



Challenges Implementing the Fourth Industrial Revolution: South African Rural Health System

Mangwanya Maonei Gladys^a, Uwizeyimana Dominique Emmanuel^b, ^aPost-Doctoral Research Fellow, School of Public Management, Governance and Public Policy, College of Business and Economics, University of Johannesburg, South Africa, ^bAssociate Professor, School of Public Management, Governance and Public Policy, College of Business and Economics, University of Johannesburg, South Africa, Email: ^agmgangwanya@gmail.com, ^bdominiqueu@uj.ac.za

The purpose of this article is to explore the challenges facing the rural health sector in South Africa and how the introduction of Fourth Industrial Revolution (4IR) technologies can assist in resolving some of these problems. While the 4IR has many potential technologies to improve the public health sector in South Africa, it also reveals many challenges facing the country and the governmental organisations responsible for delivering public services and the implementation of government programmes. South Africa's public health service delivery and its health outcomes have been poor, if not critical, for many years. With the country's under-resourced and overburdened healthcare systems, there is a chance to take advantage of the 4IR technologies to try and improve health service delivery in rural areas of South Africa. The aim of this article was to assess the challenges faced by the South African government in its attempt to use 4IR technologies to improve rural health systems. The article used a qualitative research approach based on the document review method using the desktop method. Despite the perceived benefits of the new technologies to improve healthcare services in South Africa, there is still a lack of human and material resources to execute the technological advancements in rural areas. The study showed that some of the biggest challenges faced by the South African government include lack of infrastructure, underfunding, and lack of skills for new technologies. Recommendations were made to create awareness and equip the health workforce with skills for new technologies.

Key words: *Fourth Industrial Revolution, 4IR, primary healthcare, local government*



INTRODUCTION

Since the advent of South Africa's democracy in 1994, there have been several changes in the South African health system. Around 80% of the population in South Africa depends on public healthcare, and only 20% of the wealthiest South Africans use private healthcare (Mahomed, 2018; Maphumulo & Bhengu, 2019:1). South Africa's public health service delivery and its health outcomes have been poor, if not critical, for many years (Mahomed, 2018). Most, if not all, wealthier people in South Africa use private healthcare services. The poor health outcomes in the public health system have been affecting the underprivileged and, more specifically, the rural residents in South Africa (Morris-Paxton, Reid and Ewing, 2020:1). About 32.65% of the South African population lived in rural areas in 2020 (World Bank, 2021:1). Incomplete or non-existent recordings of key events; incompetent health workers; "prolonged waiting time because of a shortage of human resources; adverse events; poor hygiene and poor infection control measures; increased litigation because of avoidable errors; shortage of resources in medicine and equipment; and poor record-keeping" are just some of the major challenges in the delivery of primary health care in most rural hospitals and clinics in South Africa (Maphumulo & Bhengu, 2019:1). Developing countries such as South Africa have embraced the adoption and use of 4IR technologies to improve the public health systems, but the impact of 4IR technology on the public sector in South Africa is paradoxical (Lee & Lim, 2017). The challenges facing the public health sector in South Africa may be indicative of the poor adoption and use of the 4IR technologies in rural areas by governmental organisations and how they view the use of 4IR technologies in the implementation of public service delivery programmes.

The 4IR "technological revolution will fundamentally alter the way we live, work, and relate to one another" (Schwab, 2016:1). There is no doubt that the adoption of 4IR technologies will bring tremendous pressure on public authorities, because they will be forced to rethink and change the way government operates (National Treasury, 2018). However, adopting new 4IR technologies can boost government effectiveness and efficiency in public service delivery. (Markowitz, 2019). This however requires evaluating financial management practices and ensuring monitoring and evaluation of health policies. The significant disparity between rural and urban healthcare services in South Africa may potentially put tremendous fiscal pressure on governments. (Gaede & Versteeg, 2011). However, even though the adoption of 4IR technologies will inevitably lead to more financial pressures, the imbalances that exist between the affluent communities and impoverished communities, who live mostly in remote rural areas with the least access to healthcare services, makes it imperative for governments to find ways to deal with them (Sutcliffe, Michael & Bannister, 2020). Some of the ways to deal with lack or poor health services provided to rural areas in most developing countries, and particularly in South Africa, may necessitate the adoption and use of 4IR technologies. Hence, the rationale of this research is derived from the increasing interest to improve primary healthcare systems, especially in remote rural areas of South Africa through 4IR technologies. The research seeks

to understand how 4IR technologies can be used in rural healthcare facilities (hospitals, clinics, and more) to ensure effective and efficient provision of public healthcare services.

There are several information and communications technology (ICT) solutions that are available and obtainable for governments to use to improve the provision of public healthcare systems. These include (but are not limited to) electronic health records (EHRs), hospital data systems, regional health information systems, telemedicine, patient portals, and the Open Medical Record System (OpenMRS). The good thing is that most of them are open sources. A systematic review of “*Open-Source Electronic Health Record Systems for Low-Resource Settings: Systematic Review*” was conducted in 2017 by Syzdykova, Malta, Zolfo, Diro and Luis Oliveira. The main argument of Syzdykova et al. (2017:1) is that information and communication technologies have a positive impact on clinical practice and on the quality of health services. However, they also state that: “Despite the great impact of information and communication technologies on clinical practice and on the quality of health services, this trend has been almost exclusive to developed countries, whereas countries with poor resources suffer from many economic and social issues that have hindered the real benefits of electronic health (eHealth) tools” (Syzdykova et al, 2017:1). The authors acknowledge that “the main barrier to adopting EHR software in low- and middle-income countries” such as South Africa “is the cost of its purchase and maintenance”. They do however argue that “the adoption of EHRs in regions with a lack of infrastructure, untrained staff, and ill-equipped healthcare providers is an important task” and is possible if countries could adopt the open-source approach. As these authors put it, the open-source approach is “a good solution for these underserved areas”. According to Syzdykova et al. (2017:2), “one of the biggest open-source software (OSS) communities in healthcare is the Open Medical Record System (OpenMRS) led by Regenstrief Institute and Partners in Health”. As the name of the company indicates, the OpenMRS “focuses on the development of an electronic medical record solution to be used in resource-constrained environments”. Bahmni is another popular “integrated clinical software, which combines three open-source platforms: (1) OpenMRS for patient records, (2) OpenELIS (OpenELIS Foundation) for laboratory management, and (3) OpenERP (Odoo SA) for hospitals’ accounting operations” (Syzdykova et al, 2017:2). The Bahmni system was developed and implemented by the ThoughtWorks company in 2012 (Syzdykova et al, 2017:2). The software's primary objective is to provide a standardized solution for healthcare organizations.. Like the OpenMRS, Bahmni has also been deployed to many “low-resource settings such as India, Bangladesh, and Nepal” and its implementation has been steadily spreading to other regions across the world” (Syzdykova et al, 2017:2).

Another non-proprietary EHR system is the Open-Source Clinical Application Resource (OSCAR) (Safadi, Chan, Dawes, Roper and Faraj, 2015:14). The OSCAR system was developed by McMaster University in Canada. The licencing conditions of this system allow other programmers in any country to modify, adapt, and reuse the system code. The only requirement is that those adapting it to their local circumstances must acknowledge the



copyright owners and must let others use and adapt their modifications under the same license agreement. The OSCAR has also been implemented in many developing countries around the world.

The OS EHR system, provides hospitals with a wide range of features for patient administration, highlighted by Syzdykova et al. (2017:2), is GNU Health. According to Syzdykova et al. (2017:2), the system was introduced in 2008 by the GNU Solidario, a non-profit organisation that focuses on social medicine and health informatics (using Libre Software). Since then, other poor countries, like Paraguay, Kenya, the Philippines, and Bangladesh, have embraced the GNU Health system” (Karopka, Schmuhl & Demski, 2014:1).

OpenVistA is another OS EHR system based on the VistA software, which has been developed by Medsphere Systems Corporation. This is one of the best HER systems on the market because it “provides progress notes, various templates, ordering and reporting tools, audit capabilities, electronic signature, document management, and data integration tools, etc.” (Syzdykova et al, 2017:2).

There is also the FreeMED developed by the FreeMED Software Foundation. The FreeMED software is described as "a modular open-source system for medical data" that was first developed in the United States about two decades ago. In addition to its health services management capabilities, the system also possesses “an external billing subsystem called REMITT” (FreeMed Software Foundation, 2017:1).

The list of available open-source systems that can be used to improve health service systems in developing countries such as South Africa is too long to list in the limited space of this article. One can also mention the OpenClinic GA, a system developed in 2006 by Medical eXchange Solutions to provide “laboratory management and pharmacy management” in addition to HER. The OpenClinic GA was first implemented in Belgium in 2006 but has now been adopted by many countries worldwide, including those in resource-limited settings, such as Rwanda, Mali, and Burundi.

There is no doubt that there are many more new technologies that have been developed or are still in the development process. Each one of them has some specific and special features that can assist one way or the other in the provision of public health systems in rural areas.

However, while the above summary shows that there are many 4IR solutions and that they all appear to be affordable, accessible, feasible, and adaptable they are hardly used to develop rural areas, particularly in South Africa (Blom & Uwizeyimana, 2020). This is a serious anomaly because, contrary to the argument of restricted availability of appropriate technology in developing countries such as South Africa (Ruxwana, Herselman & Conradie, 2010), the fact that poorer countries like Bangladesh, Rwanda, and Burundi are able to afford the OpenClinic GA and GNU Health systems suggests that the problem may be caused by the inequalities

between urban and rural areas in South Africa. The problem of excessive inequalities between rich and poor communities in South Africa partly explains why many rural communities still do not have easy access to medical services while poor people in urban communities rely on overcrowded public facilities, with limited health professionals and dilapidating equipment (Surender, 2014). These problems are compounded and exacerbated by a lack of conventional medicine supply and the lack of qualified clinical and technical personnel. In addition, quality services differ with each department and hospital facilities concerning medicines, equipment, waiting time, cleaning and infection control, and the number and attitude of health workers. The rural areas' healthcare systems in many African countries like South Africa, tend to suffer from what the World Health Organisation, OECD, and International Bank for Reconstruction and Development/The World Bank (2018) call "the five foundational elements critical to delivering quality healthcare services", which are "healthcare workers, healthcare facilities, medicines, devices and other technologies, information systems, and financing". With the existing challenges in South Africa's rural health communities, is the local government ready for 4IR? This is a critical question to consider in the South African context given the challenges faced by the country.

METHODOLOGY

The paper is premised on a constructivist paradigm that adopts a qualitative approach where desktop document analysis was employed for data collection. Secondary data from various articles, reports, and the South African Department of Health reports have been reviewed. The primary focus of this study is the situation in South Africa. The desktop method was used because of its versatility in working with data, regardless of the extent of the study. The various documents perused by the researchers provide the background information and broad coverage of data, and are therefore helpful in contextualising the research within its subject or field.

The researchers ensured that there was no bias by collecting data from reliable sources, reports, and various articles. This was reinforced by ensuring that beliefs and values were not reflected in the data collection and analysis, and that it was verified with additional data sources. This paper, therefore, assists in understanding how 4IR technologies can assist in improving the South African healthcare system, considering the already existing challenges. Data were analysed using thematic analysis and was based on the distinctive themes and sub-themes identified by the researchers during the literature review process. The following sections of the article focus on the literature, theoretical framework, conceptual data, and the challenges of the Fourth Industrial Revolution.

THEORETICAL FRAMEWORK: LEWIN THEORY OF CHANGE

The introduction of the 4IR requires change and creates a need to adjust and adapt to the new concepts of technology (Schwab, 2016). Therefore, the understanding of the theory of change is very important in the implementation of the 4IR in the rural health system in Africa, and in

South Africa in particular. Kurt Lewin (1890-1947), the founding father of change management theory, describes the process of change in three stages: unfreezing, changing, and refreezing (Sarayreh, 2013). His argument is that when introducing change, and in this case, the introduction of 4IR technology in an organisation to change the provision of public health services, one must start by “preparing employees for change, making changes”, and then integrate and normalise those changes within the hospital system. Before introducing any change in the organisation, it is important to create a perception that a change is needed and to inform everyone that they must be ready for it (Hussain et al, 2016). After setting the conditions for the imminent change, one can move toward the new desired levels of behaviour and solidify them so that they can become the norm (Akunyumu, Fugar & Adinyira, 2020). The Kurt Lewin Change Management Model is still widely used and serves as the basis for many modern change models (Esa et al, 2017). The concept of unfreezing is like the concept of creating readiness for organisational change. The organisation, in this case hospitals and clinics in South African rural areas, must carefully examine the old behaviour, thought processes, and organisational structures so that change based on the introduction of the 4IR technologies may be affected and maintained (Teczke, 2017). In this study, South Africa, the Department of Health, and health workers in rural area health systems must understand the challenges of the 4IR. The world is changing, and so are the ways of delivering healthcare services to the public. South Africa must adapt to change for the development and survival of healthcare, especially in rural communities. During the change stage, the leaders should communicate, participate, involve, and provide emotional support to the health workers and communities regarding the 4IR. The Fourth Industrial Revolution can be good for the improvement of service delivery to the citizens.

When the freezing stage has been properly implemented, the organisation finds it easy to adjust to change (Calder, 2013). Rural communities in South Africa have been lagging in providing efficient and effective healthcare services. Therefore, the introduction of new healthcare technologies would improve rural healthcare in South Africa. Lewin realised that change occurs when organisations must transform or enter this new state of existence. This phase of change, also known as “the transition”, is marked by the implementation of the change. The readiness of the organisation determines this transition. During the change stage, organisations and governments struggle with the new reality (Maharaj & Pooe, 2021). As a result, employees need education, communication, support, and time to adjust. The South African government should provide awareness of the importance of the 4IR and how the new technologies will assist in improving rural healthcare.

The final stage of the model is refreezing, which symbolises reinforcing, stabilising, and solidifying the new state. The changes that are made to the organisation’s processes, structure, and goals are accepted as the new norm. The refreezing stage is significant for any organisation because this is where readiness, adaptability, and acceptance of the change are realised (Abbas & Asghar, 2010). In addition, this stage is important as it is determined during this time whether

people will go back to their old ways of thinking before implementing the change. Therefore, change must have been cemented so that it is not lost in the process (Abbas & Asghar, 2010). The national government and the Department of Health in South Africa should therefore make efforts to solidify the new technologies in the healthcare sector. Health policies and plans should be monitored and evaluated to suit the new technologies.

THE CONCEPT OF TECHNOLOGY READINESS

Technology Readiness (TR) is a term that assesses an individual's willingness to embrace and use new technology in the course of their regular activities. (Hidayanto & Purwandari, 2017). The concept of technology readiness classifies humans into four groups, two of which accept technology while the other groups reject technology (Blut & Wang, 2020). The four groups are categorised into optimism, innovativeness, discomfort, and insecurity (Blut & Wang, 2020).

Optimism: Optimism is the degree to which people believe that new technology will benefit them and other people, and the degree to which they believe technology is controllable, flexible, and efficient in daily life (Blut & Wang, 2020). When people are optimistic about technology, they tend to be inclined towards using new technologies and forming a more positive attitude. Optimistic users have a high degree of acceptance of the technology (Jubran, Mada & Mada, 2015). In the case of using 4IR technologies in the provision of public health services in rural areas, it is important for the local government where these hospitals and clinics are located to ensure that there is optimism among the people living and working there. They must think and believe that the new technology will bring efficient and effective healthcare services to the residents. Optimism is still a serious problem in many rural areas of developing countries, and it is also a problem in rural areas of South Africa, simply because of the lack of basic infrastructure to make technology work, the problem of affordability, and ultimately, the problem of low levels of technological literacy prevalent in many African countries (Blom & Uwizeyimana, 2020). There is no doubt that countries and communities have different challenges, but those are just some of the scepticisms surrounding 4IR technologies that make it difficult to comprehend (Penz, Amorim, Nascimento & Carlos, 2017:66).

Innovation: The trend to become a technological pioneer and knowledge leader (Blut & Wang, 2020). Innovation measures the degree to which an individual considers themselves at the forefront of testing products and services based on new technologies (Penz et al, 2017:69). Others regard this as thought leaders on technology-related issues. Individuals discover new high-tech products and services without the help of others (Masudin, Pangenggar, Restuputri & Kusumadewi, 2018). The national government must understand how 4IR technology will improve healthcare in the country. Their understanding and embracing of 4IR technology will make it easier for the health workers and communities.

Discomfort: Discomfort relates to a situation in which an individual cannot use technology and is scared by their inadequacy (Peng & Yang, 2020). Hidayanto & Purwandari (2017)

summarise it as a perceived lack of control over innovation and a sense of being overwhelmed by it. Individuals in this category believe that technology is not intended for ordinary people. When dealing with someone who has a greater understanding of technology than they have, these people are usually uneasy (Erdogmus & Esen, 2011).

Insecurity: Insecurity can be defined as distrust of technology and doubts about its ability to function properly. Insecurity is concentrated in relation to technical transactions rather than a lack of control over discomfort (Penz et al, 2017:69). The result may be that users are suspicious of the new features and are reluctant to accept them (Ali, Nawanir, Nasidi & Bamgade, 2016; Larasati & Santosa, 2017; Buyle, Compennolle, Vlassenroot, Vanlishout & Mechant, 2018). Some examples of the insecure dimension are as follows:

- People who do not like doing business with companies that only provide online services.
- People who are not sure if the transaction will be successful on machines or internet services.

The concept has been used to see how users adapt to new technology. Technology readiness looks at how people will adopt and use technologies to achieve work goals. The index aims to determine the propensity of governments and communities to adopt and use new technologies. Technology readiness has been extensively researched, focusing on inventions, management, diffusion, and adoption (Ali et al, 2016).

The authors assert that, for technology to be effective, the government needs to be ready for change. The rural health sector in South Africa is underdeveloped because of a lack of infrastructure, skills, and electricity. This has a huge impact on adopting new technology because there is resistance to address the challenges in the rural health sector. The rural health sector therefore falls under the category of discomfort and insecurity.

SOUTH AFRICAN HEALTHCARE IN THE 4IR

The rise of Artificial Intelligence (AI) and other emerging technologies is still in the early stages when it comes to healthcare on the African continent (Nalubega & Uwizeyimana, 2019). One of the main challenges facing the African continent is the fragmentation, silos, and inefficiency of the integration of health information (Azevedo, 2017). This directly affects the ability to benefit from emerging technology solutions and participate in the 4IR (Azevedo, 2017). Therefore, the healthcare sector must develop strategies for how the workforce can provide patients with advanced, technology-driven, and results-driven care (Sutcliffe & Bannister, 2020). Given the lack of skills required to meet the demand, there is a need to improve health workers' skills to meet the technological demands for the 4IR era (Ayentimi, Burges & Ayentimi, 2018).



To ensure its readiness, the South African government has implemented a Health Technology Assessment (HTA). Policymakers must be flexible to meet the needs of the 4IR era. To achieve development and transformation goals, such as reducing rural poverty using artificial intelligence and the Internet of Things, policies must ultimately aid in policy development (Nagtegaal, 2020). Good policies abound in South Africa. For example, Article 27 of the South African Constitution ensures citizens' access to healthcare. The Health Technology Policy Framework (HTPF) was created in 2001 to promote fair access and optimal use of limited resources. A guide to integrating HTA into daily operational planning for public and private sector agencies. (Mueller, 2020). The public sector stands to benefit immensely from technology with the future of government operations using advanced technology. However, for the people in rural areas to benefit from existing policies, these policies must be effectively and efficiently implemented. The South African government and the national and provincial departments of health must overcome the challenges currently facing the health sector in the rural areas of the country.

CHALLENGES IN THE FOURTH INDUSTRIAL REVOLUTION (4IR)

The introduction of 4IR technology is crucial in improving the service delivery of the local government. Though the 4IR brings much-needed efficiency and effectiveness, its importance also purports to be a threat to government and communities. One of the main challenges facing the government is that the health workers and the citizens must first adopt and adapt to the new ways of providing public healthcare services through 4IR technologies. The second problem is that of ensuring that all available 4IR and health service delivery policies are properly implemented and, where necessary, adjusted to meet the current demands. The introduction of 4IR technologies requires readiness, and it is the health workers' and ordinary citizens' readiness which will determine its success or failure. The South African government must provide guarantees that 4IR technology will benefit the people. For example, the South African government can put the minds of health workers at ease by providing guarantees that 4IR technology will not take away their jobs. There is little doubt that many of the current transformation drivers will have a big influence on jobs, ranging from significant job creation to job displacement, increasing work-related productivity to growing skill shortages. (Manda & Dhaou, 2019). Mabasa (2020) acknowledges that the 4IR's surge of technology views in the labor market threatens employment for the majority of employees worldwide. These fears are exacerbated in most developing countries like South Africa, where governments already struggle to curb the ever-growing high rates of unemployment (Mahomed, 2018; Mabasa, 2020).

Furthermore, introducing new technologies requires relevant infrastructure in place to effectively implement 4IR technology (Nalubega & Uwizeyimana, 2019). Poor ICT infrastructure is one of the primary issues governments will face while using 4IR technology. For example, in developing countries like South Africa, broadband penetration remains significantly low as compared to developed economies that are known as leaders in broadband



and other ICT infrastructures (Balkaran, 2020). For the effective adoption and implementation of the 4IR paradigms, reliable and efficient electricity production is critical (Nalubega & Uwizeyimana, 2019).

Another challenge facing the adoption and use of 4IR technologies in the provision of public health services in rural areas is the existence of high levels of inequality between rich and poor, and between urban and rural areas. There has always been a vast inequality between rural and urban health sectors, and private and public health sectors in South Africa. New technology, although beneficial, may exacerbate current health disparities. The lack of financing and appropriately qualified health personnel is another obstacle to the implementation of 4IR technology in South Africa. The public sector, which employs the majority of South Africans, is severely underfunded. Disparities between private and public healthcare employees exist (Mazibuko-makana, 2020). The rural communities in many African countries, and in South Africa, are still underdeveloped, and hence the technological readiness is questionable.

FINDINGS AND DISCUSSIONS

The following findings are presented and discussed in line with the following themes: skills, financial coverage, accessibility, machines, governance, and infrastructure.

SKILLS

To design systems that can be used in the 4IR, developing countries require experts in machine learning and data science (Asgar, Rextina, Ahmed & Tammy, 2020). Having the correct degree of scientific and technical workforce and knowledge of Industry 4.0 technologies is crucial for reacting to the 4IR. Due to a lack of training and awareness campaigns, developing countries are still implementing Industry 4.0 technologies. The challenge that the 4IR presents is the integration of technology with human creativity. There is a need for knowledgeable and trained personnel to use the new medical technologies. The African continent, and Sub-Saharan Africa in particular, lacks the technological innovations necessary to face global challenges, such as increasing productivity, improving health, and protecting the environment (Balkaran, 2017).

The rural healthcare system is already lagging and thereby hampering the improvement of healthcare service delivery. For example, Mahomed (2018) & Benyera (2021) argue that artificial intelligence can reduce human error, and the digitalisation of the patients' records will make it easy for any hospital in South Africa to assess medical history. The adoption of artificial intelligence in the healthcare systems of rural areas would significantly improve healthcare service delivery. However, it is difficult to attract knowledgeable and trained personnel to rural facilities. Therefore, introducing 4IR technology to areas where there is already a shortage of trained staff would be a futile exercise.



Benyera (2021) argues that the advent of 4IR technology disadvantages people with less education and abilities. The introduction of 4IR technology may threaten the jobs of many rural health workers. Companies and governments should thus adjust to the changing nature of work by preparing personnel for future jobs. Talent, lifelong learning, and professional growth are essential for the future workforce.

FINANCIAL COVERAGE

Gaede and Versteeg (2011) noted that many families, particularly amongst the rural communities, are unable to obtain adequate medical services due to the exorbitant costs associated with them. Due to the high level of poverty, the rural population is the most affected by the lack of adequate service delivery. A disease outbreak in a low-resource family can be devastating and difficult to recover from. Another issue is that many people in rural areas are unemployed, therefore, they are also likely not to have medical insurance or medical aid cover for their healthcare needs. Most of the population relies on out-of-pocket payments and still find it challenging to access healthcare. There is poor funding and little investment in the new technologies, particularly within the public sector (Owolabi, Mhlongo & Evans, 2017). Funding is crucial when considering the new technologies to avoid challenges in their implementation. Most of these new technologies require money, and most of the underfunding issues will delay or make the adoption process difficult.

ACCESSIBILITY

Most of the country's impoverished and economically marginalized are black and live in rural and township areas. For these areas, access to technical resources like reliable internet connectivity is limited (Nkala, 2019). The effects of historical segregation brought about undeniable differences between urban and rural healthcare, and also private and public health care are clearly evident (Maphumulo & Bhengu, 2019). There is a substantial difference between rural and urban sections of the country in terms of access to healthcare services. There is also huge disparity in terms of healthcare service access between the rich and the poor, as well as vast differences on how money is spent between the public and private sectors. South Africa's healthcare system is divided into two parts; a well-funded commercial sector (private), and a resource-constrained state sector (public). Both these sectors provide prospective markets for health-tech goods, with some overlap and distinctions in the types of technologies necessary in each (Cowie, Townsend & Salemink, 2020). The huge disparity in rural and urban healthcare is problematic. All of these disparities must be considered to ensure access to the new technologies brought on by the 4IR in rural areas of South Africa.

GOVERNANCE

Linde (2020) argues that poor governance and leadership contribute to the performance of the health systems in South Africa. It should be noted that leadership is not just an executive



committee and ministerial department, but rather managers in health departments within the healthcare facilities. Bwalya (2009) asserts that it is hard to adopt the new technologies with poor governance. The rural healthcare system is already riddled with poor leadership, and for this reason the readiness remains questionable. As stated earlier, the first stage of Lewin's Theory is unfreezing; in this regard, the government must enforce the unfreezing stage. The government must make the health management, health workers, and communities aware of the 4IR and the change that will come with new technologies.

INFRASTRUCTURE

One of the main challenges in rural communities is infrastructure. The lack of infrastructure makes it difficult for the adoption of 4IR technologies (Blom & Uwizeyimana 2020). There are severe socio-economic and infrastructure challenges and high inequality regarding access to healthcare and funding within the South African healthcare system. The confidence of the international community about the democratic and effective implementation of artificial intelligence in the field of healthcare in South Africa is hampered by lack of adequate infrastructure to drive the 4IR in rural areas. For example, 11% of households in rural areas do not have access to electricity, and only 10.4% of South Africans have internet access at home (Cowie, Townsend & Saleminck, 2020). As a result, these already alienated and despairing impoverished residents cannot benefit from and participate in the value created by 4IR technological developments. Most 4IR technology advancements, such as autonomous vehicles, would likely benefit urban areas with established infrastructure, like reliable internet and ample roadways. (Nkala, 2019). The country needs to improve its ICT infrastructure to support e-government, e-health, and new technologies across the country. The majority of the hospitals in South Africa have little to no access to technological resources, which is a major barrier to adopting 4IR technologies (Ruxwana, Herselman and Conradie, 2010).

CONCLUSION AND RECOMMENDATIONS

The introduction and adoption of 4IR technology is an important aspect in improving the quality of healthcare service delivery in South Africa. The rural areas stand to benefit from the introduction of 4IR technologies in the provision of public health services. However, from the discussion in the article, it can be noted that South Africa and the rural healthcare system have been facing challenges and its readiness to the new technologies is questionable. The rural health sector in South Africa has been facing challenges in ensuring the delivery of quality healthcare services because of the many challenges such as lack or inadequate funding, lack of enabling technological infrastructure, poor governance, lack of properly trained healthcare workers, etc. The introduction of 4IR technology has the potential to improve the quality of service. However, new technologies are being introduced in already underdeveloped communities, and the rural health sector lacks optimism and innovation. Despite the potential of the 4IR to reduce challenges in the health sector in the rural areas of South Africa, these rural areas still lack infrastructure and further development. Therefore, even if the South



African government was able to introduce 4IR technologies in the provision of public healthcare services in rural areas, these 4IR technologies would not improve the healthcare service delivery. The introduction of these new technologies would instead cause discomfort and insecurity among the already poorly trained and overworked health workers, which will only result in resistance.

Recommendations

The above discussion and findings show that the introduction of 4IR technologies is being considered in an already challenged system. Some of the main recommendations that could be implemented to facilitate the adoption of the 4IR technologies in the rural healthcare system in South Africa include training of health workers and communities on how to use the new technologies to improve healthcare. The South African government should try to develop and provide 4IR enabling infrastructures such as electricity, broadband networks, and more in the rural healthcare sector in South Africa. Most importantly, the South African government should introduce 4IR learning skills in tertiary institutions and healthcare training institutions so that graduates from these institutions are made aware of the new technologies before they graduate. The acquisition of 4IR technological skills and competency should be made a *cine-qua-non* condition for new healthcare graduates, irrespective of whether they will work in urban or rural area healthcare systems. The government and its social and development partners would need to provide proper funding for the infrastructure, training, and public healthcare service delivery for the adoption and use of 4IR technologies in the provision of public healthcare services to succeed in rural areas of the country.

ACKNOWLEDGEMENTS

The authors acknowledge the School of Public Management, Governance and Public Policy in the College of Business and Economics at the University of Johannesburg. The authors declare that no competing interests exist; and that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

REFERENCES

- Abbas, W. & Asghar, I. (2010). The role of leadership in organizational change. Relating the Successful Organizational change to Visionary and Innovative Leadership. MA thesis: University of Gavle.
- Akunyumu, S., Fugar, F.D. K. & Adinyira, E. (2020). 'A review of models for assessing the readiness of construction organizations to innovate'. *Constructi*, 1471–4175. DOI: 10.1108/CI-01-2020-0014.
- Ali, B., Nawanir, Y., Nasidi, Y. & Bamgbade, J. A. (2016). Akademia Baru Examining Technology Readiness Constructs : A Validation Study Akademia Baru'. *Journal of Advanced Research in Business and Management Studies*, 3(1): 71–84.
- Asghar, S., Rextina, G., Ahmed & Tamimy, M.I. (2020) The Fourth Industrial Revolution in the Developing Nations: Challenges and Road Map.
- Ayentimi, D. T., Burgess, J. & Ayentimi, D. T. (2018). 'Technology Analysis & Strategic Management Is the fourth industrial revolution relevant to sub- Sahara Africa?' *Technology Analysis & Strategic Management*. Taylor & Francis, 0(0):1–12. DOI: 10.1080/09537325.2018.1542129.
- Azevedo, M.J. (2017). The State of Health System(s) in Africa: Challenges and Opportunities. In: Historical Perspectives on the State of Health and Health Systems in Africa, Volume II. African Histories and Modernities. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-32564-4_1.
- Balkaran, S. (2020). 'The Fourth Industrial Revolution - Its Impact On The South African Public Sector, (047). Available at: https://www.academia.edu/22826511/the_fourth_industrial_revolution_its_impact_on_the_south_african_public_sector.
- Bayode, A., van der Poll, J.A. & Ramphal, R.R. (2019). '4th Industrial Revolution : Challenges and Opportunities in the South African Context', in *17th Johannesburg International Conference on Science, Engineering, Technology & Waste Management*, 4–10.
- Benyera, E. (2021). *The Fourth Industrial Revolution and the Recolonization of Africa*. New York: Routledge.
- Blom, P. & Uwizeyimana, D.E. (2020). Assessing the effectiveness of e-Government and e-Governance in South Africa: during national lockdown 2020. *Research in World Economy*, 11(5):208-219.
- Blut, M., Wang, C. (2020). Technology readiness: a meta-analysis of conceptualizations of the construct and its impact on technology usage. *J. of the Acad. Mark. Sci*, 48, 649–669.
- Buyle, R., Compernelle, M.V., Vlassenroot, Z., Vanlishout, Z & Mechant, P. (2018). Technology Readiness and Acceptance Model as a Predictor for the Use Intention of Data Standards in Smart Cities. *Media and Communication*, 6(4):127–139. DOI: 10.17645/mac.v6i4.1679.
- Bwalya, K.J. (2009). Factors affecting adoption of e-government in Zambia. *The Electronic Journal of Information Systems in Developing Countries*, 38, 1-13.



- Calder, A.M. (2013). Organizational Change : Models for Successfully Implementing Change Organizational Change. Honours dissertation: Utah State University.
- Cowie, P., Townsend, L. & Saleminck, K. (2020). ‘Smart rural futures : Will rural areas be left behind in the 4th industrial revolution?’ *Journal of Rural Studies*, 79:169-176. DOI: 10.1016/j.jrurstud.2020.08.042.
- Erdogmus, N. & Esen, M. (2011). ‘An Investigation of the Effects of Technology Readiness on Technology Acceptance in e-HRM’, in *7th International Strategic Management Conference*, pp. 487–495. DOI: 10.1016/j.sbspro.2011.09.131.
- ESA, N., Muda, M.S., Ibrahim, M.Y. & Mansor, N.R. (2017). ‘The Application of Kurt Lewin’s Model of Change in the Implementation of Higher Order Thinking Skills’ in, *Exploring Intellectual Capital*, 7(8):109–115. DOI: 10.6007/IJARBSS/v7-i8/3212.
- FreeMED Software Foundation *Transifex*. [2017-11-01]. FreeMED open source EMR/PM system. Available at: <https://www.transifex.com/freemed/freemed/> *webcite*.
- Gaede, B. & Versteeg, M. (2011). ‘The state of the right to health in rural South Africa. (9):99–106.
- Hidayanto, A.N. & Purwandari, B. (2017). ‘Factors influencing citizen’s intention to participate in e-participation : integrating Technology Readiness on Social Cognitive Theory.
- Human Sciences Research Council (2020) Artificial Intelligence & Data In South Africa ’.
- Hussain, S.T., Lei, S., Akram, T., Haider, M.J., Hussian, S.H. & Ali, M. (2016). ‘Journal of Innovation Conceptual paper Kurt Lewin’s process model for organizational change : The role of leadership and employee involvement : A critical review’. *Journal of Innovation & Knowledge*, pp. 1–7. DOI: 10.1016/j.jik.2016.07.002.
- Jubran, S., Mada, U.G. & Mada, U.G. (2015). ‘The Technology Readiness Or Social Presence, Which One Could Explain The Technology Acceptance Better ? An Investigation On Virtual Communities’. *Journal of Indonesian Economy and Business*, 30(2), pp. 120–138.
- Karopka, T., Schmuhl, H., Demski, H. Free/Libre open source software in health care: a review. *Health Inform Res.* 2014 Jan;20(1):11–22. DOI: 10.4258/hir.2014.20.1.11. Available at: <http://www.e-hir.org/journal/viewJournal.html?year=2014&vol=020&num=01&page=11>.
- Larasati, N. & Santosa, P.I. (2017). ‘Technology Readiness and Technology Acceptance Model in New Technology Implementation Process in Low Technology SMEs’, 8(2), pp. 113–117. DOI: 10.18178/ijimt.2017.8.2.713.
- Lee, J. & Lim, J. (2017). ‘The Prospect of the Fourth Industrial Revolution and Home Healthcare in Super-Aged Society’. *Annal Geriatric Medicine and Research* 21(3), pp. 95–100.
- Linde, S.J.L. (2020). Possible Futures for the Health System of South Africa towards 2030. Nelson Mandela University.
- Mabasa, F.D. (2020). ‘Fourth Industrial Revolution : Threat and Opportunity on Employment



- Relations'. *The 5th Annual International Conference on Public Administration and Development Alternatives 07 - 09 October 2020, Virtual Conference* (October), pp. 325–331.
- Maharaj, S. & Pooe, R. (2021). 'Overcoming challenges associated with managing change towards Digital Banking - a case of a South African bank'. *Journal of Contemporary Management*, 18(1), pp. 70–92.
- Mahomed, S. (2018). 'Healthcare, artificial intelligence and the Fourth Industrial Revolution : Ethical, social and legal considerations', 11(2), pp. 93–95. DOI: 10.7196/SAJBL.2018.v11i2.664.
- Manda, M.I. & Dhaou, S.B. (2019). 'Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries'. *ICEGOV2019, 3-5 April 2019*, pp. 244–253.
- Maphumulo, W.T & Bhengu, B.R. (2019). 'Challenges of quality improvement in the healthcare of South Africa post-apartheid: A critical review', 42(1), pp. 1–9. DOI: <https://doi.org/10.4102/curationis.v42i1.1901>.
- Markowitz, C. (2019). 'Occasional Paper Harnessing the 4IR in SADC: Roles for Policymakers', (October).
- Marwala, T. (2020). News & Events - Improving rural health care using 4IR technologies. The University of Johannesburg. Available at: <https://www.uj.ac.za/newandevents/Pages/Improving-rural-health-care-using-4IR.aspx>.
- Masudin, I. Pangenggar, I.L.T., Restuputri, D.P. & Kusumadewi. (2018) 'A Review Of Technology Readiness Index (Tri) On Retail Industry : Approach And Application'. *Seminar Nasional Teknologi dan Rekayasa*, pp. 113–118.
- Mazibuko-makena, Z. (2020). 'The potential of Fourth Industrial Revolution technologies to transform healthcare : The question of access for the marginalize'd, in *Leap 4.0: African Perspectives on the Fourth Industrial Revolution*, pp. 287–316.
- Morris-Paxton, A.A., Reid, S., Ewing R-MG. (2020). Primary healthcare services in the rural Eastern Cape, SouthAfrica: Evaluating a service-support project. *AfrJ Prm Health Care Fam Med.* 2020;12(1), a2207.
- Mueller, D. (2020) 'Addressing the challenges of implementing a Health Technology Assessment Policy Framework in South Africa', *International Journal of Technology Assessment in Health Care*, (7), pp. 1–6. doi: <https://doi.org/10.1017/S0266462320000562>.
- Nagtegaal, J. (2020). The Fourth Industrial Revolution is the Future –is South Africa Ready? Available at: <https://www.dailymaverick.co.za/opinionista/2020-12-03-the-fourth-industrial-revolution-is-the-future-is-south-africa-ready/>.
- Nalubega, T. & Uwizeyimana, D.E. (2019). Implications of the fourth industrial revolution for public sector monitoring and evaluation in Africa. *Africa's Public Service Delivery & Performance Review* (7)(1), a318.
- National Treasury. 2018. The Fourth Industrial Revolution and the Future of Government. Service Delivery Review (SDR). Available at: [chrome-](https://www.nat-treasury.gov.za/pressroom/2018/04/18/4ir)



- extension://efaidnbmnnnibpcajpcgglefindmkaj/viewer.html?pdfurl=http%3A%2F%2Fwww.dpsa.gov.za%2Fdpsa2g%2Fdocuments%2Fservice_delivery_review%2FSDR%2520Vol%252011%2520No%25203%25202018.pdf&clen=1901332&chunk=true.
- Nkala, T. (2020) 4IR, The Good and the Bad and the Inequality gap. Available at: <https://www.dailymaverick.co.za/article/2019-07-04-4ir-the-good-the-bad-and-the-inequality-gap/>.
- Owolabi, A.K., Mhlongo, T.P. & Evans, N. (2017) 'The status and challenges of clinical informatics development in South Africa'. *Journal of Human and Social Science*, 8(2), pp. 125–135.
- Peng, M.Y. & Yang, Y. (2020) 'The Influence of Technology Readiness on Use Intention toward Information System'. *International Journal of e-Education, e-Business, e-Management and e-Learning*, 10(1), pp. 1–12. DOI: 10.17706/ijeeee.2020.10.1.1-12.
- Penz, D., Amorim, B.C., Nascimento, S.R., & Carlos R. (2017). The Influence of Technology Readiness Index in Entrepreneurial Orientation: A Study with Brazilian Entrepreneurs in the United States of America. *International Journal of Innovation*, 5(1):64-78.
- Putzier, M. L. (2017) The Readiness Of The South African Private And Public Sector. Nelson Mandela University.
- Ruxwana, N. L., Herselman, M. E. & Conradie, D. P. (2010) 'ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa'. *Health Information Management Journal*, 39(1), pp. 17–29.
- Safadi, H., Chan, D., Dawes, M., Roper, M., Faraj, S. (2015). Open-source health information technology: a case study of electronic medical records. *Health Policy Technol*, 4(1):14–28.
- Sarayreh, B. H. (2013) 'Comparative Study : The Kurt Lewin of Change Management'. *International Journal of Computer and Information Technology*, 02(04), pp. 4–7.
- Schwab, K. (2016). The Fourth Industrial Revolution: what it means, how to respond. Available at: <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>.
- Shava, E. and Hofisi, C. (2017) 'Challenges and Opportunities for Public Administration in the Fourth Industrial Revolution'. *African Journal of Public Affairs*, 9(9), pp. 203–215.
- Surender, R. (2014) 'Working Paper 2014-19 The Drivers of Universal Health Care in South Africa The Role of Ideas, Institutions and Actors', (December).
- Sutcliffe, Michael & Bannister, S. (2020) *Research On The 4th Industrial Revolution : Implications For Local Government In The Context Of Skills Development*. Available at: www.cityinsight.co.za.
- Syzdykova, A., Malta, A., Zolfo, M., Diro, F. and Luis Oliveira, J. (2017). *Open-Source Electronic Health Record Systems for Low-Resource Settings: Systematic Review*, 5(4): 1-25.
- Syzdykova, A., Zolfo, M., Malta, A., Diro, E., Oliveira, J.L. (2017a). Customization of OpenMRS for leishmaniasis research and treatment center in Ethiopia. *J Int Soc Telemed*



-
- eHealth*, 2017;5:e65. Available at:
<http://journals.ukzn.ac.za/index.php/JISfTeH/article/view/314>.
- Teczke, M. (2017) 'Approaches and models for change management, *Jagiellonian Journal of Management*, 3(3), pp. 195–208. DOI: 10.4467/2450114XJJM.17.014.9785.
- United Nations Industrial Development Organization. (2020). Bracing for the New Industrial Revolution Elements of a Strategic Response Discussion paper. Vienna.
- World Bank. (2021). South Africa - Rural Population. Available at:
<https://tradingeconomics.com/south-africa/rural-population-percent-of-total-population-wb-data.html>.
- World Health Organization, OECD, and International Bank for Reconstruction and Development/The World Bank. (2018). Delivering quality health services: a global imperative for universal health coverage. Available at: <chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/viewer.html?pdfurl=http%3A%2F%2Fapps.who.int%2Firis%2Fbitstream%2Fhandle%2F10665%2F272465%2F9789241513906-eng.pdf&clen=3668785&chunk=true>.