

Challenges and Opportunities of South Africa's Electronic Vaccination Data System in the Provision of COVID-19 Vaccines

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Abstract: The increase in the development and availability of COVID-19 vaccines has resulted in countries developing strategies to inoculate their populations. The Government of South Africa, for example, developed the Electronic Vaccination Data System (EVDS) in a bid to swiftly monitor the distribution and administration of vaccines in the country. The EVDS allows the government to keep track of all the vaccinated people and makes it easy for the Department of Health to capture all important data related to the country's COVID-19 vaccination program. However, very few studies have explored the potential challenges and opportunities presented by the EVDS. The pertinent question remains: To what extent does the EVDS enable the South African government to provide vaccinations to all citizens without leaving anyone behind? In answering this research question, this paper seeks to use desktop research and extensive literature review to explore a constellation of factors that can present both challenges and opportunities of using the EVDS in South Africa. The paper argues that the following factors are possible challenges to the EVDS: lack of information, technical barriers, information communication technology literacy gaps, and vaccine apartheid. It also makes a case that the EVDS provides the government with possibilities and opportunities in decision support, logistics management, and vaccine administration. The paper recommends that the EVDS platform be complemented by other strategies to provide vaccines to the poor and vulnerable population members.

Keywords: COVID-19, Electronic Vaccination Data System, vaccine, innovation.

INTRODUCTION

The first case of the COVID-19 virus was reported in the Hubei Province of China in November 2019. Since then, COVID-19 has been reported in almost every country in the world. In South Africa, the first case was reported in March 2020 in the Kwazulu Natal province. In about a year after the first case was reported in South Africa, official government statistics released by the Department of Health indicated that about 50 thousand people had died. Since the first reported case of COVID-19 in South Africa, the government adopted several strategies meant to slow down the pandemic. By the end of 2020, several countries had developed vaccines meant to fight the virus. The government of South Africa received its first delivery of COVID-19 vaccines in February 2021.

The development and administration of vaccines are recommended as one of the ways to reduce the effects of the virus. According to the National Institute for Communicable Diseases (2016), vaccines are widely acknowledged as the most successful medical interventions as they can save hundreds of thousands of lives annually. The availability of COVID-19 vaccines has presented countries such as South Africa with a unique opportunity in the COVID-19 response (Dzinamatira *et al.*, 2021). To administer vaccines to South Africans, the government developed the

Electronic Vaccination Data System (EVDS). The EVDS is key and plays a critical role as South Africa embarks on arguably one of its largest vaccination campaigns. Therefore, the availability of vaccination and vaccine administration technology is central to the government of South Africa's provision of the COVID-19 vaccines.

According to the Pan American Health Organisation (PAHO) (2019), calls to rally the quality and use of data systems feature prominently in several national plans of action and global strategies like the Global Vaccine Action Plan. In a COVID-19 pandemic environment, Guerazi (2021) argues that "given the anticipated scale and speed of the vaccine delivery process, digital technologies can play a critical role in supporting the planning, delivery, monitoring, and management of the vaccine delivery process vaccination programs." Therefore, there is a need for studies that examine influential factors that can present both challenges and opportunities for systems such as the EVDS in providing COVID-19 vaccines, most importantly in South Africa.

In order to bridge this knowledge gap, this paper focuses on examining the EVDS as an example of a public sector innovation by the government of South Africa aimed at developing a technical, infrastructural architecture that facilitates the transmission of national and provincial vaccine administration data from a variety of sources. The study papers seek to build up from the World Health Organisation (WHO) work, which has been holding discussions on the benefits of

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information communication technology tools in the health sector for several years, reiterating their potential and profiling the limitations (Howe, 2008). Guerazi (2021) also carried out a study and noted that using digital tools for large-scale and high-profile activities (like mass vaccination campaigns) also creates challenges and risks for governments. In the South African context, this research paper underscores the fact that the EVDS is a new phenomenon and argues that this means literature on its utility and effectiveness in vaccine administration is still emerging and scarce.

Against this background, the purpose of this paper is to explore how the EVDS works, its import as a digital innovation, and its use as a data system in the distribution and administration of COVID-19 vaccines. In a bid to boost the paper's scientific value, the EVDS is conceptualized as both a public sector innovation and disruptive innovation. An explication of the Technological Acceptance Model and the Diffusion of Innovation Theory is also undertaken to provide a theoretical exposition of the EVDS. All this is being done to subsequently necessitate an exploration of a constellation of factors that stand out as effective opportunities, associated challenges and further expose any knowledge gaps.

CONCEPTUALIZING AND CONTEXTUALISING THE EVDS AS A PUBLIC SECTOR INNOVATION

Rowe (2008) acknowledges that information and communication technology (ICT) in healthcare practice has become an important facet in improving the delivery of health services, communication between health workers, and boosting decision making through the smooth flow of information. Alberti and Bertucci (2006) stress that ICT innovation in the public sector is imperative for governments operating with reduced resources and limited operational capacities. The emergency of the COVID-19 pandemic has amplified the situation, which, according to the Western Cape Government (2021), has had a multi-sectoral impact on South Africa, including significant socio-economic consequences; a devastating effect on mortality and morbidity; and the knock-on effect of increased healthcare costs.

The development of the EVDS by the South African government represents what Alberti and Bertucci (2006) conceptualize as attempting to use resources and build capacities more effectively and creatively. In other words, the government innovative responses to COVID-19, through the development of the EVDS, as

further explained by Alberti and Bertucci, ought to introduce creative modernizations in their organizational structure, practices, capacities; and how they mobilize, deploy and utilize the human, material, information, technological and financial resources for vaccine deliver, to remote, disadvantaged and challenged people. According to the World Health Organisation (WHO) (2013), the following are some of the developments necessitating innovations in the health sector in general and the fight against COVID-19 in particular:

- “Availability of mobile networks and devices to connect even the most remote locations;
- Availability of internet access and cloud-based server hosting, making it possible to operate systems without the need to install and maintain software on thousands of computers; and
- Availability of barcodes that could be printed on vaccine packaging, enabling traceability of vaccine lots down to the district level or beyond” (WHO, 2013:1).

However, the myth that technology-enhanced systems can help improving the equitable administration of COVID-19 vaccines is something that literature has struggled to debunk. Hence, the WHO (2013) admits that, for example, a better vaccines data system must not be an end in itself, arguing that health information systems are only valuable to the extent that they produce better health outcomes or increase efficiency to reach those outcomes. Rowe (2006) adds that while increasing pervasive, technology is still unevenly distributed and is not a solution to the challenges faced in health. To this end, more research is needed to investigate the outcomes of vaccination data systems, particularly concerning the accessibility of vaccines to the poor. In the meantime, facts on that are still anecdotal, particularly in Africa in general and South Africa in particular.

UNDERSTANDING THE EVDS AS A DISRUPTIVE INNOVATION

The European Commission Expert Panel on Effective Ways of Investing in Health (2016) defines disruptive health care as a type of innovation that creates new systems based on a new set of values. Involving new players makes it possible to improve outcomes and other valuable goals, such as equity and efficiency. The development and use of the EVDS is one of the few examples of disruptive innovations

taking to the frontiers of public health delivery and spearheading COVID-19 vaccination programs in South Africa. Since the concept "disruptive innovation" was formulated by Christensen *et al.* (1995), Sounderajah *et al.* (2021) observe that it now permeates health care studies and practice. Christensen *et al.* (2000) suggest that government and health practitioners need to find ways of allowing more disruptive innovations to emerge. Christensen *et al.* (2000) further argue that if disruption is permitted to flourish, it will lead to high quality, low cost, and equitable health services. Sounderajah *et al.* (2021) concur, stressing that contextualizing disruptive innovation within the healthcare sector is key to prospectively identifying cost-effective innovations. Further research is needed to understand fully the phenomenon of these disruptive innovations in health care administration, particularly their effect on outcomes such as equity. As Sounderajah *et al.* (2021) conclude, available literature and researches are coupled with imprecision and unreliability.

THE IMPLEMENTATION OF THE EVDS IN SOUTH AFRICA

The EVDS provides and tracks vaccine information (type of jab administered and batch number), patient information, including demographics and number of doses, safety information (likely adverse effects after immunization), and details of vaccine administration sites (GAVI, 2021). The initial phase of the EVDS targeted healthcare workers from both the public and private sectors. According to the South African government EVDS Self Registration Portal (www.gov.za/covid-19/evds#), the information submitted through the system would be used to:

- i. Identify eligible vaccination beneficiaries;
- ii. Plan supply of supply and ancillary items;
- iii. Allocate beneficiaries to their nearest available service point; and
- iv. Communicate with enrolled individuals about the vaccination program, including but not limited to:
 - eligibility,
 - where they will be vaccinated, and
 - follow-up vaccination appointments

An important characteristic of the EVDS system is a self-enrollment portal allowing users to register to own

their own online for a Covid-19 jab. According to Nkgadima (2021), the EVDS allows the creation of an electronic health record. The system further allows the government to track the vaccines, including their transit, monitor uptake, and coverage.

UNFOLDING THE EVDS USING THE TECHNOLOGICAL ACCEPTANCE MODEL

Several researchers have applied the Technology Acceptance Model (TAM) to understand factors and perceptions linked to the uptake or rejection of new technology (Nyasulu and Chawinga, 2018; Lucas, 2008). The TAM was developed by Davis (1989) to explain the general determinants that drive people to accept or reject technology. Davis introduced two main determinants that included: "perceived usefulness" and "perceived ease of use." Davis (1989), cited in Lai (2017), conceptualized perceived usefulness as the potential user's subjective view that the use of a certain system will improve his/her action while perceived ease of use is defined as the extent to which the likely user expects the target system to be effortless. According to Lai (2017), a user's beliefs towards a system may be influenced by other factors identified in TAM as "external variables." The paper adopts the TAM model, particularly the two variables "perceived usefulness and perceived ease of use," in a bid to explore the challenges and opportunities of South Africa's EVDS.

This paper acknowledges that the TAM has been used in various studies investigating the uptake of digital technologies in the health sector, which the researchers cannot exhaust. Nyasulu and Chawinga (2018) used the TAM to investigate the role of ICT in delivering health care services focussing on rural Malawi. Their study found that health surveillance assistants working in rural Malawi were using digital gadgets and applications. Kalayou *et al.* (2020) used TAM to examine the sustainable adoption of e-health systems in resource-scarce systems. Their quantitative study exposed that perceived usefulness has a significant influence on attitude. Karkonasasi *et al.* (n.d.) using TAM to explore the use of SMS vaccination reminder and management systems among health centers in Malaysia and found that the system's compatibility has a significant and positive effect on attitude.

EXPLICATING THE EVDS THROUGH THE DIFFUSION OF INNOVATION THEORY

The researchers used the Diffusion of Innovation Theory in this paper to explain why the EVDS might

face some challenges in its adoption in the delivery, distribution, and administration of COVID-19 vaccines in South Africa. After that, the authors reflect on the theory to highlight some of the opportunities made available by the system. Rodgers developed the Diffusion of Innovation Theory in 1962. The premise of the theory is that when introducing an innovation, it is key to consider the characteristics of the targeted people that can propel or sink the innovation. According to Rodgers, the following four factors are key in the success of an innovation: communication channels, attributes of the innovation, the characteristics of the adopter, and the social system (Zhang *et al.*, 2015). Rogers developed five determinants that influence the adoption of an innovation: relative advantage, compatibility, complexity, trialability, and observability.

Many studies have been carried out using the Diffusion of Innovation Theory generalizing on technologies adopted in health services. However, studies investigating the challenges and opportunities specific to systems such as the EVDS are still hard to come across. Therefore, this paper seeks to reflect on the theory to examine the challenges and opportunities presented by the EVDS.

OPPORTUNITIES PRESENTED BY THE EVDS

Innovations such as the EVDS comes with several opportunities and benefits in vaccination efforts. As a digital technology, the system brings efficiency to the health sector and increases the government's effectiveness in fighting the COVID-19 virus. Thus, the EVDS system is key because it can inform overall vaccination efforts by data. Accordingly, as emphasized by Pan American Health Organisation (PAHO) (2017), data from these systems assist in developing vaccination strategies and tactics that reach vulnerable and under-immunized populations; communication, education, and social mobilization activities; and the adjustment of vaccination schedules, among others. The authors argue that the EVDS provides possibilities in decision support, logistics management, and vaccine administration in the paper.

The EVDS is a Decision Support System

According to the PAHO (2017), systems such as the EVDS play an important part in producing information that can guide the strategic, managerial, and operational decisions regarding vaccination intervention in a country. The organization adds that

systems like the EVDS are key in producing "essential data for monitoring and accountability, both from an administrative standpoint (to higher hierarchical levels) and to the beneficiary population in general" (PAHO, 2017). In other words, national leaders (in South Africa) can use high-quality data produced by vaccination data systems to inform resource allocation, vaccine distribution, and strategic decision-making (WHO, 2013). To the people who are likely to be the recipients of the vaccines, a system such as the EVDS allows them to decide when and where to register to receive the COVID-19 jab.

The EVDS in Logistics Management

The EVDS can help government and supporting staff to track vaccine stocks and storage conditions by allowing a platform that shows if vaccines are kept in the right conditions and ready for access when needed (WHO, 2013). This means that the Government of South Africa can, in real-time, be able to monitor COVID-19 vaccines consumption rates. According to the WHO (2013), this helps in forecasting and distribution planning and having visibility over stock balances, thereby helping to deal with overstocking and understocking circumstances. Strategies involving vaccination information systems such as the EVDS improve and increase vaccination delivery (Patel *et al.*, 2014).

The EVDS in Vaccine Administration

The EVDS can help the Department of Health South Africa efficiently register people who receive the vaccination jab. The WHO (2013) notes that online immunization data systems help to replace the traditional paper-based registers. The EVDS makes it easy to register citizens who get the first dose and helps track and remind people to get the second jab. Platforms such as the EVDS, as PAHO (2017) stresses, are cost-effective tools that help improve coverage and improve the timeliness of vaccination. Innovations such as the EVDS help "overcome the challenges of paper-based systems by standardizing data collection, allowing for vaccine tracking in real-time, transmitting data quickly throughout the system for accurate vaccine forecasting and stock management, reducing errors, and automating reporting" (PAHO, 2019; WHO-PATH, 2013). Thus, EVDS provides the Department of Health in South Africa with a platform serving multiple functionalities: vaccine administration, data aggregation, synthesis, and simple visualization (WHO, 2018).

LIKELY CHALLENGES OF THE EVDS

Rowe (2006) claims that not everyone supports the adoption of disruptive ICTs in health practice. Guerazi (2021) further acknowledges that vaccine delivery, distribution, and administration come with challenges. Guerazi (2021) sums the challenges as relating to manufacturing delays, the availability or reliability of ultra-cold supply chains, risks of delays in vaccine shipments crossing borders, prioritization of populations to receive vaccinations, the complexity of scheduling vaccinations, ensuring the quality of vaccines, tracking recipients for follow-up, and ensuring that the majority of people are mobilized and vaccinated. In the sections below, the paper discusses some of the potential challenges resulting from using the EVDS.

Lack of Information

The roll-out of the EVDS in an equally desperate and rushed situation makes it difficult to evaluate the system properly. The challenge is further worsened by the fact that, as WHO (2013) stresses, data on innovations generally is not available in a structured and accessible way. The WHO (2013) argues that people who could benefit from the innovations are usually poorly informed to push down new technology and systems. The unavailability of comparative data also worsens the lack of information on the utility of the EVDS. For example, available research data on a system in the United States of America similar to South Africa's EVDS is inconclusive. Rowe (2006) further notes that research results on ICT systems in developing countries are difficult to find. Coyne (1995) and Edejer (2000) bemoan the prevalence of unreliable, contradictory, inconsistent, and dubious information on both ICT and health care found on the internet.

ICT Literacy

Competencies in modern and evolving ICT gadgets and software continue to be a challenge for several health practitioners. Research done by WHO identifies ICT literacy as a barrier affecting mainly older health workers. In South Africa, studies indicate that the adoption and utilization of ICTs in rural areas are handicapped by low literacy levels (Nyasulu and Chawinga, 2018; Ruxwana *et al.*, 2010). When potential users of innovation are not capacitated to use it, they might not see the perceived benefits.

Guaranteeing Freedom of Vaccine Choice

The EVDS, in its current state, does not provide adequate information on whether applicants/registrants can choose a vaccine of their choice or not. The system also does not provide people with enough vaccine efficacy information. Since it is clear that there are many vaccines that different countries and pharmaceutical companies have developed. Even though access and availability of those vaccines depend on several factors, citizens must be allowed to choose a vaccine of their choice and reject the ones they are skeptical of. This means that the government must provide on the EVDS adequate information on vaccine efficacy based on science and research.

Technical Barriers

In South Africa, poor internet connection in some remote areas and lack of or inconsistent access to electricity present a huge challenge in using the EVDS. The online scheduling provided for by the EVDS raises concerns of better positioning only those with reliable access to the internet. The system is likely to be ineffective in areas where there is limited telecommunications connectivity. Ensuring that a system such as the EVDS in South Africa "can operate at unprecedented scale and are configured for two-dose vaccines is a major software development, data-hosting and operational challenge" (McKinsey and Company, 2021).

Vaccine Apartheid

Vaccine apartheid is a term developed to conceptualize a situation where: 1. wealthy nations secure vaccines while developing countries do not; 2. two groups emerge – the vaccinated and the unvaccinated (Flemming and White, 2021). According to the UNAIDS Executive Director, Winnie Byanyima, "South Africa today is facing a vaccine landscape of depleted supply where it is purchasing power, not suffering, that will secure the few remaining doses" (UNAIDS, 2021). The use of the EVDS is likely to perpetuate disparities by making COVID-19 vaccines accessible to the privileged few who have ICT gadgets at their disposal. Due to existing inequalities in South Africa society, vaccine access, even though the EVDS, is likely to favor those from a high socio-economic class and structurally discriminate against the poor members. The government provides no evidence on how the EVDS addresses inequalities necessitated by the system. For example, WHO's (2014) concerns on

inequities arise from the fact that health services are not accessible to the poorest or marginalized populations or women and girls due to their remoteness from health facilities, financial barriers in many societies, or social taboos. The emanating vaccination gaps will curtail the country's efforts meant to fight the virus. This has led to medical experts warning that the virus will mutate and become more lethal. Vaccine apartheid is a challenge that South Africa must be cautious of, especially in its use of the EVDS.

Difficulties in Integrating Communication and Collaboration Linkages Amongst Stakeholders

The EVDS system produces volumes of data used to inform activities, actions, and decisions of different stakeholders at different levels and with different capacities. Such as system generally follow well defined and elaborate vertical structure involving many people and reporting systems. The stakeholders, besides being numerous, have different interests and values, some of which compete, leading to inertia and tensions. In these circumstances, building and strengthening communication and collaboration amongst the stakeholders can be a mammoth task. Vaccine distribution and administration is complex and a complicated endeavor. It involves hundreds of – vaccine handlers, medical and pharmaceutical workers, and transporters – from both the public and private sectors. Integrating collaboration and communication becomes complicated considering the involvement of different governmental levels in vaccination efforts and use of the EVDS, i.e., from national, provincial, and up to district level.

THE EVDS: INNOVATING FOR EQUITY IN COVID-19 VACCINATION

Questions on how innovation can improve equity in health care continue to be asked. Improving the EVDS use in the fight against the COVID-19 pandemic is heavily dependent on the government and its technical partners' ability to formulate a package of interventions that are "theoretically sound and contextually driven, addresses technical and behavioral barriers and can be sustained" (PAHO, 2019). Firstly, as Shava and Hofisi (2017) agree, it is clear that continued technological progress is inevitable. Still, governments should remain vigilant to mitigate the unintended consequences of these technological advancements. Secondly, the government needs to monitor and respond to class (social and economic), racial, ethnic, or even other

demographic disparities emanating from the use of the EVDS. Thirdly, as more vaccines are procured, and the EVDS' use improves, more complementary and rudimentary technologies that fit society's poor and underprivileged conditions must be developed so that no one is left behind. Public health experts and the WHO emphasize that "no one will be safe from the COVID-19 pandemic until everyone is safe".

CONCLUSION

The use of the EVDS by South Africa in the COVID-19 vaccines has been shown to produce mixed outcomes. On the one hand, it improves government efficiency in the national vaccination effort through supporting decision-making, logistics planning, and the general administration of the COVID-19 vaccination drive. On the other hand, many challenges also emanate from using the EVDS. While general challenges presented by the EVDS as an innovation include: lack of information, ICT literacy issues, technical barriers, and difficulties in integrating communication and collaboration of stakeholders, new other concerns are emerging and gaining ground. The new concerns relate to freedom of choice and vaccine apartheid. All these challenges and concerns affect the adoption and use of the EVDS by different stakeholders.

Innovations such as the EVDS are increasingly becoming part of the public sector, and their adoption in the future is likely to continue. These innovations have shown to be very critical, for example, in supporting government efforts to respond to calamities efficiently. However, further studies are needed to ensure that as efficiency in health delivery in particular and the public sector, in general, is sought through ICT systems, these systems should also respond to ethical issues of addressing disparities and enable equity in vaccination against COVID-19.

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