cash and YouTube, (2) Dimension Data -designed as a Tier 3 data centre, (3) Orange Mobile Network, (4) Mascom Mobile network and, (5) C-NEST (UNCTAD, 2021b). To be precise, Botswana Telecommunications Corporation Limited (BTC) offers a Tier II 'Sentlhaga Data Center' facility to house customers' ICT platforms and is the home to BTC's Cloud Connect Offerings. Similarly, BoFiNet is in the process of hosting a Tier III 'Digital Delta Data Centre' at the Science and Technology Park in Gaborone. The data centre is certified by the Uptime Institute. The organization is said to have invested over P100 million (7424822,00 US$) to develop a facility that will host at least 400 racks in 1,000 sqm (10,800 sq ft) of white space (Moss, 2021). In addition, there is Document Bank Cloud and Botswana-Post Poso Cloud platform which aims to solve the needs ranging from SMEs to large enterprises. Last but not least, Botswana Digital & Innovation Hub (BDIH), also established a Tier III compliant data centre. BDIH has also been awarded a Tier IV Certification of Design Documents for their Government Integrated Data Center project (The World Bank Group, 2022). Despite these findings, sources such as Datacenters.com declare that "there are currently 0 providers and 0 data centres in Botswana. This includes 0 colocation facilities, 0 cloud nodes, 0 Internet exchanges (IX), and 0 disaster recovery and business continuity (DRBC) sites" (para 1). This shows a dearth of online trustworthy sources of information for Botswana. Thus, this gap leads to the country attaining low scores in the AI readiness index.

4.3.2. Data Availability

To establish the availability of data that could be used to train AI models, five indicators were assessed. According to the findings in Figure 10, Botswana is doing well in the areas of high mobile-cellular telephone subscriptions (100), a relatively high number of households with internet access (63.50), and statistical capacity (57.35). In support of this, from the researcher's experience, most universities and colleges provide free Wi-Fi on campus. Whilst others such as the Institute of Development Management (IDM) provide students with mobile sim cards with data bundles to enable them to access online classes and learning materials remotely.

Figure 10: Data Availability Dimension. Data adapted from Oxford Insights (2022)



In the same vein, no scores were attained on data governance and availability of open data. Due to this, the researcher was also not able to retrieve supporting data in some instances. For example; an effort to verify the availability of female graduates in STEM programs was not fruitful as no data

was recorded on the World Bank-Gender Data Portal. Nevertheless, all hope is not lost as several AI studies indicated that they used Botswana datasets in various areas. For instance; Hyperspectral images, Orapa diamond mine provided blasting datasets, and there is data available in the United Nations SDG data repository (Gaopale, et al., 2019; Li, et al., 2020; Mwitondi, et al., 2020; Seera & Lim, 2014).

4.3.3. Data Representativeness

To ascertain the extent of data representativeness in Botswana, two indicators were measured. The findings indicate that Botswana is not doing badly in ensuring inclusivity regarding internet access and use. For instance, the gender gap in internet access scored 78.0 (Rogerson et al., 2022), which is promising. However, on the Network Readiness Index 2022, it scored 47.77. With regards to the cheapest internet-enabled devices, Botswana attained 72% of monthly GDP per capita (Rogerson, et al., 2022). On another note, data representativeness should also be measured in terms of internet accessibility in urban and rural areas. This will help with providing a clear picture of the extent of the digital divide in Botswana. For instance, through the SmartBots initiative public spaces and clinics have been equipped with free Wi-Fi. But this seems to be eminent in major cities. Thus, leaving the rural areas without internet access.

5. Conclusion and Recommendations

AI is seen as an enabler in building digital economies; therefore, key to transformation agendas. Accordingly, this paper has attempted to provide a high-level mapping of AI readiness status in Botswana. At a broader level, the findings revealed that the 'Data and Infrastructure' pillar is faring slightly better than the technology and government pillars. Only two dimensions (data representativeness and, 'governance and ethics') across three pillars attained a score higher than 50%. More specifically, the following findings were established; (1) the government has limited capacity to support change; (2) the technology sector is not yet mature enough to support AI innovation; (3) there are inadequate skills to support AI development; (4) insufficient technological infrastructure to support AI; and (5) insufficient data to train AI models. Additionally, it has been difficult to establish AI use cases in Botswana. It is, therefore, safe to conclude that to a certain extent, Botswana is not yet AI-ready. However, the country is putting efforts to digitally transform and there are opportunities for improvement. On another note, the country is faring similarly or even better than regional peers but is lagging behind global peers in the upper middle-income group. Consequently, it is recommended that the government should start by developing an AI strategy to set the vision for AI adoption.

The country should also actively implement the recommendations suggested by international organizations such as UNESCO and the World Bank Group. Appendix 1 further provides a comprehensive summary of findings based on each dimension and recommendations are also presented. Most importantly, the government should implement open data repositories, to enable researchers to have access to reliable and authentic statistics and information required for informed decision-

making. Availing local data on international data repositories will also enable researchers to establish the correct AI readiness index scores. It is also worth noting that Botswana's population of approximately 2.5 million people poses certain challenges and constraints on the country's capacity to deploy AI technology. With a relatively smaller population size compared to some other African countries, the resources available for AI development and implementation are limited. As such, both the government and industries need to make strategic choices about the areas of AI to focus on and prioritize.

6. Study Limitations and Future Research Areas

The current study is based on secondary data only. Therefore, it is necessary to conduct further research on the AI readiness status of Botswana based on primary data such as questionnaires and conducting interviews with high-level officers. Secondly, this paper addresses AI readiness from a general perspective based on numerous indicators, hence making the discussion broad. It is therefore necessary for future research to look into discussing AI readiness based on a single pillar or specific indicator. That way it will enable focus and comprehensive analysis of a specific situation. Lastly, some scores on the index could not be easily expanded due to a lack of online data about Botswana. Hence, a need for more empirical research on this phenomenon and the need to publish associated related data sets. In addition, there need to conduct AI readiness and adoption research across industries/firms and professions. This will help identify the obstacles and opportunities from different spheres, thus providing the information needed to support policymakers and accelerate AI adoption in Botswana.

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About the Author

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Liah Shonhe is a records and information manager. Currently she is a PhD candidate at Dalian University of Technology. She holds a Master's Degree in Archives and Records Management and a Bachelor's Degree in Library and Information Studies from the University of Botswana. Her research interests are; AI technology adoption, knowledge/information management, ICTs & education, digital libraries, staff motivation, organizational culture, open data sharing, and change management. Her scholarly work has been presented in professional conferences and published in peer-reviewed journals. Pertaining to work experience, Liah has worked as a teaching assistant at the University of Botswana for four academic years in the Department of

Library and Information Studies and for one academic year at the Communication and Study Skills Unit. She has been an external consultant (Lecturer) at the Institute of Development Management from 2019 to 2022. Liah has been the president of the Records and Information Association in Botswana from 2018-2022 and also participates in charity work via the Botswana Inner Wheel Club. Liah is also an activist dedicated to combating child marriage and advocating for the education of girls especially within the Zezuru tribe. She passionately works towards raising awareness about the harmful impacts of child marriage on young girls and the importance of empowering them through education.

Mavis Kolobe

Mavis Kolobe is an economist and avid researcher. She is currently a University of Botswana economics lecturer. She received her PhD from the University of International Business and Economics (UIBE) in Beijing, China. She has experience in multiple fields, including research, teaching, and consulting. Her research mainly focuses on globalisation, ICT, social capital, and socioeconomic issues like unemployment, inequality, and poverty. Her scholarly work has been published in peer-reviewed journals. As a consultant, she did research for the Botswana government and UNFPA-Botswana. She was a member of a group that received study funding from the Partnership for Economic Policy (PEP) in 2018–2020 to localise the SDGs for Botswana and investigate the factors that affect youth unemployment and the transition to the Botswana labour market. Mavis is also involved in volunteer work and has held positions of leadership in several of the organisations with which she is affiliated. She is presently the Vice President for Southern Africa for the Organisation of African Academic Doctors (OAAD).

Appendix 1: Summary of Findings and Recommendations

Dimensions	Strength	Weakness	Recommendations
Government Pillar (Overall result (33%): Governance is weak)			
Vision Q1: Does the government have a vision for implementing AI? A: No there is none.	Strategies such as the 'SmartBots', acknowledges the 4IR and shows aspirations to digitally transform the nations through disruptive technologies such as blockchain, IoT, and AI.	No AI strategy established; thus, the government has no vision or roadmap set for AI technology adoption.	ST: Botswana should benchmark from other African countries such as South Africa and integrate an AI vision within the SmartBots strategy.
Governance & Ethics Q2: Are there the right regulations and ethical frameworks in place to implement AI in a way that builds trust and legitimacy? A: To a certain extent.	Foundational ICT-related laws are present. E.g., Data Protection Act and Cybercrime and Computer-Related Crimes Act. -Satisfactory exhibition of accountability and transparency demonstrated through laws such as; the Electronic Records Act and the Electronic Communications and Transactions Act.	-There are no AI-specific regulations and ethical principles in place. For instance; CCTVs have been implemented in public spaces but there is no clear law to safeguard citizens against the use of such high-risk AI such as facial recognition. -Implementation of some existing laws is siloed and not able to keep up pace with advances in technology. - Lack of security and safety on the Internet. -Therefore, digital business models are unable to adapt and strive in a weak regulatory environment.	**LT:** The government needs to review and strengthen existing regulations to cater to AI technology. Lest human rights continue to be violated in the digital environment. LT: Establish a regulatory implementation taskforce to oversee and monitor the coordinated implementation of the regulatory framework across the public sector. ST: Adopt and implement AI ethical principles recommended by UNESCO.
Digital Capacity (DC) Q3: What is the existing digital capacity within the government? A: DC is very weak	Moderately doing well on the provision of foundational IT infrastructure	-Inadequate promotion of investment in emerging technologies. -Weak or poor online services leading to low e-participation. - Efforts to actively engage citizens in collaborative governance are limited.	ST: improvements needed on the government website: (1) Establish an active information and knowledge management team to monitor, enrich and update content. The team should also ensure accurate indexing of annual reports uploaded; (2) Implement a chatbot for e-consultation; (3) Activate and improve the search function by apply-

			ing AI algorithms for information classification and retrieval; (5) Train and monitor all public relations officers in all MDAs to ensure they attend to email queries made through the contact function on the website. Ignoring citizens' quest for information is akin to infringement of their rights.
Adaptability Q4: Can the government change and innovate effectively? A: No, the government has limited capacity to support change.	Moderately doing well on government effectiveness due to transparency and accountability measures in place. However, without AI strategy, effectiveness will remain low.	-Government responsiveness to change is unsatisfactory and disheartening. -Scarcity of procurement data hence, posing challenges to effective deployment of AI technology.	LT: The Public Procurement and Asset Disposal Board (PPADB) should develop an open data repository for capturing and disseminating procurement data. This has the potential to influence decision-making and accelerate research and development.
Technological sector (Overall result (26%): technological capacity is insufficient)			
Maturity Q5: Does the country have a technology sector capable of supplying governments with AI technologies? A: technology maturity is very weak	-There is at least one AI startup firm. And two IT firms that are now developing AI-based applications.	-Unavailability of AI unicorns and non-AI unicorns, hence leading to low investment capability in AI technology. -There is insufficient computer software spending. -The value of trade in ICT goods and services is very low.	LT: With AI strategy implementation, an adequate budget can be channelled to AI technology adoption. LT: Botswana Digital & Innovation Hub (BDIH) should re-strategize to support start-ups by building AI labs to train young people. This will help to raise awareness, improve digital skills, and accelerate AI adoption.
Human Capital Q6: Are there the right skills in the population to support the technology sector? A: There are inadequate	-Botswana putting effort into closing the gender gap in STEM graduates.	The quality of engineering and technology in higher education is poor. - There are few graduates in STEM or computer science. -There is less participation by software developers on the GitHub repository.	ST: The government should develop supportive structures to attract software developers and cybersecurity expert citizens who currently own AI firms outside Botswana.

skills to support AI technology.		- Weak human capital due to a lack of digital skills. - The total number of STEM graduates is very low.	LT: There is an urgent need to overhaul the education curriculum to raise a tech-savvy generation.
Innovation Capacity Q7: Does the technology sector have the right conditions to support innovation? A: The government does not have sufficient conditions to support AI innovation.	- Availability of business administrative requirements.	-Unavailability of venture capital. -Low AI research output. -Lack of research and development (R&D) funding. - Low company investment in emerging technology. -There are few AI solutions implemented in the public sector.	LT: The Ministry of Communications, Knowledge, and Technology (MCKT) should be international about leading Botswana to a knowledge-based economy through the utilization of AI. This will include setting aside a specific budget to raise funds for R&D. ST: Local researchers need to collaborate with international organizations/researchers for cross-pollination of ideas and improve AI research output locally.
Data and Infrastructure (Overall result (55%): moderately doing well)			
Infrastructure Q8: Does the country have a good technological infrastructure to support AI technologies? A: To a certain extent	-5G infrastructure available. -Moderately sufficient Telecommunication Infrastructure considering geographical constraints.	-Insufficient cloud providers -Poor broadband quality - Low capacity to adopt emerging technologies. The quality of connectivity offered is only suitable for basic applications, thus limiting AI usage.	LT: Both the private and the public sectors need to collaborate and share resources. This will help accelerate AI adoption and eliminate some implementation hurdles.
Data Availability Q9: Is there good availability of data that could be used to train AI models? A: To a certain extent	- High mobile-cellular telephone subscriptions. - Relatively high number of households with internet access.	-Lack of data governance. Thus, posing a security risk for digital businesses. -Insufficient availability of open data. Hence, lack of data to train AI models.	LT: Academic institutions and the government need to collaborate in the establishment of an open data repository. LT: Botswana researchers should publish papers together with related supplementary data. This will enhance representation in an international data repository.

Data Representativeness Q10: Is the data available likely to be representative of the population as a whole? A: Yes, but there is room for improvement.	-The government is doing well in closing the gender gap in internet access. -Availability of cheapest internet-enabled devices.		LT: NGOs should lobby for more investments by multinational companies such as IBM Research, Google, Microsoft, and Amazon, to support public libraries in rural areas that can be used as data repositories and provide free access to the community.

*LT: Long term
ST: Short term

