Good Health-Sustainable Development Nexus: Assessing the Prospects and Opportunities of Artificial Intelligence in Africa

ERIC BLANCO NIYITUNGA
School of Public Management, Governance and Public Policy
University of Johannesburg
ericn@uj.ac.za

Abstract

The aim of this paper was to assess the prospects and opportunities of Artificial Intelligence (AI) in addressing the challenges in public healthcare that have prevented the achievement of good health for sustainable development in Africa. The assessment was done in efforts to understand the nexus between good health and sustainable development. Good health remains a prerequisite for sustainable development. It is the cornerstone of human development and growth, and the development of projects that lead to sustainable development depend on it. A qualitative method was used with a document analysis approach. Secondary data was collected through a literature survey, and document and content analysis techniques were used in the interpretation. The paper found that the use of AI technologies in the public healthcare system protects healthcare providers, quickens treatment and administrative tasks, and promotes innovations in healthcare systems. It combats inequality, long waiting times, corruption and various types of financial crimes that inhibit the performance of the public healthcare system. The use of exoskeleton robots enable paralysed patients to walk again and become self-sufficient in conducting their daily activities. There is need for African countries to use AI technologies in the public healthcare systems to achieve good health for sustainable development.

Keywords: Good health, Sustainable development, Public healthcare system, Artificial Intelligence, Africa.

Introduction

Good health and well-being, the third goal of the United Nations' (UN) Sustainable Development Goals, remain a prerequisite for the achievement of sustainable development. The UN 2030 agenda for member states to have achieved sustainable development depends on a healthier society (Zhao et al., 2022). A healthier society is a workforce that leads to sustainable development because it produces a working group of

people that is able to positively affect economic growth and development. Healthier people in society means there is strong human capital that positively promotes economic development, thus, sustainable development. To have healthy working people with an average lifespan that is increasing, means having the physical means or mechanisms that drive sustainable investment and development (Gunduz & Yahaya, 2018: 65). Good health and well-being enable a healthy workforce that becomes the active drivers of poverty alleviation and development, as well. However, the achievement of the good health and well-being that lead to a working, energetic group of people that are able to drive the development process has been a mystery in Africa. This makes it difficult for Africa, in the remaining eight years until 2030, to have achieved sustainable development as spelled out in the UN 2030 agenda.

The topic of achieving good health and well-being for sustainable development has been the cause of numerous debates in the newspapers, social media, blogs and reports. The debates have also been going on in the scholarly research journals, conferences and occasional papers presented by both development and health scholars and practitioners, and yet nothing has been done to strengthen and reform the public healthcare sectors in Africa. However, the achievement of good health and well-being requires a better and stronger public healthcare system. Therefore, it can be stated that a public healthcare system that promotes good health and well-being for all people at all ages is the prerequisite for sustainable development, and yet it remains one of the major challenges of health security in most African countries.

There is a vast but surprisingly disjointed and unfocused body of literature across diverse fields regarding the impact of public healthcare systems on good health and well-being in the workplace. Despite the efforts by African governments to improve the public healthcare systems to promote the quality of service delivery in healthcare systems, media reports show that health services in public health institutions have failed to lead to the good health (National Department of Health, 2012: 4). While the extant literature addresses numerous developments and programmes aimed to improve healthcare, and the efficiency, safety and quality of delivery and access for all users (Stuckler, Basu, & Mckee, 2011), the literature shows that "Africa has less than one health worker per 1000 population, compared to 10 per 1000 in Europe" (Fonn, Ray, & Blaauw, 2011: 658). There has also been major changes in health policy and legislation to ensure compliance in delivering quality care, (Moyakhe, 2014: 80; Mogashoa & Pelser, 2014: 142), but still good health has become a norm that is impossible to achieve. The above efforts have failed to address the issue from the perspective of the public healthcare system that brings about

either good health or ill health. This has caused the public to lose trust in the healthcare system (Zubane, 2011: 1). For example, Koelble and Siddle (2014:1118) have described the healthcare system in South Africa as ruined and in serious need of repair.

Factors such as corruption, inequality, failure to govern and manage the information records of the patients, lack of health professionals, together with the chronic underfunding of public health have prevented the continent from achieving the level of good health that can lead to the realisation of the achievement of sustainable development. Scholars have argued that corruption is at the heart of a nation's failure to achieve good health and well-being (Jackson 2020; Jackson & Jabbie, 2020). For example, Barron and Padarath (2017: 4) noted that the failure to achieve good health and well-being is due to unequal distribution of health professionals between the private and public sectors. This situation is also worsened by the unequal distribution of public sector health professionals among the provinces (Barron & Padarath, 2017: 4). Similarly, Tana (2013: 82) maintained that the insufficient and inadequate number of health workers has led to physical and mental exhaustion among the staff, and has deteriorated medical conditions in Africa. The nature of the public healthcare system defines the nature of health of the people. For instance, as has often been observed, the poorly performing public healthcare systems typically fail to contain epidemics in African countries.

Other challenges include overwhelming the public healthcare systems in Africa which are characterised by a serious lack of good governance that has weakened the public healthcare systems (Brinkerhoff & Bossert, 2008), long waiting times, poor-quality healthcare delivery, old and poorly maintained infrastructure, and poor disease control and prevention practices (Young, 2016: 20). The challenges also include negative staff attitudes and insufficient infection control, and the compromised safety and security of both staff and patients (Department of Health South Africa, 2017). These challenges still persist and keep threatening the realisation of sustainable development in Africa.

The above challenges have remained a problem and act as barriers for countries in Africa to achieve the economic development that can lead to sustainable development. There is scant literature that examines the prospects and opportunities for Artificial Intelligence (AI) to address the challenges engulfing the public healthcare system, so that a strong public healthcare that promotes good health and well-being, and that leads to sustainable development in Africa remains lacking. There is a prevalence of ill health among the population still battling various diseases, thus leaving the population in deep and chronic poverty. This paper aims to address this gap by assessing the prospects and opportunities

for the use of AI to address the challenges in public healthcare in an effort to enable the production of good health and well-being for African citizens, and thereby explaining the nexus between good health and sustainable development.

The research question the paper seeks to answer is: to what extent does the use of AI technologies have the ability to address the challenges encountered by the public healthcare system to lead to good health and well-being in Africa, and what is the nexus between good health and sustainable development? This paper is arranged in six main sections. While the first section was an introduction and a brief background, the second section defines the concepts public healthcare system, sustainable development and AI. The third section is a literature review that examines the nexus between good health and sustainable development, and examines the challenges encountered by the public health sector in Africa, and explains how these challenges have retarded the ambitions of achieving good health. The fourth section explains the research methodology and design the paper employed in the process of collecting data, and the technique used in data collection and analysis. The fifth section consists of the discussion of results and/or findings. The discussion includes the role of AI in addressing those challenges and strengthening public healthcare to lead to good health. The final section consists of concluding remarks and presents the recommendations made by this paper.

Definitions of Terms

Defining the terms and concepts used in this paper play a key role in setting the foundations that will help achieve the aim of this paper. Hence, this section defines terminologies used in this paper.

Public Healthcare System

The term 'public healthcare system' is made up of health, public health and healthcare system. The World Health Organisation (WHO) defines the concept of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2006: 5-6). The dimensions of health include people's ability to fulfil their potential and obligations. It has been argued that this ability enables people to manage their lives with some degree of independence, despite a medical condition, and the ability to participate in social activities in their workplaces (Lorig, Ritter, & González, 2003). Health in this domain is therefore a dynamic balance between opportunities and limitations (Lorig

et al., 2003). By successfully adapting to an illness, people are able to work or to participate in social activities and feel healthy, despite their limitations (Lorig et al., 2003).

As stated by the WHO, healthcare systems comprise of all the organisations, institutions and resources that are devoted to producing actions whose primary purpose is to improve health (WHO, 2000). The overall vision of a health system must "provide greater health services and well-being in a sustainable and equitable way to all" (WHO, 2007: 5). This means that it must address inequality and strengthen an all-inclusive integrated public health system that is friendly to all the people (WHO, 2019). Health systems are therefore "more than the pyramid of publicly owned facilities that deliver personal health services" (WHO, 2007: 2), and can more comprehensively be defined as "all public, private, and voluntary entities that contribute to the delivery of essential public health services within a jurisdiction" (WHO, 2019: 4). Furthermore, a health system is the act of "improving health and health equity, in ways that are responsive, financially fair, and make the best, or most efficient, use of available resources" (WHO, 2007: 2). It is measured across dimensions like quality, cost, access, equity, and patient experience and safety (Ahluwalia et al., 2017). Health and health systems equate to healthcare (Jarvis et al., 2020).

Public health consists of organised initiatives that aim to improve and sustain the health and well-being of communities. It is concerned with the process of assuring the conditions in which all people can be healthy (Detels & Breslow, 2006). It has been argued that "it develops and conserves health and lengthens life by means of community activities organised to secure environmental sanitation, communicable disease control, early discovery and preventive treatment of disease, and the education of the public in the principles of healthful living" (Hiscock, 1940: 965-966). These are all organised measures to prevent disease, promote health, and prolong life among the population as a whole (WHO, 1948). It aims to provide conditions that enable people to be healthy and focus not only on individual patients or diseases but also on the entire global population (WHO, 1948). It includes health promotion, prevention of disease and disability, recovery and rehabilitation, and disability support (WHO, 1948). This means that public health aims to create the right conditions to provide this state of health for the benefit of society. Public health is "essential to all aspects of health and well-being, and is crucial to reducing health inequalities, and influencing the wider determinants of health" (Levesque, Bergeron, & Roy, 2013: 1). It can be described as those organised efforts that address diseases and prevent their outbreak in and within society.

Therefore, public health systems can be defined as "all public, private, and voluntary entities that contribute to the delivery of essential public health services within a jurisdiction" (Malakoane et al., 2020: 2). Public healthcare systems are "more than the pyramid of publicly owned facilities that deliver personal health services" (WHO, 2007: 3). It is a network of entities with differing roles, relationships, and interactions that contribute to the health and well-being of the people in community. Public health systems are unique and vital entities within health systems (Jarvis et al., 2020). The main goal of a public health system is "to promote greater health and well-being in a sustainable way, while strengthening integrated public health services and reducing inequalities" (Malakoane et al., 2020: 2). The public health system must play a critical role in handling major threats to public health.

Artificial Intelligence

Artificial Intelligence (AI) is a "computerised system that exhibits behaviour that is commonly thought of as requiring intelligence" (National Science & Technology Council, 2016: 6). It is the science of making machines do things that would require intelligence if done by man, and a system that thinks and acts like humans (Bertram, 1976). It is a system that "has ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Haenlein & Kaplan, 2019: 8). According to Poole and Mackworth (2017), AI refers to computational agents that act intelligently. AI can be used in public healthcare to support hospitals or individual users (such as patients, doctors, and medical personnel). Russell and Norvig (2016) argued that AI describes the systems that simulate cognitive functions related to human learning, speech, and problem-solving. It refers to "any application or device that perceives the environment in a similar manner to humans and acts to optimally achieve a goal" (Begg, 2009: 12).

AI technologies include machine learning systems, deep learning systems, rule-based systems, imaging recognition systems, natural language processing, and voice recognition (Jiang et al., 2017). AI has the potential to address some of the biggest challenges that society faces (National Science & Technology Council, 2016). It has opened up new markets and new opportunities for progress in critical areas such as health, education, energy, and the environment. Smart vehicles may save hundreds of thousands of lives every year worldwide, and increase mobility for the elderly and those with disabilities. Smart buildings

may save energy and reduce carbon emissions (National Science & Technology Council, 2016).

Sustainable Development

Sustainable development is made up of two concepts 'sustainable' and 'development'. Development means a multi-dimensional process that involves major changes in social structures, attitudes, and institutions, as well as economic growth, reduction of inequality, and eradication of absolute poverty (Todaro & Smith, 2006). Holden, Linnerud and Banister (2014: 132) argued that "development is a process whose output aims to improve the quality of life and increase the self-sufficient capacity of economies that are technically more complex and depend on global integration". Sustainability refers to the capacity to maintain some entity, outcome or process over time (Basiago, 1999). According to Stoddart et al. (2011), sustainability is the well organised and impartial intra-generationally and inter-generationally distribution of resources. Other scholars have argued that sustainability connotes improving and sustaining a healthy economic, ecological and social system for human development (Thomas, 2015; Tjarve & Zemīte, 2016; Mensah & Enu-Kwesi, 2018). It literally means "a capacity to maintain some entity, outcome, or process over time" (Jenkins, 2009: 380) and refers to carrying out activities that do not exhaust the resources on which that capacity depends.

Sharpley (2000) argued that development and sustainability could be in juxtaposition, where both could have possible counterproductive effects. The neoclassical economists say that there is no contradiction between sustainability and development (Lele, 1991). Sachs (2010: 28) suggested that "there can be development without sustainability and vice versa". This means that there must be a process that creates stimulating environment that enables people to enjoy and have long, healthy and creative life (Tangi, 2005). Hence, sustainable development simply means "development that can be continued either indefinitely or for the given time period" (Stoddart et al., 2011: 12). Schaefer and Crane (2005) defined sustainable development as the type of development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs. Sustainable development should enable people to achieve the type of sustainable health that facilitates the achievement of their basic human needs. It needs to integrate the sustainable protection of the environment to achieve equality, ensure social self-determination and cultural diversity, and maintain ecological integrity (Klarin, 2018: 87). Holden et al. (2014) argued that the underlying pillars of sustainable development

ensure the long-term preservation of ecological sustainability, meet the basic human needs and achieve equality for current and future generations. However, with the status of the public healthcare system and the kind of health services being delivered to the people, it is unlikely that African countries will have achieved sustainable development by 2030.

Literature Review

The nexus between good health and sustainable development is highly recognised. It is difficult to achieve economic and development growth without a healthy workforce that drives the process. It has been argued that "there are wide linkages between sustainable development and public health" (Adshead, Thorpe, & Rutter, 2006: 1103). The achievement of sustainable development depends on a healthy populace. Accordingly, public health is not only an important outcome of health but also a prerequisite of sustainable development. A state of good health and well-being is a driving force for development, and increases people's income, which later increases the prospects of economic growth. It has been further presented that public health and sustainable development are connected, as both focus on a long-term workforce and integrate environmental, social and economic factors into decision-making (Public Health Agency of Canada, 2006).

Authors have stated that "sustainable development deals with improving the physical, social, and personal quality of individual lives in ways that do not hinder future generations" (Porritt, 2005: 952-953). Therefore, it can be stated that sustainable development depends on a functioning and strong public health system sector that leads to good health. For example, if the environment is not kept healthy, it exposes toxins and poisons that cause diseases. It is important to note that keeping the environment healthy, also requires a healthy workforce and populace. A healthy environment mitigates diseases which makes able to focus on development projects that lead to sustainable development. However, a healthy environment and healthy workforce or populace depend on an equal society. This means that sustainable development cannot exist in communities where socio-economic inequalities persist (Public Health Agency of Canada, 2006). This is because a large number of inequalities breed environmental degradation which makes the community vulnerable to widespread disease (Public Health Agency of Canada, 2006).

Good health is also a central ingredient of development insofar as it can be seen as an investment in human capital, which plays an important role in both the endogenous growth models and neoclassical theories, as applicable to health (Becker, 1962; Grossman, 1972). In addition, good health is a precious tool for improving the economic and social future of a population by improving not only individuals' aspirations but also their capacities to live a healthier life (Sen, 1980, 1988; Anugwom, 2020). It contributes to the well-being of individuals and enables them to positively affect economic growth by strengthening the workforce. Good health enables individuals to be active agents of change in the development process, both within and outside the health sector (Ruger, 2003). While increased investment in health requires public action and mobilisation of resources, it also provides individuals with the opportunities for social and political participation in health-system reform and implementation (Ruger, 2003).

It is critical to note that good health is a means to achieve the economic development that leads to sustainable development, and the state invests so much to improve public healthcare systems to achieve a healthy populace that drives the development projects that lead to sustainable development. A public healthcare system that produces good health inevitably leads to well-being, thus constituting the ingredients of sustainable development. Anugwom (2020) argued that good health is a prerequisite for sustainable development because it leads to a healthy working class that becomes a direct contributor to the growth of the Gross Domestic Product (GDP). Ruger (2014: 2) argued that "good health enables individuals to be active agents and forces of change in the development process, both within and outside the health sector". Ruger (2014: 2) further maintained that "certain aspects of health, in particular, sustain all other aspects of human flourishing because without being alive and healthy, no other human being can function or work to have a sustainable income".

The nexus between good health and economic development can be understood as two-directional, in that good health depends on economic development, and vice versa. For example, on the one hand, "good health and demography can affect income through their impact on labour productivity, savings rates, investments in physical and human capital, and age structure" (Ruger, 2014: 2). While, on the other hand, it has been argued that income can affect health and demography by, improving the ability to obtain food, sanitation, housing, and education, and providing incentives to limit family size (Ruger, Jamison, & Bloom, 2001). Unfortunately, in a society characterised by rampant

inequalities, it is difficulty to have such economic development, as people do not receive the quality health services that lead to good health. Marmot, Bobak and Davey Smith (1995), and Dadaczynski et al. (2020) supported this argument that inequalities in income and social position harm the provision of health services. It therefore important to address inequality in the healthcare system by integrating strategies and policies that enable people to receive equal economic opportunities and equal healthcare services.

Good health and well-being also impact and affect economic development, growth and wealth. Good health, as an asset that individuals possess, has intrinsic as well as instrumental value (Commission on Macroeconomics and Health, 2001). It is an instrument because good health impacts economic growth, increases the income of the people and enables them to become wealthy. For example, good health reduces production losses due to worker illness, and increases productivity due to better nutrition. It, furthermore, lowers absenteeism rates and improves learning among primary, secondary and tertiary institutions (Commission on Macroeconomics and Health, 2001).

Good health also allows for the use of natural resources that used to be totally or partially inaccessible due to illnesses. A healthy population strengthens the economy and reduces poverty (Husain, 2010). Scholars have argued that good health is one of the key determinants of wealth, and a means to achieve economic development and poverty reduction (Alsan, Bloom, & Canning, 2006; Bloom & Canning, 2003; Bloom, Canning, & Sevilla, 2004). The improvement and maintenance of good health through new health technologies promote higher incomes (Cutler, Deaton, & Lleras-Muney, 2006). It has been argued that 'wealthier is healthier' (Pritchett & Summers, 1993) and 'healthy bodies ensure thick wallets' (Smith, 1999).

Good health is a decisive component of human capital, and thus a potential determinant of economic growth and development (Suhrcke et al., 2005: 9). According to Grossman (1972), good health is human capital that is based on investments in health and education, and thus improves outcomes in both the marketplace and non-market place sectors. Grossman (1972) argued that good health is a durable capital good that produces a flow of services over time in terms of healthy time and/or sickness-free time. It has also been argued, for example, that healthier nations are able to attract larger amounts of foreign direct investments (Alsan et al., 2006). This is because foreign investors avoid

environments where the labour force is likely to be weakened by a heavy burden of disease, and where access to healthcare is limited (Alsan et al., 2006).

It has been argued that "the promotion of health and delivery of good healthcare to the people has economic outcomes that sustain economic development objectives" (Suhrcke et al., 2005: 11). Smith (1999) also argued that the impact that health bears on family saving decisions increases the prospect of a longer and healthier life. Howitt (2005) identified five different channels that a healthy population impacts in its long-run growth performance:

- health induced productive efficiency;
- life expectancy affecting skill-adjusted death rate;
- creativity and research intensity;
- learning capacity; and
- inequality affecting the school attendance rate.

Cross-country macroeconomic literature shows that health positively affects economic and human growth (Suhrcke et al., 2005). It has been argued that "an increase in life expectancy from 50 to 70 years (a 40% increase) would raise the growth rate by 1.4 percentage points per year" (Barro, 1996:11). For example, a 10% decrease in malaria is associated with an increased annual growth of 0.3% (Gallup & Sachs, 2000), and malnutrition causes a decrease in the annual GDP per capita growth worldwide of between 0.23 and 4.7% (Arcand, 2001).

Methodology

This paper adopted a qualitative research methodology with a content analysis approach to achieve the data that helped gain an understanding of the nexus between good health and sustainable development. It helped collect data and achieve findings that enable to understand the prospects and opportunities of AI to improve public healthcare to achieve good health. Qualitative methodology being a naturalistic, interpretive approach to studying human experiences or social phenomena (Aspers & Corta, 2019), it served as a unique instrument (Creswell & Poth, 2018) that enabled to understand the impact of AI in public healthcare systems. The qualitative research design was selected because the

method is known and recognised for producing descriptive data (Taylor, Bogdan, & DeVault, 2015). Descriptive data was produced by describing the phenomena and the interactions between AI, public healthcare systems and sustainable development in Africa. This is because the main purpose of descriptive research is to understand and describe a phenomenon and its characteristics (Taylor, et al., 2015). The paper was more concerned with understanding how AI can be applied to public healthcare system to address challenges that overcome the sector thus achieve good health that enable the attainment of sustainable development possible in Africa. A literature survey and analysis was used as a tool to gather data (Becker, 2017).

To analyse and interpret data, qualitative content analysis was adopted. Qualitative content analysis recently found its way into health studies and related research (Hammersley, 2018). Content analysis is a widely used strategy for discourse treatment in qualitative investigation (Fine & Hancock, 2017). Qualitative content analysis has been viewed as a flexible method for analysing the text data collected from literature (Mayring, 2014). It is further one of numerous research methods used to analyse textual data (Hammersley, 2018). It involves "the interaction and questioning of concepts (theory), data, and evidence and strict textual analyses" (Franzosi, 2016:619). More importantly, the study reviewed textual data collected from the literature survey. The readings included academic papers, books, and medical and development journals. The primary keywords that were used to search for the papers during the literature review included public healthcare, health systems, sustainable development, and AI technologies. Qualitative content analysis helped to go beyond merely counting words to examining language intensely to be able to classify large amounts of text into an efficient number of categories that represent similar meanings (Swedberg, 2017).

Results

Sustainable development can be achieved in Africa if the current public healthcare system is reformed and strengthened to achieve good health. Good health impacts on economic growth, development and human growth thus leads to sustainable development. In order to achieve such good health, the use of AI becomes important and critical. The research proven beyond doubt that the nexus between good health and sustainable development is a crucial factor, and AI plays a significant role. AI promotes integrated health information systems, patient education, geocoding health data, social media analytics, epidemic and

syndromic surveillance, predictive modelling and decision support, mobile health, and medical imaging (Nejad et al, 2018). Panda et al. (2018) argued that AI accelerates accuracy and productivity in delivering healthcare services to citizens. It reduces the burden of disease in the targeted population (Panda et al, 2018), thus leading to the achievement of sustainable development. It improves the delivery of a broad range of critical public health services (Wahl, 2018: 1).

AI Manages Electronic Medical Records to Lead to Good Health

The keeping of records and data has been a challenge in Africa, and has led to poor health services delivery, thus affecting the achievement of good health on the continent. The paper found that the use of AI technologies would lead to the digitising of the medical records of the patients, based on the traditional paper medical records (Wahl, 2018). These medical records can be collected at pharmacies, hospitals and even private clinics. The use of AI in the hospitals leads to good health in that it increases, for example, the efficiency of hospital operations, patient management, and treatment (Amisha et al., 2019; Uslu, Okay, & Dursun, 2020: 67). Chaudhry et al. (2006: 748) postulated that "sharing of health information such as insurance data, pharmacy supply chain system, Electronic Medical Records (EMRs) and computerised provider order entries is critical to the performance of healthcare". Prabu (2021) argued that the records can be obtained by anybody and telemetered to the doctor because there is no need for training to use the digital instrument. For example, during the COVID-19 pandemic, the use of digital technologies lowered the probability of contracting the disease, and it became easier to provide better medical care in inaccessible areas.

The use of AI in public healthcare allows health workers to maintain the EMRs of the patients that can be accessed from anywhere around the globe using cloud computing. EMRs are also very important to the health professionals in the collection of data for research in the medical field and health informatics. AI can be used for surveillance of chronic diseases (Chiolero et al., 2013). It can healthcare workers "to accurately classify diseases, reclassify pre-existing disease categories according to individual characteristics, and accelerates the analysis of quickly analyse images and medical data in order to provide appropriate health services" (Tian et al., 2019: 62-65). The use of AI in public healthcare system remains essential for the creation of new services, such as improvements of medical quality and real-time health management (Lee, Kim, & Kim, 2016), thus leading to

all citizens achieving the type of good health that enables them achieve sustainable development.

Digital Consultations Strengthen Public Healthcare System to Lead to Good Health

The paper found that the use of AI in the public healthcare systems promotes digital consultations that lead to efficient health service delivery. According to Choy et al. (2018: 322), the use of Buoy, a digital consultation in healthcare, acts as symptom checker chatbot through the use of scanned responses to assist healthcare professionals to understand symptoms of the disease in patients and help them to receive the best treatment options. Machine learning has been applied to public healthcare, and is being used in various applications like estimating diagnoses from radiology images (Choy et al., 2018: 322), but the adoption and acceptance of new digital technologies in healthcare in general has been curbed by trust issues, strict regulations, and lack of thorough investigation (Aboueid et al., 2019; Ćirković, 2020: 1-2).

The type of digital technology that has been applied in public healthcare to promote good health include Ada (Jungmann et al., 2019), a Berlin-based application that was first applied to public healthcare in the New Zealand market in 2016, and was released more broadly afterwards (Leigh, 2016). There are also the Babylon Health or Babylon Check (Middleton et al., 2016) and Your.MD (Garbuio & Lin, 2018) applications. Moreover, the digital consultations have also included Baidu Doctor (Yao et al., 2016), which is available only in Chinese, and K Health (Aboueid et al., 2019). However, Baidu Doctor and K health are not available in English which restricts their use to only a limited number of countries. Buhr (2017) explained that at the time of testing, the Buoy application could only be used as a web application but today it can be used as an Android-based application.

Digital consultations and tools, such as contact tracing applications, promote online consultations that monitor the outbreak of diseases and their effects, and also keep health professionals and patients safe. This has proved true during the COVID-19 pandemic era, where online consultations and digital health technologies kept people and health professionals safe while providing continued care (Cassione et al., 2020; Hill, 2020). Furthermore, during the COVID-19 pandemic era, South Africa being an unequal state, digital consultations can reduce inequality in the public health sector. This means that the

use of AI technologies can enable everyone to access health services via the online platforms without any sign of inequality. However, this will depend on the role of the government in offering civic education to the citizens about digital technologies, and the doctors' and the patients' ability to afford wearables, smartphones, laptops, and any other handsets that supports AI technology.

AI Enhances Monitoring and Evaluation in Public Healthcare Systems

Monitoring and evaluating public healthcare systems is the key to understanding the nature of health services delivered to the people. It is the foundational platform that enables people to monitor their lives, and the types of medical services delivered to them, and therefore, it serves as the key to achieving the good health that leads to sustainable development. The paper found that AI technologies such as the Fit-bit, apple watch and Garmin that serve as health trackers can be used to monitor health and evaluate its delivery to the people (Gomez & Schwartz, 2016: 36). They also include modern wearable devices such as "the Fitbit health monitor, Pebble smartwatch, and Google Glass, [that] inspire new ways of thinking about the Internet of Things for the body and even beyond" (Gomez & Schwartz, 2016: 36). Furthermore, they include applications that are downloadable to smartphones, handsets and computer laptops as well.

For example, "computing devices, such as personal computers, tablets, and smartphones, which play a large role in this new user-focused Internet of Things development" (Gomez & Schwartz, 2016: 36). Moreover, "the Internet of Things is vital, as it enables a more personalised form of healthcare, where patients are self-managing and self-monitoring their own health, and providers are enabled to improve the experience of care" (Gomez & Schwartz, 2016: 36-37). Dias and Cunha (2018: 6) argued that "the above mentioned wearables keep track of the health and fitness status of the user which is also important for early diagnosis of cardio vascular diseases and providing data to the clinicians for the treatment". However, the continuous monitoring with a cuff can result in unwanted side effects, such as sleep disruption, skin irritations and an increase in stress levels (Dias & Cunha, 2018: 6). To solve this problem, new technologies for ambulatory blood pressure monitoring can be used (Yilmaz, Foster, & Hao, 2010). The paper further found that "the self-monitoring of health status can lead to an increased awareness of maintaining good health among people" (Dias & Cunha, 2018: 6). AI technologies provide "a variety of web-based services for the public during the outbreak of any pandemic diseases" (Tilahun et

al., 2021: 36). It can establish "online screening and consultation services, and data monitoring and evaluation, exchange and convergence" (Tilahun et al., 2021: 36). The use of AI can lead to the quality treatment of diseases that not only saves lives but also leads to the achievement of good health within society. It also offers specific remote patient monitoring solutions that enable the achievement of good health for all citizens possible.

AI Can Quicken the Manufacturing and Distribution of Quality Drugs

The paper found that the use of AI in a pharmaceutical product can aid rational drug design (Duch, 2007), assist in decision-making, determine the right therapy for a patient, including personalised medicines, and manage the clinical data generated and use it for future drug development (Blasiak, 2020). For example, the use of AI in drug development brought about E-VAI, which is an analytical and decision-making technology that uses Machine Learning algorithms to create analytical roadmaps that drive sales of pharmaceuticals (Baronzio, Parmar & Baronzio, 2015). The E-VAI technology enables marketing executives to allocate resources for maximum market share gain, reversing poor sales, and enables them to make investments (Baronzio, Parmar & Baronzio, 2015). The manufacturing of drugs through traditional methods that involve clinical trials is a slow, time-consuming process that requires a great deal of money. Thus, the use of AI in the pharmaceutical industries leads to the manufacturing of more drugs in a quicker time and at less expense. The use of AI technologies in the pharmaceutical industries has helped to address the therapeutic needs of the patients who suffer from viral to complex diseases, such as cancer, tuberculosis and Alzheimer's disease (Hill, 2020). It has helped the pharmaceutical industry to provide better results by cutting down on the time and cost of the drugs (Reiss, 2020). For example, an AI-based drug development programme played a major role in containing and controlling the spread of the Ebola virus in West and Central Africa. Kilgore et al. (2015) argued that the use of AI helped scan the existing two medicines, redesigned them to become very effective in treating the Ebola Virus and prevented its spread, thus saving many lives.

AI Addresses Corruption in Public Healthcare Systems

Corruption is a usual consequence of the poor governance characterised by lack of transparency, weak accountability and inefficiency, and lack of citizen participation (Ciccone et al., 2014) in healthcare governance. Corruption takes various forms, such as

"paying-off management authorities for taking unlawful leave, stealing government revenues such as patient registration fees, taking the salary of a deceased or ghost worker, and making false bills for events like training that didn't occur or in which the incumbent didn't participate" (Azad, 2014; Abdallah, Chowdhury, & Iqbal, 2015: 4). It also includes fake and counterfeit drugs, hiring fake and unqualified medical professionals, and establishing private clinics and hospitals that do not fulfil all the conditions required to deliver health services. The issue of corruption in the health sector is pervasive (Kim & Wang, 2019). AI can facilitate good governance for healthcare systems through the better allocation and efficient use of available resources (Makuta & O'Hare, 2015), and monitoring the checks balances and loopholes on which corruption feeds.

Corruption in healthcare systems arises from "the asymmetry of information that characterises the patient-provider relationship, the uncertainty that surrounds the illness experience, the multiplicity of actors and services involved in illness care, and the challenges of ensuring accountability in complex health systems" (Azfar & Gurgur, 2008: 234). It is further argued that "corruption increases the cost of treatment to patients if a bribe is demanded or an informal payment is made in addition to the official payment, and thereby reduces demand for services and worsen health outcomes" (Azfar & Gurgur, 2008: 234). In addition, "the impacts of corruption in healthcare systems include failure to ensure timely and appropriate treatment care for those who can least afford costly services from the private sector" (Ramadhan & Santoso, 2015: 168), leads to low quality of health services, and wastage and misuse of resources (Lewis, 2006).

With regard to fraud and corruption, the use of AI technologies in healthcare, particularly, Machine Learning platforms combined with Supervised and Unsupervised Machine Learning, are able to address all forms of corruption (Finextra & Feedzai, 2019). AI technologies can serve as a prevention system that can examine years, and in some cases, decades of transaction data in a 250-millisecond response rate to calculate risk scores (Finextra & Feedzai, 2019). The use of AI technologies can also address counterfeit and fake drugs, and fight all sorts of financial crimes in the public healthcare sector, thus increasing the probability of society achieving good health. Similarly, with regard to Machine Learning, Zimiles and Mueller (2019) argued that it can be used to detect suspicious actions that jeopardise health service delivery. They further argued that Machine Learning platforms can improve the timeliness and accuracy of their customers' due diligence and the detection of money laundering-related activities (Zimiles & Mueller,

2019). This means that the use of AI in the public healthcare system ensures that the fight against corruption is effective and successful, thus leading to the achievement of good health for sustainable development. Aarvik (2019) supported this finding and agreed that the use of digital technologies in the health sector, especially AI, provides new hope to effectively fight corruption. This is because most of the activities that involve human activities would be performed by a digital technology systems that knows no favouritism, and is set to provide equitable healthcare services to all.

Rahwan et al. (2019) concurred that the use of AI in the healthcare system can autonomously execute a wide range of health tasks previously reserved for human actors. Lima & Delen (2020) argued that the use of AI can take over anti-corruption tasks like predicting, detecting and disclosing corruption cases. AI can also serve to fight the crime (Crawford, 2019) related to health services delivery. It can also serve as an anti-corruption tool, not only for governments to scrutinise its citizens, but also for the citizens to scrutinise their government (Lima & Delen, 2020). The use of AI in the fight against corruption in all sectors has been praised as the next frontier in anti-corruption (Petheram, 2018) that will make life easier. It is without doubt that the use of AI in the public healthcare system will increase the performance that ensures that health services are delivered to the people, and hence, leads to the achievement of good health.

AI Addresses Long Waiting Times When Delivering Health Services

The paper found that the use of AI technologies reduces the time patients use when waiting for health professionals. It facilitates the transmission of information from person to person. It enhances the exchange of health information, early testing and diagnosis, early isolation, early treatment during the outbreak, and remote consultation (Cassione et al., 2020). In addition, during the outbreak of pandemics, the use of AI can help to ease and reduce the burnout of healthcare providers, psychological stress, and overcrowding in health facilities (Carlson & Goldstein, 2020). It can also enable real-time information interaction and provide support for data-driven decision-making in the time of diseases control (Cassione et al., 2020; Carlson & Goldstein, 2020). This finding was supported by Moazzami et al. (2020) and Katzow, Steinway and Jan (2020) who argued that the use of AI in healthcare reduces the major causes of psychological distress among healthcare personnel, as well as patients. It has been argued that AI can lead to lower stress among healthcare providers because it reduces long work hours, sleep disturbances, debilitating

fatigue, and fear of getting an infection that could also put their family at risk of infection (Moazzami et al., 2020). The use of AI in hospitals or clinics protects patients from contaminating other patients while waiting for health services in the hospitals. Katzow et al. (2020) argued that digital health technologies protect patients who otherwise might have to come to the hospitals. Thus, the use of AI in hospitals not only prevents patients from contaminating others but also preserves the lives of healthcare providers.

AI Enhances the Control and Prediction of Disease

The paper also found that the use of AI technologies leads to better infection control and treatment. For example, the use of "Machine Learning and Deep Learning have been successfully used to identify new risk factors, patterns and medical associations, and have the potential to make predictions of diseases better than the existing traditions ways" (Panahiazar et al., 2015: 42). This means that the use of the Machine Learning model in hospitals can predict whether a patient will have a return of the disease and can determine the total eradication of the disease in the body. The Machine Learning model allows health workers to identify the characteristics that seem to increase the relapse risk in those patients (Weng et al., 2017). In this way, AI applied in the public healthcare system leads to good health, which in turn, leads to sustainable development.

The use of AI in the public healthcare system can predict the onset of congestive heart failure (Choi et al., 2016), and improve risk assessments in patients with suspected coronary artery disease (Cheng et al., 2016). The AI, through Machine Learning, can be used "to predict risks of cataract surgery complications, improve diagnosis of glaucoma and age-related macular degeneration, and perform risk assessment of diabetic retinopathy" (Saleh et al., 2018: 53). The risks of hypertension, high blood pressure and high or low sugar can be detected and addressed through the use of AI. This finding is supported by Kwon et al. (2020) who argued that AI can help to evaluate and prevent the risk of hypertension, and thus reduce the prevalence and burden of heart-related diseases while reducing medical expenses for management. Lin et al. (2020: 13) concurred and argued that AI technologies can further be used to improve ocular disease diagnosis, risk assessment, and as well as disease progression. The use of AI in public healthcare is bringing about digital health technologies such as telemedicine, telehealth, mobile health, big data, 5G, and the Internet of Things (IoT) (Ye, 2020) to alleviate diseases and pandemics, and to enable people to achieve good health. These digital technologies can

be used to control and treat pandemics. They can also be used to strengthen public healthcare to achieve the good health that makes the achievement of sustainable development a reality in Africa.

For example, the use of big data in public healthcare has been linked to the production of good health because it improves not just the precision and agility of genetic disease detection, but enables the achievement of individualised medical treatments (Hummel & Braun, 2020). Digital health technologies enable the efficient delivery of health services to the people, and help the healthcare systems to reach everyone in every community (Ye, 2020). The use of telehealth in health surveys and data collection, surveillance, and the raising of health awareness have served as pandemic control (Wang, Ding, & Xiong, 2020; Kahn, 2020). Telehealth has also been used to support public health systems when preventing and controlling the outbreak of pandemics without disrupting the regular social order (Wang et al., 2020; Kahn, 2020).

Conclusion

The achievement of sustainable development in Africa depends on the achievement of good health. However, the paper found that the current public healthcare system in Africa is engulfed by numerous challenges that have hindered the citizens from achieving good health. The paper also found that good health enables people and empowers them to carry out activities that lead to human development and economic growth, thus leading to sustainable development. Ill health has remained a critical cause and consequence of poverty in Africa. It limits productivity in all sectors, starting with education and ending with farming, hence, thwarting any possibilities of Africans escaping from poverty. In order to overcome ill health and achieve good health, the use of AI is not only significant but also timely. Good health is both an important socio-economic and political asset, and people's livelihoods, prosperity and security depend on it.

AI technologies offer prospects and opportunities that improve healthcare systems by monitoring and evaluating the types of health services provided to the people. The achievement of good health among the citizens is a critical factor that impacts economic growth, development and human growth. The application of AI technologies in healthcare systems can promote integrated health information systems, enhance patient education and allow the geocoding of health data. It can also promote epidemic, and syndromic monitoring and evaluation. It can predict corrupt activities and deals. Mobile applications

in health and medical imaging can accelerate the accuracy and output in delivering healthcare services to society. Furthermore, the use of AI in the public healthcare system reduces the burden of disease and the inequality suffered in a targeted population. It is has been found that the use of AI in the healthcare sector accelerates the treatment of patients, protects patients from cross-contamination when in the hospital, and saves time. The use of AI enables the patients to recover from their illnesses in less time, and thus, that time can be used in the development of projects. For example, the use of robotics such as exoskeleton robots, can lead to sustainable development because they can enable paralysed patients to walk again and become self-sufficient when carrying out their daily activities. AI technologies protect healthcare providers and speed up treatment and administrative tasks. Furthermore, AI in healthcare also promotes innovation in the manufacturing and distribution of drugs. The nexus between good health and sustainable development is vital. This is because good health depends of sustainable development, and at the same time sustainable development leads to good health. Therefore, the applications of AI in public healthcare leads to good health that is based on a strong, vigorous population that is free from physical or mental diseases which is a prerequisite for achieving sustainable development.

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