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Implementing artificial intelligence in South African public hospitals: A conceptual framework

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Orientation: Artificial intelligence (AI) is stimulating the generation of knowledge and innovations in healthcare by making machines smart through algorithms to nurture learning and improve resilience in global health systems. Despite these potential benefits, operations managers in a South African public hospital continue to favour manual systems over existing AI technologies within their units.

Research purpose: The purpose of this study was to develop a conceptual framework to facilitate the implementation of AI in a public hospital in South Africa.

Motivation for the study: A gap was identified, highlighting the need for a conceptual framework that facilitates the successful implementation of AI in a public hospital. The aim is to ensure that operational managers fully embrace the benefits of AI, thereby improving the healthcare system.

Research design, approach and method: A qualitative, exploratory, descriptive and contextual research design with a phenomenological research approach was adopted. Five phases were followed to develop a conceptual framework. Twelve individual interviews and two focus group interviews were conducted to collect data. Thematic data analysis was applied to extract and identify significant themes.

Main findings: Three themes were identified: positive experiences related to AI, management and leadership processes in AI facilitation and challenges related to AI. These themes served as the foundation for the development of a conceptual framework.

Practical/managerial implications: There is ambivalence in embracing AI in the units of this public hospital, and it will be addressed by this conceptual framework.

Contribution/value-add: The proposed conceptual framework is designed to enable the operational managers in facilitating the implementation of AI in a public hospital setting. It serves as a valuable resource to promote the integration of AI technology in healthcare operations.

Keywords: facilitation; implementation; artificial intelligence; public hospital; conceptual framework.

Introduction

Artificial intelligence (AI) is influencing our daily activities and its applications are gradually being intertwined (Laï, Brian & Mamzer 2020). In the healthcare, AI is defined as a scientific field that fosters the generation of knowledge and innovations through the use of algorithms to enhance machine intelligence, promote learning and improve resilience of global health systems (Davenport & Kalakota 2019; Sharma, Veepanattu & Chauhan 2019; Schwab 2016; World Health Organization [WHO] 2016; Xu, David & Kim 2018).

Zaidi (2018) reported that Africa is a developing continent and is lagging behind in the implementation of AI in healthcare. Wahl et al. (2018) reported that the AI systems used in Africa are manufactured in Western developed countries, using their data, and this introduces the risk of possible unintended biases, leading to potential discrimination and inaccurate outcomes. Walsh et al. (2020) assert that this fact should not be ignored, as it may produce outcomes that are not relevant to the African context. As a result, Zaidi (2018) suggests that using data generated in Africa to develop AI systems for use in Africa will yield positive outcomes in

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healthcare, especially in administrative and clinical services. In support of this, Owoyemi et al. (2020) caution that AI systems might also incorporate algorithms influenced by the prejudices and specific beliefs of their users.

The global healthcare system needs to evolve with the changing times in order to improve (Xu et al. 2018). Consequently, AI is playing an important role in bringing significant enhancements to healthcare. Artificial intelligence is transforming the future of the healthcare system by providing support to clinicians in diagnosis, treatment planning and risk factor identification while still maintaining their ultimate responsibility for patient care (Broome & Marshall 2020; Lee & Lim 2019). Frost and Sullivan Growth Pipeline Company (2016) and Batra, Queirolo and Santhanam (2018) predicted that by 2021, AI systems were expected to become a $6 billion industry, with healthcare being one of the top five sectors having more than 50 use cases that would involve AI, and over $1bn already allocated for start-up equity. Daley (2020), Jarbandhan (2017), Marwala and Hurwitz (2017) confirm that AI has numerous applications in the healthcare sector, including uncovering connections between genetic codes, powering surgical robots and optimising hospital efficiency through machine learning, system optimisation and improved predictability and adaptability within the sector. Unicorn HRO (2018) and Timely Blog (2021) highlight three reasons for resistance to AI adoption: fear of the unknown, fear that staff might not have the competence to use the new technologies and uncertainty about the need for change. Canning and Found (2015) postulate that public health operation managers (OMs) may resist AI implementation because of their perception of its consequences, misalignment with their values or group norms and doubts about its importance. Owoyemi et al. (2020) added that another factor that might contribute to resistance is the lack of enacted laws specifying responsibility for adverse outcomes resulting from the AI usage. Wahl et al. (2018), He et al. (2019) and Sallstrom, Morris and Mehta (2019) elicit that data privacy and security are critical to the implementation of AI medical technologies, both for compliance purposes and for maintaining public trust, as breaches of sensitive data may pose a serious threat to patient safety.

Research question

From the introduction discussed above, the following research question surfaced: How can the implementation of AI in South African public hospitals be facilitated?

Problem statement and motivation of the study

The outbreak of the coronavirus disease 2019 (COVID-19) pandemic exposed a crisis of inadequate resources and appropriate infrastructure in global healthcare systems, especially in developing countries (WHO 2021). Public hospitals globally were overwhelmed by the pandemic, and it was difficult for them to manage the rapid increase of patients who needed medical attention (Lin et al. 2020). The pandemic resulted in the loss of over 1 million lives (WHO 2020) and created an unprecedented demand for secondary and tertiary medical care, straining the already weakened global healthcare systems across the globe during the initial stages of the pandemic.

In South Africa, public health OMs were entrusted with the responsibility of taking swift action to reduce the number of fatalities during the pandemic. To achieve this, the introduction of AI systems, such as virtual meetings, management WhatsApp groups and healthcare digital machines, was deemed necessary. However, it was observed that many public health OMs still preferred to use outdated machines that lacked AI technologies. They continued to rely on paper-based systems, citing that AI systems were not user friendly and appeared confusing to them. As a result, a gap was identified to explore leadership strategies applied by OMs to implement AI in healthcare. Solbakken et al. (2018) emphasised the need for OMs to acquire more knowledge and evidence about leadership strategies that facilitate the implementation of AI in hospitals.

Research methods and design

Research design and approach

The study employed a qualitative, exploratory, descriptive and contextual research design with a phenomenological research approach to achieve its objectives. In qualitative research, the intentions of the researcher are to explore and understand the meaning individuals or a group ascribe to a social problem or phenomenon of interest (Polit & Beck 2018). These authors also postulated that exploratory research design examines the nature of the phenomenon, its manifestation and associated factors. According to Creswell and Poth (2019), descriptive design is a method that delineates the phenomenon being studied. The researcher explored and described the experiences of the participants on the facilitation of the implementation of AI as discussed by the participants. Polit and Beck (2018) confirm that qualitative researchers must collect data in natural settings to capture a true reflection of events; hence, the data of this study were collected in a specific public hospital within the nursing units of this hospital.

The research process comprised five phases. Phenomenologists are interested in a subjective phenomenon in the belief that critical truths about reality are grounded in people's lived experiences (Polit & Beck 2018). Twelve in-depth phenomenological individual interviews were conducted and two focus groups (consisting of 13 and 14 participants, respectively) interviews were conducted to collect primary data. All interviews were conducted by the researcher, who had no close or personal relationship with any of the participants and the management of the public hospital.

A postmodern constructivist philosophy guided this study as it resembles the researchers' worldview, which is that the public health OMs as leaders in public hospitals use specific leadership strategies to lead within these settings and play a

critical role in the facilitation of the implementation of AI. This worldview was discovered through spectacles of literature immersion that happened in phase 1 and phase 2 of the study when the researchers were reviewing literature that is related to the phenomenon understudy. A semantic thematic analysis was employed based on descriptive phenomenology to extract and identify key themes from the data.

Research method

The research process comprised the following five phases to develop the conceptual framework, namely: (1) exploration of the concept of AI and its application and practices in healthcare systems; (2) exploration of theories, models and frameworks related to leadership strategies that facilitate change; (3) exploration and description of the lived experiences of public health OMs to implement AI, using phenomenology inquiry method; (4) contrasting and evaluation of leadership strategies applied by public health OMs to implement AI and (5) development of the conceptual framework to facilitate the implementation of AI.

Population and sample

The population comprised 1134 public health OMs who are employed by the Gauteng province department of health. A purposive sampling method was used to identify the participants who were most informative about the phenomenon. Only 60 OMs were purposively selected based on specific inclusion criteria, which included: having staff members reporting to them and having exposure to AI in their respective units.

Data collection

Participants were recruited during an information session about the study, held in a public hospital's boardroom. Those who expressed interest in participating provided informed consent by signing the necessary documents, which included information about the recording of the interviews. The following open-ended central question was paused to the participants: What are your experiences on facilitating the implementation of AI in this public hospital? The participants were probed to expand on relevant and interesting responses. Primary data were collected by conducting 12 open in-depth individual phenomenological interviews lasting 45 to 60 min, as well as two separate focus group interviews consisting of 13 and 14 participants, respectively (excluding the previous participants).

Data analysis

Thematic analysis was employed based on Giorgi and Collaizi's descriptive phenomenology technique of data analysis in this study as cited by Whiting (2002), and it consists of the following five steps: (1) the researchers obtained a general set of each transcript which included the field notes and significant statements were extracted; (2) meanings were formulated from each significant statement; (3) the formulated meanings were then organised to a central theme, themes and categories; (4) all the resulting ideas were then integrated into an exhaustive description of the phenomenon and its fundamental structure and (5) the researchers returned to the participants to validate the findings to ensure that the analysis was appropriate and it did not alter their meaning. An independent coder followed the same five steps of thematic analysis to code the data independently, and a consensus meeting on findings was held by the independent coder and researchers. During this process of data analysis, the researchers and the independent coder avoided any preconceived ideas they had on a phenomenon of interest that could contaminate the findings. From this descriptive data analysis, central themes, themes and categories emerged.

Trustworthiness and rigour

A model of Lincoln and Guba (1985) to ensure trustworthiness and rigour was employed, and it comprises credibility, dependability, transferability and confirmability. Credibility was maintained through data triangulation and prolonged engagements. In addition, credibility was ensured by using purposive sampling method to ensure that the participants are appropriate and relevant individuals to address the research question. The researchers collected data utilising individual and focus groups interviewers, and the field notes were recorded during the interviews. More than three months were spent by the researchers on the field collecting data, ensuring prolonged engagement and data immersion. The findings of the study were coded by an independent coder to ensure dependability, who was well versed on qualitative research and leadership as a speciality. A thick description of the study context, methods and findings was provided to afford other researchers with an opportunity to transfer the findings of this study to a similar setting should they anticipate to do so. After data analysis, the researchers returned to the participants to confirm the findings of the study.

Ethical considerations

Ethical clearance to conduct the study was obtained from the University of Johannesburg Department of Industrial Psychology and People Management Research Ethics Committee (IPPM-2-21-476(D)). An information session was held in a hospital boardroom with the participants after obtaining prior consent from both the department of health and the management of a public hospital where the study was conducted. Written permission for participation and audio-recording was secured from the participants. Confidentiality and anonymity were maintained by using codes when transcribing the data, and each transcript and record of the data were stored in a security-protected file, and only the authors and an independent coder had access to open the files. An independent coder signed a legally binding confidentiality agreement form to maintain the data's confidentiality. All participants were treated with respect, and their involvement did not cause any harm. Ethical considerations were upheld throughout the research process.

Main findings and discussion

A conceptual framework

A conceptual framework is a network or plane of concepts that are interlinked to best explain a specific phenomenon (Adom, Hussein & Agyem 2018; DeMarco 2020). The central concept of the conceptual framework was derived from the findings of the phenomenology inquiry, which emerged as positive experiences related to AI, management and leadership processes in AI facilitation and challenges related to AI. These findings suggested that there is a need for a conceptual framework to facilitate the implementation of AI in a public hospital. The survey list of Dickoff, James and Wiedenbach (1986) was adopted to develop a conceptual framework and to classify the central concept. This survey is focussing on six elements of practice theory: the agent, the recipient, the procedure, the context, dynamics and outcome.

Overview of conceptual framework

The framework focusses on the public health OMs interacting with the Chief Executive Officer of Gauteng Department of Health, Chief Executive Officer of a public hospital, Nursing Service Manager, Deputy Directors and Assistant Managers to facilitate the implementation of AI in a public hospital**.** The interaction takes place in three phases: relationship phase, working phase and maintenance phase. In the relationship phase, a therapeutic, mutual and ongoing collaborative working relationship is established. In the working phase, the facilitation of the implementation of AI is happening. In the maintenance phase, the benefits of AI are embraced and this is the outcome of this process.

Structure and process of a conceptual framework

The structure and a process of this conceptual framework are discussed as the context, agent, recipients, dynamic, procedure and outcome. Figure 1 (graphic diagram) presents a conceptual framework to facilitate the implementation of AI in a public hospital that is discussed next.

The context: A public hospital

This refers to the hospital where the study was conducted, which is a public hospital. Creswell and Poth (2019) state that a structural description and a setting, where the phenomenon is facilitated by the agents and experienced by the recipients is the context of the study. This study was conducted in a 2888-bedded public hospital in Gauteng providing comprehensive healthcare services of complicated conditions to ±4.5 million healthcare users per year from Soweto and peripheral areas. It has employed 118 OMs and 1229 professional nurses, 804 enrolled nurses and 926 nursing assistants.

The agent

The agents are the facilitators of an activity (Dickoff et al. 1968), and in this study, these are the Chief Executive Officer Gauteng Department of Health, Chief Executive Officer of a public hospital, Nursing Service Manager, Deputy Directors and Assistant Managers of a public hospital where the study was conducted. All these individuals have qualifications in health service management and nursing management and are competent to facilitate the implementation of AI in a public hospital.

The recipients

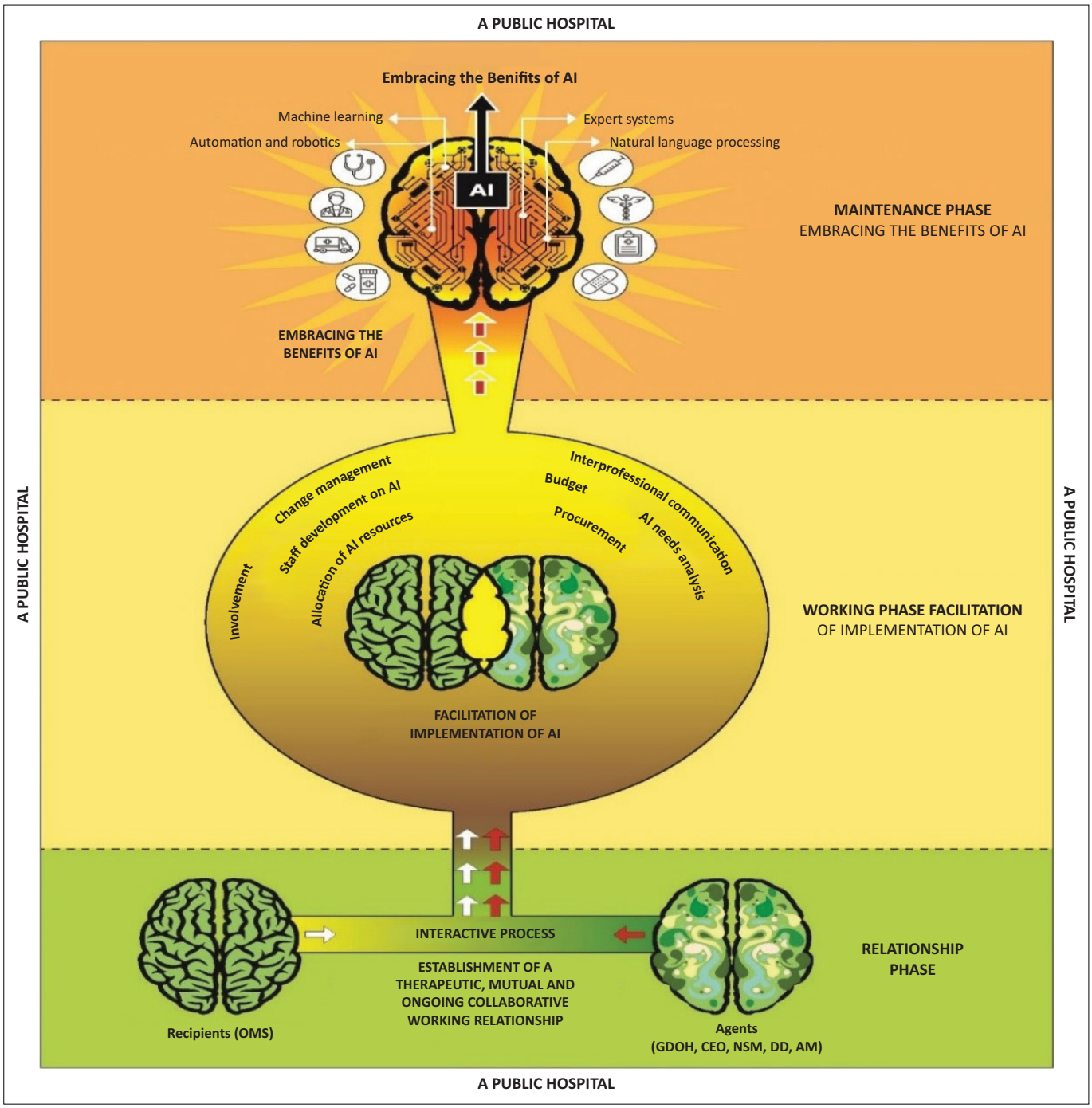
The recipients were the public health OMs responsible for the implementation of AI in the units of this public hospital. The OMs are leading and managing the operational activities within the units; they plan organise and direct the activities to achieve the objectives of the units that are aligned to the vision of a public hospital (Solbakken et al. 2018). To implement AI in the units is one of the objectives to be achieved by the OMs.

The dynamic

The dynamic of the study was the experiences of the public health OMs on the implementation of AI in a public hospital. These experiences revealed that there is ambivalence in embracing AI in the units of this public hospital, which motivated for the procedure to facilitate the implementation of AI. Dickoff et al. (1968) argue that agents and recipients are, respectively, motivated by a specific dynamic.

The procedure

The procedure is a protocol that is guiding the activity (Dickoff et al. 1968). The procedure in this study refers to the facilitation of the implementation of AI, and it is discussed based on the three phases mentioned in the overview of the conceptual framework: relationship, working and maintenance phase. The interaction between the agents and recipients commences by establishing a therapeutic, mutual and ongoing collaborative working relationship. Burns (2012) posits that the agents should shape the discussions by enabling the recipients to ask questions to ensure that a therapeutic ongoing collaborative relationship is established. The next phase is the working phase that focusses on the facilitation of implementation of AI, and it is responding to the dynamic of the study, which are the experiences of the public health OMs. In this phase, the agents and recipients are working together to execute the following activities to ensure the implementation of AI: involvement of all those affected, AI needs analysis, ensuring effective change management and interprofessional communication, staff development on AI, allocation of AI resources, budget and procurement. Mind Tools (2021) clarifies that the procedure is all about facilitation; as a result, the first concern is to determine the content knowledge required to facilitate the activity, how to utilise such knowledge and what it takes to practically implement that knowledge. Rogers (1962) emphasises that the recipients must be supported and their concerns must be addressed for the effective facilitation of the procedure.



AI, artificial intelligence; OM, operation manager.

FIGURE 1: A conceptual framework to facilitate the implementation of artificial intelligence in a public hospital.

The outcome

The outcome of the conceptual framework was embracing the benefits of AI and is expected to be achieved by following an interactive, mutual facilitation process between the agents and the recipients. The outcome in the conceptual framework takes place in the maintenance phase because the implementation of AI cannot be terminated but it must be sustained (Dickoff et al. 1968).

Conclusion and recommendation

There is ambivalence on the implementation of AI in a public hospital in South Africa. The implementation of AI is critical for the public health sector and will improve the healthcare system of public hospitals in South Africa. This study proposes a conceptual framework to facilitate the implementation of AI in a public hospital. It is also suggesting that public health OMs should be actively involved to implement AI in the units they are responsible for.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

S.E.N. prepared the manuscript under a supervision and support of L.M.H.

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Data availability

Data sharing does not apply to this article as no new data were created or analysed in this study.

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