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Challenges of 4IR Implementation in Post Offices in Developing Countries: A Case Study of South Africa

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Abstract: The Fourth Industrial Revolution (4IR) presents an unprecedented opportunity for post offices in developing countries to modernise and enhance their services, addressing the evolving demands of a digital economy. However, implementing 4IR technologies in this sector is fraught with challenges, including inadequate infrastructure, corruption, inclusion bias, disparities in employee skillsets, and financial constraints. This study investigates these challenges, focusing on the South African context, to provide actionable insights and recommendations for effective 4IR adoption. The research adopts a qualitative design, utilising semi-structured interviews with 25 purposively selected participants across five socioeconomic classes in South Africa. This approach ensured the inclusion of diverse perspectives on the risks and barriers associated with 4IR implementation. Data were analysed using thematic analysis to identify key challenges and potential strategies to address them. The findings reveal significant hurdles, including corruption in financial management, insufficient infrastructure to support digital technologies, exclusion of underserved populations, skillset gaps among employees, and limited financial resources. These challenges highlight systemic and structural barriers that hinder the post office's ability to transition into a fully digitalised environment. To address these issues, the study recommends measures such as establishing stringent financial oversight mechanisms, investing in infrastructure upgrades, bridging skillset gaps through training and mentorship programmes, adopting inclusive service models, and fostering equity through community engagement. A strategic and collaborative approach to 4IR implementation can help post offices in developing countries overcome challenges, modernise operations, enhance service delivery, and drive digital transformation and national development.

Keywords: Corruption, developing countries, inclusion bias, Fourth Industrial Revolution, infrastructure, post offices, skillset disparities.

1. Introduction

The Fourth Industrial Revolution (4IR) is reshaping industries globally by integrating advanced technologies such as artificial intelligence (AI), blockchain, robotics, and the Internet of Things (IoT) into operational processes (Alsulaimani & Islam, 2022). These innovations promise enhanced efficiency, connectivity, and service delivery. For developing countries, 4IR presents a significant opportunity to transform critical sectors, including logistics and postal services (Oloba & Ramhurry, 2024). Traditionally viewed as essential hubs for communication and commerce, post offices have the potential to modernise their operations and redefine their roles in the digital age through 4IR technologies (Alexander, 2022). They play a vital role in underserved regions, where alternative infrastructure for communication, logistics, and financial services is often limited (Oloba & Ramhurry, 2024; World Bank, 2022). The advent of 4IR technologies, such as AI and IoT for optimising logistics, along with blockchain for securing financial transactions, offers post offices the potential to improve operational efficiency and expand their service offerings (Khan et al., 2024). However, systemic barriers in developing countries, including South Africa, hinder the adoption of these innovations. The postal sector in South Africa has historically played a critical role in connecting communities, facilitating commerce, and delivering essential government services. As the

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country's designated postal operator, the South African Post Office (SAPO) has been instrumental in providing mail delivery, financial services, and logistical solutions to millions, particularly in rural and underserved areas (Ittmann, 2023). However, in an era where 4IR technologies—such as AI, automation, blockchain, and IoT—are transforming global logistics and communication networks, South Africa's postal system faces significant challenges in keeping pace (Alexander, 2022). Despite its vast network of over 1,300 branches, SAPO struggles with inefficiencies, financial instability, and outdated infrastructure. The rise of digital communication has led to a decline in traditional mail services, while logistical inefficiencies and frequent service disruptions have eroded customer trust. Additionally, cybersecurity concerns, a slow adoption of automation, and bureaucratic constraints further hinder modernisation efforts. This stagnation comes at a time when e-commerce is booming, presenting an opportunity for SAPO to reposition itself as a key player in the digital economy. Research into these challenges is essential to understand how post offices in developing countries can strategically navigate the complexities of 4IR implementation while maintaining their relevance and inclusivity.

While discussions on the Fourth Industrial Revolution (4IR) have predominantly focused on developed nations with robust infrastructure, limited research has explored its contextual challenges in developing countries, particularly in the postal sector. Existing studies often emphasise the benefits of 4IR while overlooking the socio-economic and cultural barriers that hinder its adoption in resource-constrained settings (Cowie et al., 2020; Sutherland, 2020). This gap is especially evident in developing countries, particularly South Africa, where post offices play a crucial role in bridging the digital divide. South Africa's post offices face unique obstacles, yet the literature addressing these challenges remains scarce. This study seeks to fill this gap by providing contextually relevant insights to guide 4IR adoption strategies. As digital transformation accelerates globally, integrating 4IR technologies into post office operations is imperative for maintaining their relevance as hubs of communication and innovation (Zhu et al., 2024). Successfully adopting these technologies can improve service delivery, bridge the digital divide, and foster socio-economic growth (Okocha & Edafewotu, 2022). This research explores the challenges encountered by developing countries in implementing 4IR technologies, using South African post offices as a case study. It provides practical recommendations for policymakers, industry leaders, and stakeholders to address these challenges effectively. By tackling these issues, post offices in developing countries can build resilience, enhance efficiency, and ensure inclusivity in the digital era.

1.2 Literature review

The Fourth Industrial Revolution refers to the fusion of advanced technologies that blur the lines between the physical, digital, and biological worlds. Key technologies include AI, the IoT, robotics, automation, blockchain, cloud computing, and big data (Schwab, 2024). AI enhances decision-making through predictive analytics, while the IoT connects devices for real-time data exchange, thereby improving operational efficiency (Marengo, 2024). Robotics and automation streamline processes, reducing human error and increasing productivity, particularly in logistics and sorting (Jie et al., 2023). Blockchain technology offers secure, transparent transactions, which are vital for postal services in digital financial systems (Javaid et al., 2022). Cloud computing enables scalable data storage and computational power, which is essential for post offices' digital infrastructure (Sehgal et al., 2020), while big data allows for predictive analytics and customer insights, optimising service delivery (Theodorakopoulos & Theodoropoulou, 2024). Digital transformation, driven by these technologies, is disrupting traditional industries, including postal services, by enabling e-commerce integration, reducing reliance on physical mail, and offering more efficient and accessible services (Verhoef et al., 2021). The shift from conventional methods to digitally enhanced operations presents both opportunities and challenges, particularly in developing countries, where infrastructure and financial constraints may hinder full 4IR adoption.

The implementation of the 4IR in post offices across developing countries presents various challenges that hinder the efficient adoption of transformative technologies. A significant barrier is the lack of modern infrastructure and the reliance on outdated systems that are incompatible with advanced digital technologies like automation, blockchain, and artificial intelligence (Gkrimpizi et al., 2023). Additionally, post offices in developing countries often face financial constraints that make it difficult to fund the high costs associated with technological upgrades, further exacerbating the digital divide (Faloye & Ajayi, 2022). Moreover, the absence of sufficient digital literacy and technical expertise among employees is a critical obstacle, leading to resistance to change and an inability to manage new technologies effectively (Scholkmann, 2021). These challenges are compounded by political and regulatory issues, including inefficient governance, which slows down decision-making processes and delays digital transformation initiatives. Consequently, addressing these barriers requires targeted investments, robust policy frameworks, and extensive capacity-building programmes to equip the postal workforce and infrastructure for the digital era.

The successful implementation of 4IR technologies in post offices in developing countries requires a multi-faceted approach to overcome existing challenges. One critical strategy is collaboration between governments and private sector players to foster public-private partnerships that can provide financial and technological resources (Ramolobe & Khandanisa, 2024). Governments can play a pivotal role by developing policies that support infrastructure investments, such as improving digital connectivity and creating regulatory frameworks that encourage innovation (Ndubuisi et al., 2021). Additionally, reskilling and upskilling postal employees is essential to ensure a workforce capable of handling advanced technologies, with initiatives focusing on digital literacy and change management to reduce resistance (Morandini et al., 2023). The integration of emerging technologies, such as AI, IoT, and blockchain, is also key to enhancing operational efficiency and improving service delivery. For instance, AI-driven automation in sorting and logistics has been successfully implemented in various postal systems to reduce costs and improve accuracy. These strategies, alongside the development of a clear and supportive roadmap for 4IR adoption, are vital for addressing the unique challenges faced by post offices in developing nations.

1.3 Theoretical framework

The theoretical framework for this study was grounded in the Technology Acceptance Model (TAM) and Diffusion of Innovations (DOI) theory, providing a comprehensive lens to examine the challenges associated with the implementation of 4IR technologies in post offices, particularly in developing countries like South Africa. These theories are highly relevant to understanding the adoption of emerging technologies, which often face unique barriers in contexts where infrastructure, digital literacy, and organisational readiness may be underdeveloped. TAM, developed by Davis (1989), was used to explore how individual perceptions—specifically perceived ease of use and perceived usefulness—affect the adoption of 4IR technologies. Meanwhile, Rogers' (2003) DOI theory offered a broader view of how innovations spread within an organisation and society, helping to understand the organisational and societal dynamics that influence technology diffusion.

TAM provided valuable insights into the factors influencing technology acceptance in South African post offices. The model suggested that the perceived usefulness (PU) and perceived ease of use (PEOU) of 4IR technologies would significantly affect their adoption. Employees in post offices often expressed resistance to new technologies, particularly when they did not perceive clear, tangible benefits. This resistance stemmed from doubts about how technologies like automation, artificial intelligence, and blockchain would improve their performance or streamline their tasks. TAM's focus on perceived usefulness highlighted the importance of demonstrating how 4IR innovations could enhance operational efficiency and service delivery in the post office environment. Additionally, perceived ease of use played a key role in shaping adoption rates, as employees and customers with

varying levels of digital literacy found it challenging to embrace technologies that seemed overly complex. Therefore, user-friendly interfaces and tailored training programmes were identified as essential for overcoming these barriers, ensuring smoother adoption and integration of 4IR technologies in post offices.

The DOI theory further complemented this framework by examining the broader process of how innovations were introduced and diffused within the post office system. Rogers' (2003) theory identified several factors that influence the rate of adoption: relative advantage, compatibility, complexity, trialability, and observability. These factors were instrumental in understanding the challenges faced by South African post offices in adopting 4IR technologies. Relative advantage, the perceived benefit of innovations over existing methods, was crucial in motivating adoption. For instance, digital tracking systems were seen as faster and more accurate than traditional methods; however, infrastructural challenges and staff training deficits hindered their full implementation. Compatibility was another critical factor; 4IR technologies needed to align with the existing systems and organisational culture of South African post offices. Resistance emerged when employees perceived these technologies as incongruent with their traditional ways of working, leading to delays in adoption.

Moreover, complexity emerged as a significant challenge. Post office staff often viewed 4IR technologies as difficult to understand or operate, particularly when digital literacy varied across the workforce. The study found that providing opportunities for trialability, such as pilot programmes or small-scale rollouts, was essential for mitigating this barrier. Through trialability, post offices could test and refine these innovations, making them more acceptable to employees. Observability also played a key role; the visible success of 4IR technologies in certain post office branches encouraged adoption in others. By observing the benefits firsthand, employees and managers became more confident in the potential of these innovations to improve service delivery and operational efficiency. However, *the study examines the challenges associated with 4IR implementation in post offices in South Africa.*

2. **Methodology**

This study employs a qualitative research approach to examine the challenges associated with the implementation of 4IR technologies in post offices in developing countries, focusing particularly on South Africa. A qualitative approach was chosen for its capacity to explore complex, nuanced, and subjective experiences, providing a deeper understanding of how individuals interact with and perceive the impact of technological advancements in this context (Creswell, 2017). This study adopts a generic qualitative research design, which is suitable for research that seeks to understand participants' experiences and perspectives without adhering to the rigid frameworks of phenomenology, ethnography, or grounded theory (Lim, 2024). This approach offers flexibility in data collection and analysis, allowing the researcher to adapt the inquiry as new insights emerge (Busetto et al., 2020). It is particularly valuable in contextual studies, where identifying practical challenges and solutions is essential (Ellis & Hart, 2023). Given the study's focus on real-world challenges rather than theory-building, this design enables an in-depth yet broad exploration of the barriers to 4IR adoption in South African post offices.

To ensure the collection of relevant and diverse insights, purposive sampling was employed. This technique, widely used in qualitative research, targets individuals with specific knowledge or experiences related to digital transformation in post offices, providing valuable insights into the challenges of 4IR implementation (Burns & Grove, 2010). A total of 25 participants were selected, with five drawn from each of South Africa's five socioeconomic classes: upper class (executives, high-income business owners), upper middle class (senior professionals, IT specialists, entrepreneurs), lower middle class (small business owners), working class (service workers), and lower class (unemployed individuals, informal sector workers, social grant recipients) within Gauteng Province.

To capture diverse challenges related to infrastructure and service delivery, participants were drawn from both urban and rural areas. This approach ensured a representative sample, reflecting varied interactions and challenges experienced by users of South African Post Office services across different contexts. Additionally, participants were selected based on their direct engagement with postal services, ensuring their responses were relevant to the study's objective. Data were gathered through semi-structured interviews, a method that balances structure with flexibility, allowing for in-depth exploration of participants' perspectives (Kallio et al., 2016). The interviews enabled the researcher to adapt questions based on the flow of the conversation, probing for detailed insights and fostering an environment where participants could openly share their experiences. While the interviews were primarily conducted in English, participants were encouraged to express themselves in their native languages to ensure clarity and authenticity. Ethical considerations were upheld throughout the study. Informed consent was obtained from all participants, and the research was approved by the Johannesburg Business School Research Ethics Committee at the University of Johannesburg under approval number JBSREC202454.

The data analysis process adhered to the guidelines for qualitative content analysis established by Richards and Hemphill (2018). Recorded interviews were transcribed verbatim immediately following each session to maintain the integrity of the data. The transcripts were reviewed repeatedly to ensure familiarity prior to the inductive coding of the data, allowing themes to emerge organically from participants' responses. Thematic analysis was subsequently employed to group the codes into broader themes, thereby capturing recurring patterns and providing meaningful insights pertinent to the research question. These themes were critically examined in relation to existing literature to contextualise the findings within the broader discourse on 4IR and its implications for the postal sector. To ensure rigour and trustworthiness, the study employed multiple strategies, including triangulation to validate findings against existing studies, member checking to confirm interpretations with participants, and the maintenance of a reflexive journal to minimise researcher bias. These measures enhanced the credibility and dependability of the study's outcomes. The findings will be synthesised to develop actionable recommendations for policymakers, post office administrators, and other stakeholders. These recommendations aim to address the challenges identified and support the effective implementation of 4IR technologies, thereby ensuring that post offices in developing countries can successfully navigate the transition to the digital era.

3. Presentation of Results and Discussion of Findings

The data highlight that the challenges of 4IR implementation in postal services in South Africa encompass inclusion bias, inadequate infrastructure, corruption, disparities in employee skill sets coupled with generational gaps, and financial constraints.

3.1 Inclusion bias in 4IR implementation

Inclusion bias occurs when certain groups are systematically overrepresented or underrepresented in a study due to the selection criteria, leading to skewed results and reduced generalisability (Agrawal et al., 2023). Inclusion bias was identified as a significant challenge associated with implementing 4IR technologies in post offices in developing countries. One of the upper-middle-class participants explained:

> *Inclusion bias occurs when the needs of the majority are prioritised, while the needs of minority groups are overlooked, even though the latter may rely more heavily on these services.*

This concern was echoed by an upper-class participant, who noted:

> *The post office's primary mission is to serve impoverished and underserved populations. However, as 4IR technologies – such as digital platforms and automated services – are introduced, there is growing concern that these innovations may primarily benefit wealthier,*

> *more tech-savvy users, excluding the impoverished populations who rely most on traditional post office services.*

While many participants agree that the 4IR transformation is essential for keeping the post office relevant and efficient, there is widespread concern that this shift risks alienating the very communities the post office was designed to serve. One of the working-class participants indicated:

> *Lower-income communities often lack access to digital devices, stable internet connections, and the technical skills needed to navigate these new systems. Prioritising the demands of wealthier customers would be counterproductive, as it would alienate those who rely most on postal services.*

The challenge of inclusion bias in the implementation of 4IR technologies in the post offices of developing countries is a significant concern, as revealed by the data. These insights highlight the potential consequences of excluding marginalised groups from the benefits of 4IR. Participants noted that marginalised groups, particularly impoverished populations, may be unintentionally left out of the advantages presented by 4IR innovations. Inclusion bias occurs when the focus of technological advancement is disproportionately skewed towards more affluent and tech-savvy users, thereby neglecting those who rely most on traditional services. The participants' concerns align with existing literature on the digital divide, which refers to the gap between individuals who have access to modern information and communication technologies and those who do not. Okocha and Edafewotu (2022) argued that access to digital technologies remains unevenly distributed, particularly in developing countries, where significant segments of the population lack access to reliable internet and digital devices. Similarly, findings from a study by Shibambu (2024) revealed that digital transformation in public services can disproportionately favour wealthier, urban populations who are better equipped to engage with digital platforms, while rural and lower-income communities are left behind. This digital divide is exacerbated when institutions like the post office, historically designed to serve all citizens, begin to prioritise digital innovations that are inaccessible to poorer communities.

The concern expressed by participants regarding lower-income communities lacking access to digital devices, stable internet connections, and technical skills is supported by studies that demonstrate how digital illiteracy and lack of infrastructure hinder the participation of marginalised groups in digital economies (Aminah & Saksono, 2021; Shibambu, 2024). For post offices, this poses a dilemma; while they must modernise to remain relevant, they must also ensure that these advancements do not alienate the very populations they are designed to serve. One of the potential risks of ignoring inclusion bias in 4IR implementation is the widening of the digital divide. According to Liu et al. (2024), as digital technologies become more integrated into public services, there is a growing need to address accessibility issues to avoid exacerbating inequalities. In the context of post offices, if the transition to digital platforms prioritises the demands of wealthier customers, it risks deepening existing social and economic disparities. The data underscores the need for a balanced approach to 4IR adoption in post offices. This includes developing strategies that ensure marginalised groups, such as those in rural or low-income communities, can access and benefit from digital innovations. Mhlongo et al. (2023) found that one solution is to invest in digital literacy programmes and infrastructure improvements tailored to disadvantaged populations, ensuring that the benefits of 4IR technologies are distributed more equitably. Additionally, hybrid service models that integrate both digital and traditional services can provide an inclusive approach to modernisation (Gaorekwe & Bwalya, 2022).

The findings that marginalised groups face exclusion due to a lack of access to digital technologies (e.g., internet, devices) validate TAM's emphasis on perceived ease of use and perceived usefulness. The exclusion of these groups from 4IR technologies indicates that these innovations may not be perceived as useful or easy to access for disadvantaged populations. In such cases, adoption is

hindered due to the lack of perceived value and usability, especially when these populations lack the necessary infrastructure or skills. DOI's concept of compatibility is also relevant here, as the findings suggest that 4IR technologies are not well-aligned with the needs of low-income or rural communities. This misalignment contributes to slower adoption rates. Innovations that are incompatible with the existing lifestyles or infrastructure of these groups are less likely to be adopted. Furthermore, the lack of trialability (the ability to test new innovations before fully adopting them) and observability (the absence of visible benefits to early adopters) may prevent widespread acceptance in these areas.

3.2 Inadequate infrastructure

The data reveal that a significant challenge hindering the implementation of 4IR technologies in post offices in developing countries is inadequate infrastructure. Participants highlighted the outdated condition of many post office branches, with one of the upper-class participants stating:

> *Many post office branches are outdated, reflecting the broader neglect of government structures over the years.*

A working-class participant added that:

> *The deterioration of post office facilities demonstrates how disconnected these institutions are from modern technological advances.*

One of the upper middle-class participants further emphasised the government's reactive approach:

> *The government tends to intervene only when the situation becomes dire, leaving critical services like the post office in a state of disrepair.*

Many participants echoed the sentiment that post offices are "stuck in the past," with infrastructure ill-equipped to support the necessary technological upgrades for 4IR implementation. A lower middle-class participant pointed out the need for a complete overhaul of post office infrastructure, arguing that:

> *The expectation for post offices to leapfrog into the digital age is unrealistic given the current state of facilities.*

An upper-class participant elaborated:

> *The post office feels outdated and has become associated primarily with grants and services for the elderly. It hasn't kept up with modern times. It needs to rebrand itself and offer services similar to more competitive options like PostNet, which provides printing, packaging, and courier services. Many people, like myself, resort to more expensive courier options simply because the post office isn't seen as a viable option anymore.*

This challenge reflects a broader issue of neglected government facilities, which have not kept pace with technological advancements. Participants in the study expressed frustration with the outdated and deteriorating state of post office branches, arguing that these institutions are stuck in the past and unable to support the upgrades necessary for 4IR implementation. The deteriorating infrastructure of post offices underscores a reactive governmental approach, where intervention only occurs in response to crises rather than as part of a proactive strategy to modernise essential services. This reactive behaviour mirrors findings in a study by Marzouki et al. (2023), which point to the systemic underinvestment in public service infrastructure as a hindrance to technological adoption in developing countries. The lack of adequate infrastructure is a major obstacle for post offices looking to implement 4IR technologies, such as automation, artificial intelligence, and digitised logistics. As one participant noted, post offices are perceived as relics of legacy systems, primarily associated with grants and services for the elderly. This public perception further hampers the post office's ability to rebrand itself as a modern, digitally capable institution. Research has shown that

public services in developing countries often fail to innovate due to inadequate facilities and a lack of strategic vision (Thusi & Selepe, 2023).

In the case of post offices, these infrastructure deficiencies prevent the adoption of modern services such as digital parcel tracking, integrated payment systems, and automated customer services, all of which are key to 4IR-driven innovation. The participants' reference to the preference for services like PostNet highlights how private sector alternatives are filling the gap, offering modern courier, printing, and packaging services that the post office cannot currently compete with. This dynamic is consistent with findings by Thusi and Selepe (2023), who note that inadequate infrastructure in public institutions in developing countries pushes consumers toward private solutions, even when they are more expensive. The infrastructure gap is not just a technical hurdle; it affects the post office's relevance in a rapidly evolving technological landscape. As noted in the data, the inability to digitise efficiently limits the post office's capacity to offer modern services and undermines its competitive edge. This is further supported by Layton-Matthews and Landsberg (2022), who argue that without substantial investment in digital infrastructure, public institutions in developing countries risk being sidelined in the 4IR revolution.

As indicated by TAM, the challenge of inadequate infrastructure directly impacts the perceived ease of use of 4IR technologies, as outdated infrastructure cannot support modern digital services. TAM suggests that if users find the technology difficult to use due to poor infrastructure, they are less likely to adopt it. The findings about post offices being perceived as outdated institutions mirror this, showing a lack of readiness for technological change. According to DOI, the lack of infrastructure is a key barrier to adoption, as it limits the relative advantage of adopting 4IR technologies. The perceived benefits of these technologies are diminished when the infrastructure needed to support them is not available. Without adequate infrastructure, the complexity of adopting these technologies increases, slowing down the diffusion process. The challenge of inadequate infrastructure also undermines compatibility, as the existing systems are not conducive to digital transformation..

3.3 Corruption

Corruption emerged as one of the significant challenges to the implementation of 4IR technologies in the post offices of developing countries. Participants expressed deep concerns regarding the pervasive influence of corruption. Many referenced South Africa's history of corruption scandals, emphasising that it remains a systemic issue within both governmental and political spheres. Specific examples of corruption within the postal system were highlighted, such as the 2012 Postbank embezzlement scandal, in which R43 million was stolen. Participants also cited more recent incidents, including the R90 million hack of the South African Social Security Agency and the disappearance of funds from a Postbank savings account reported by a 66-year-old woman in 2023. These incidents reinforced participants' belief that corruption continues to undermine the integrity of the organisation, raising concerns that similar issues could hinder the effective implementation of 4IR. One of the lower-class participants speculated:

> *The delays in digitising the post office might be intentional, driven by individuals who benefit financially from the current, outdated systems*.

This viewpoint highlights the perception that the diversion of funds intended for technological upgrades, along with the unexplained disappearance of private funding and tenders, suggests that self-interest among leadership is a significant barrier to progress. An upper-middle-class participant succinctly articulated the collective sentiment:

> *Corruption at various levels of leadership is a major obstacle to the successful implementation of 4IR technologies within the post office in South Africa. Unless these systemic issues are addressed, efforts to modernise the post office and leverage technological advancements will continue to be undermined*.

The data highlights how corruption directly undermines efforts to modernise and secure the post office's digital infrastructure. The mismanagement of funds intended for technological upgrades suggests a broader failure of governance that not only damages the institution's credibility but also compromises its ability to adapt to the demands of the 4IR. Research supports the view that corruption contributes to inefficiencies in public institutions, leading to significant resource wastage and project failures (Pattanayak & Verdugo-Yepes, 2022). For example, in many developing countries, large-scale technology-driven initiatives like 4IR implementation often suffer from delays due to the diversion of resources into the hands of corrupt officials. Participants in the study echoed this sentiment, with one speculating that delays in digitising the post office could be intentional, driven by individuals who benefit from the continued use of outdated systems. This aligns with existing literature, which suggests that entrenched elites in developing countries may actively resist modernisation efforts that threaten their economic interests (Eriksen et al., 2021). Moreover, participants noted that private funding and tenders meant to support the post office's digital transformation often disappear without explanation. These concerns are consistent with studies showing that corruption in procurement and project management can result in incomplete or poorly executed public sector projects (Babajide & Smith, 2022). For instance, the disappearance of funds from a Postbank savings account underscores the lack of financial accountability within the post office, which further erodes public trust in its ability to implement 4IR technologies effectively.

Corruption, as highlighted in the findings, can negatively affect the perceived usefulness and ease of use of new technologies. When funds meant for technological upgrades are misused or siphoned off, it can result in poorly implemented systems that fail to meet user needs, leading to disillusionment and resistance. This is consistent with TAM's assertion that if the technology fails to deliver promised benefits due to mismanagement, adoption is less likely. DOI theory suggests that corruption may hinder the diffusion of innovations by affecting relative advantage. If innovations are poorly implemented due to mismanagement, their perceived benefits are minimised, and users are less likely to embrace them. Corruption also reduces observability—when people see that technology fails to deliver due to resource mismanagement, they become less likely to adopt similar technologies in the future.

3.4 Employee skillset disparities and generational gaps

Another significant challenge in the implementation of 4IR technologies within the post office sector in developing countries is the disparity in employee skill sets, largely influenced by age and experience. Participants highlighted that the median employee age (46) reflects a workforce predominantly composed of individuals who operated under legacy systems. As one of the working-class participants noted:

> *The generational gap in technical familiarity is apparent. While younger employees understand the need for 4IR processes, older employees often resist or struggle to adapt, preferring the legacy systems they are accustomed to.*

This generational divide creates inefficiencies in workflow, as customers sometimes experience delays due to a reliance on employees with legacy system expertise. A social grant recipient participant observed that:

> *We had to wait for a specific employee with the necessary legacy skills to complete a task, reflecting the broader skill gap that hinders the post office's 4IR transformation.*

The challenge is further exacerbated by inadequate training. Participants pointed out that not all employees are sufficiently equipped for the transition to 4IR technologies. An upper-middle-class participant explained:

> *Some employees face difficulties grasping 4IR processes, especially when current training efforts do not adequately address the shift in operations. This variation in technical proficiency—*

> *ranging from manual processes to digital systems—slows down the adoption of new technologies.*

The disparity in employee skillsets, coupled with insufficient training, presents a major obstacle to the effective implementation of 4IR technologies, hindering the post office's ability to modernise its services in developing countries. These disparities, primarily influenced by age and previous work experiences, affect the pace and efficiency of digital transformation efforts. This generational gap in technical familiarity creates inefficiencies and operational delays as the post office attempts to modernise. Research supports the view that generational differences significantly impact the adoption of 4IR technologies. Zervoudi (2020) opined that older employees in sectors transitioning to 4IR often exhibit reluctance or face greater challenges in adapting to new technologies due to their entrenched familiarity with traditional systems. This generational lag can slow down processes, leading to inefficiencies that frustrate both employees and customers.

The data revealed that the skill gap is compounded by inadequate training efforts, which fail to equip all employees with the knowledge and proficiency required to navigate 4IR technologies. A lack of proper upskilling initiatives for older employees contributes to their resistance or inability to fully engage with new systems. This reflects findings by Billiot (2023), who emphasises the importance of continuous and tailored training programmes to ease transitions into new technological frameworks. The skillset disparity between employees with manual expertise and those more adept with digital systems creates a fragmented operational structure within post offices, limiting their capacity to fully integrate 4IR technologies. In many developing countries, this challenge is exacerbated by the absence of robust infrastructure and policies that promote comprehensive workforce training (Khunoethe & Reddy, 2023). Without significant investment in employee training and professional development, post offices risk falling behind in the global shift toward digitisation. Ultimately, the combination of generational gaps and insufficient training initiatives presents a considerable obstacle to the successful implementation of 4IR technologies in post offices across developing countries. As studies suggest, overcoming these challenges requires strategic workforce development efforts that focus on upskilling older employees, fostering intergenerational collaboration, and aligning training programmes with the specific technological demands of 4IR (Li, 2022; Rotatori et al., 2024).

TAM's concept of perceived ease of use is especially relevant in this case. Older employees or those less familiar with digital technologies may find the new systems difficult to use, which can reduce their adoption rates. The lack of adequate training also impacts the usefulness of the technology for these employees, as they may not fully understand how the innovations could benefit them. DOI theory emphasises the importance of compatibility and trialability. Older employees may perceive digital tools as incompatible with their skills or the way they have worked in the past, hindering their acceptance. The findings that employees' generational gaps create operational inefficiencies align with DOI's suggestion that the faster the technology is seen as compatible with an individual's existing values or skills, the more likely it will be adopted.

3.5 Financial constraints

Financial constraints also emerged as one of the critical challenges in implementing 4IR technologies within the post office system of developing countries. Participants consistently expressed concerns about the government's limited capacity to provide the necessary support, citing years of neglect and chronic underfunding. One of the lower-class participants remarked:

> *Even after 30 years of democracy, there has been little improvement in our area, because government resources are stretched thin across various national priorities.*

This comment underlines the widespread perception that the government is financially overwhelmed, prioritising immediate national concerns at the expense of long-term infrastructure development. An upper-class participant observed:

> *The government only steps in at the last minute. They have the money to bail out the post office, but they can't seem to help transform it. This could be because they are too busy putting out other fires.*

This reflects a broader reality in many developing countries, where limited financial resources compel governments to prioritise essential services, often sidelining institutions like the post office, which are not perceived as critical. Participants indicated that the government might see the post office as more of a financial burden than an opportunity for innovation. One of the upper middle-class participants noted:

> *The government may have given up on transforming the post office, seeing it as a financial liability rather than a potential for growth.*

As a result, these financial challenges represent a significant obstacle to the post office's ability to adopt Fourth Industrial Revolution (4IR) technologies and modernise its services. Without substantial investment, the post office risks being left behind, unable to leverage the benefits of digital transformation in an increasingly competitive global environment.

Participants' concerns regarding the government's limited capacity to support the post office reflect a broader issue of chronic underfunding and resource allocation priorities that have persisted over years of governance. As noted, many developing countries often grapple with competing national priorities, which result in insufficient investment in essential public services, including postal systems. Studies have indicated that governments in developing nations frequently prioritise immediate and visible services, such as health and education, while relegating other institutions, such as the post office, to the periphery (Azevedo & Azevedo, 2017; Popoola, 2020). This neglect has significant implications for the ability of the post office to modernise and adopt new technologies. Furthermore, the observation that "the government only steps in at the last minute" highlights a reactive rather than proactive approach to financial management. This aligns with the perspective of Badu et al. (2023), who suggest that many governments in developing countries operate under a crisis management model, often addressing problems only when they become acute. This reactive stance impedes long-term planning and investment, which are crucial for the successful implementation of 4IR technologies in the post office.

The perception among participants that the government views the post office as a "financial liability rather than a potential for growth" further complicates the scenario. Research indicates that when government institutions are perceived primarily as burdens on public finances, they struggle to secure the investment needed for innovation and technological advancement (Hinkley, 2023). This lack of confidence in the post office's viability can lead to a vicious cycle of underfunding and diminished public trust, ultimately limiting the post office's capacity to modernise. As articulated by participants, these financial constraints represent significant barriers to the post office's ability to adopt 4IR technologies and modernise its services. Without substantial investment in digital infrastructure, training, and technology, the post office risks being left behind in a rapidly evolving global landscape where digital transformation is critical for survival. As outlined by Alexander (2021), the inability to leverage 4IR technologies can result in decreased competitiveness, reduced service efficiency, and a decline in customer satisfaction, further exacerbating the financial challenges faced by these institutions.

This finding validates the Technology Acceptance Model (TAM), which posits that financial constraints directly impact the perceived usefulness and ease of use of technology. If there is inadequate investment in technological upgrades, employees and customers may perceive that the technology is neither useful nor worth adopting. The lack of funding for training and infrastructure complicates users' ability to recognise the potential benefits of 4IR technologies, which in turn affects adoption rates. The Diffusion of Innovations (DOI) theory highlights that financial constraints limit the relative advantage of adopting 4IR technologies. Without proper funding, innovations may fail

to deliver the promised improvements in efficiency or cost-effectiveness. This lack of investment also hinders trialability and observability, as users may not have the opportunity to test new systems or witness their benefits firsthand.

4. Conclusions and Recommendations

This study aimed to examine the challenges associated with the implementation of Fourth Industrial Revolution (4IR) technologies in post offices in South Africa, within a developing country context. The findings revealed several key obstacles hindering this transformation, including inclusion bias, inadequate infrastructure, corruption, disparities in employee skillsets coupled with generational gaps, and financial constraints. These challenges collectively slow down the adoption of digital innovations and limit the ability of post offices to modernise their services effectively. Despite the potential of 4IR technologies to enhance service efficiency, drive socioeconomic development, and position post offices as hubs of digital connectivity, the study underscores significant barriers that require urgent attention.

Addressing these challenges necessitates governance reforms to enhance transparency and accountability, substantial infrastructure investments to support advanced technological systems, and the development of inclusive service models that cater to diverse populations. Additionally, workforce upskilling is critical to bridging the generational and skillset gaps, ensuring that employees are adequately prepared to engage with new digital tools and processes. Strengthening public-private collaborations and increasing stakeholder engagement will further enhance the success of 4IR implementation.

While this study provides valuable insights into the challenges of 4IR implementation in post offices, it is not without limitations. The research primarily focused on South Africa, and the findings may not be fully generalisable to other developing countries with different economic, political, and technological contexts. Additionally, the study relied on available qualitative data, which, while rich in detail, may benefit from further quantitative analysis to strengthen its generalisability. Future research could expand to include comparative studies across multiple developing nations and assess the long-term impact of specific 4IR interventions within postal services. Therefore, adopting a strategic and inclusive approach, post offices in developing countries can transform into modernised, efficient, and digitally integrated service providers. Overcoming these barriers will not only enhance customer experiences but also foster economic inclusion, improve service accessibility, and position post offices as key enablers of national development in the digital age. With a clear vision, policy-driven interventions, and collaborative efforts, post offices can successfully navigate the 4IR landscape, ensuring their continued relevance and contribution to societal advancement.

The study presents the following recommendations:

Combatting Corruption: To combat corruption in the implementation of 4IR technologies in post offices, it is recommended that stringent financial oversight mechanisms be established and enforced. This includes implementing robust financial management systems to track the allocation and use of funds, ensuring that every transaction is transparent and auditable. Periodic audits conducted by independent bodies could play a critical role in identifying and mitigating the risks of misappropriation. Anti-corruption measures, such as whistleblower protection programmes, should be established to encourage employees and stakeholders to report unethical practices without fear of reprisal. Collaboration with anti-corruption agencies could further enhance the integrity of leadership and procurement processes. Additionally, performance-based evaluations for managers and leaders could be introduced, aligning their accountability with the success of digitisation projects. Implementing these measures could foster trust, improve efficiency, and safeguard public resources in the digitisation journey.

Improving Infrastructure: Improving the infrastructure of post offices is essential for the successful adoption of 4IR technologies. A dedicated allocation of funds should be directed towards upgrading facilities, ensuring they are equipped to support automation, digital platforms, and other advanced technologies. Public-private partnerships could be a key strategy in this endeavour, as private firms can bring expertise and additional resources to execute these upgrades effectively. Developing a proactive maintenance strategy is equally important; a long-term plan for maintaining and updating infrastructure may prevent costly reactive interventions and ensure sustained operations. By enhancing infrastructure, post offices can provide a seamless, modern experience for customers, significantly improving their competitiveness in a rapidly digitising world.

Addressing Inclusion Bias: Addressing inclusion bias is critical to ensuring that 4IR technologies benefit all demographics. Hybrid models that combine digital and traditional services could be developed to cater to both tech-savvy users and underserved populations. Providing free or low-cost internet services at post offices in these areas, along with distributing affordable digital devices to low-income users, may enhance accessibility. Additionally, offering community training programmes focused on digital literacy, particularly in rural and low-income areas, can empower individuals to utilise digital platforms effectively. By prioritising inclusion, post offices can bridge the digital divide, enabling equitable access to services and fostering social and economic development.

Bridging Skillset Gaps: Bridging skillset gaps among employees is vital for the successful implementation of 4IR technologies in post offices. It is recommended that comprehensive training programmes tailored to different roles and levels be designed to enhance digital competencies and familiarise staff with emerging technologies. Mentorship initiatives that pair experienced employees with younger, tech-savvy staff can facilitate knowledge exchange, easing the transition to a digital work environment. Recruitment should prioritise individuals with expertise in 4IR skills, and continuous professional development programmes should be offered to upskill existing employees. These efforts will create a workforce that is adaptive, competent, and equipped to drive the post office's digital transformation effectively.

Promoting Equity in 4IR Implementation: Promoting equity in 4IR implementation requires a community-focused approach. Engaging marginalised communities in the planning and decision-making processes ensures that their unique needs are addressed. Policy development at the national level should prioritise equitable access to the benefits of 4IR, bridging the gap between urban and rural areas. Tailored initiatives to provide affordable and accessible digital services to underserved populations could create a more inclusive digital ecosystem. These actions will not only enhance social equity but also expand the reach and impact of the post office in fostering nationwide technological advancement.

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Data availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access will be granted to researchers who meet the criteria for data sharing established by the institutional review board or ethics committee.

References

Alexander, R. (2022). *Key opportunities and challenges for 4IR in South Africa*. SARChI, University of Johannesburg.

Alsulaimani, B., & Islam, A. (2022). Impact of 4ir technology and its impact on the current deployment. *International Journal of Computer Science & Information Technology, 13*(4)1, 53-67. https://doi.org/10.48550/arXiv.2209.01791

Aminah, S., & Saksono, H. (2021). Digital transformation of the government: A case study in Indonesia. *Jurnal Komunikasi: Malaysian Journal of Communication*, *37*(2), 272-288. https://doi.org/10.17576/JKMJC-2021-3702-17

Azevedo, M.J. (2017). The State of Health System(s) in Africa: Challenges and opportunities. In M. J. Azevedo (Ed.), *Historical perspectives on the state of health and health systems in Africa*. African Histories and Modernities. Palgrave Macmillan. https://doi.org/10.1007/978-3-319-32564-4_1

Babajide, O. P., & Smith, C. (2022). Teachers' challenges in the introduction and implementation of systemic change in the Nigerian primary school system. *SAGE Open*, *12*(2), 1-12. https://doi.org/10.1177/21582440221093033

Badu-Prah, C., Agyeiwaa-Afrane, A., Gidiglo, F. K., Srofenyoh, F. Y., Agyei-Henaku, K. A. A., & Djokoto, J. G. (2023). Trade, foreign direct investment and agriculture in developing countries. *Research on World Agricultural Economy*, *4*(3), 1-14. https://doi.org/10.36956/rwae.v4i3.861

Billiot, T. (2023). Continuous learning and advancing technologies: a framework for professional development and training in artificial intelligence. *Development and Learning in Organizations: An International Journal*, *37*(3), 28–31. https://doi.org/10.1108/DLO-04-2022-0064

Burns, N., & Grove, S. K. (2010). *Understanding nursing research-eBook: Building an evidence-based practice*. Elsevier Health Sciences.

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, *2*(1), 1–10. https://doi.org/10.1186/s42466-020-00059-z

Cowie, P., Townsend, L., & Salemink, K. (2020). Smart rural futures: Will rural areas be left behind in the fourth industrial revolution? *Journal of Rural Studies*, *79*, 169–176. https://doi.org/10.1016/j.jrurstud.2020.08.042

Creswell, J. D. (2017). Mindfulness interventions. *Annual Review of Psychology*, *68*(1), 491-516. **https://doi.org/10.1146/annurev-psych-042716-051139**

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. https://doi.org/10.2307/249008

Ellis, J. L., & Hart, D. L. (2023). Strengthening the choice for a generic qualitative research design. *Qualitative Report*, *28*(6), 1759-1768. DOI:10.46743/2160-3715/2023.5474.

Eriksen, S., Schipper, E. L. F., Scoville-Simonds, M., Vincent, K., Adam, H. N., Brooks, N., ... & West, J. J. (2021). Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance? *World Development*, *141*, 1-16. https://doi.org/10.1016/j.worlddev.2020.105383

Faloye, S. T., & Ajayi, N. (2022). Understanding the impact of the digital divide on South African students in higher educational institutions. *African Journal of Science, Technology, Innovation and Development*, *14*(7), 1734-1744. https://doi.org/10.1080/20421338.2021.1983118

Gaorekwe, S. V., & Bwalya, K. J. (2024). Hybrid cloud approach to data platforms: A South African perspective. *South African Journal of Information Management*, *26*(1), 1-13. https://hdl.handle.net/10520/ejc-info_v26_n1_a1829

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of barriers to digital transformation in higher education institutions: Systematic literature review. *Education Sciences*, *13*(7), 1-24. https://doi.org/10.3390/educsci13070746

Hinkley, S. (2023). Technology in the public sector and the future of government work. https://laborcenter.berkeley.edu/wp-content/uploads/2023/01/Technology-in-the-public-sector-and-the-future-of-government-work.pdf

Ittmann, H. W. (2023). The postal performance of the South African Post Office: An international and local perspective. *Journal of Transport and Supply Chain Management*, *17*, 1-18. https://doi.org/10.4102/jtscm.v17i0.948

Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Khan, S. (2022). A review of Blockchain Technology applications for financial services. *BenchCouncil Bransactions on Benchmarks, Standards and Evaluations*, *2*(3), 1–18. https://doi.org/10.1016/j.tbench.2022.100073

Balbaa, M. E., & Abdurashidova, M. (2023). Enhancing student engagement and learning outcomes through gamification in education. In S. M. Curle & M. T. Hebebci (Eds.) *Proceedings of International Conference on Academic Studies in Technology and Education* 2023, (pp. 13-20). Antalya, Turkiye. ARSTE Organization

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954-2965. **https://doi.org/10.1111/jan.13031**

Khan, M. I., Yasmeen, T., Khan, M., ul Hadi, N., Asif, M., Farooq, M., & Al-Ghamdi, S. G. (2025). Integrating industry 4.0 for enhanced sustainability: Pathways and prospects. *Sustainable Production and Consumption*. *54*, 149-189. https://doi.org/10.1016/j.spc.2024.12.012

Khunoethe, H., & Reddy, P. S. (2023). Challenges in South Africa's Post-School Education and Training System on Local Governance Performance. *Administratio Publica*, *31*(3), 17-39. https://hdl.handle.net/10520/ejc-adminpub_v31_n3_a4

Layton-Matthews, S., & Landsberg, C. (2022). The Fourth Industrial Revolution (4IR) and its effects on public service delivery in South Africa. *The Thinker*, *90*(1), 55-64. https://doi.org/10.36615/thethinker.v90i1.1173

Li, L. (2022). Reskilling and upskilling the future-ready workforce for Industry 4.0 and beyond. *Information Systems Frontiers*, 1–16. https://doi.org/10.1007/s10796-022-10308-y

Lim, W. M. (2024). What is qualitative research? An overview and guidelines. *Australasian Marketing Journal*, 1–31. https://doi.org/10.1177/14413582241264619

Liu, H., Wang, X., Wang, Z., & Cheng, Y. (2024). Does digitalisation mitigate regional inequalities? Evidence from China. *Geography and Sustainability*, *5*(1), 52-63. https://doi.org/10.1016/j.geosus.2023.09.007

Marengo, A. (2024). Navigating the nexus of AI and IoT: A comprehensive review of data analytics and privacy paradigms. *Internet of Things*, 27, 1–22. https://doi.org/10.1016/j.iot.2024.101318

Morandini, S., Fraboni, F., De Angelis, M., Puzzo, G., Giusino, D., & Pietrantoni, L. (2023). The impact of artificial intelligence on workers' skills: Upskilling and reskilling in organisations. *Informing Science*, *26*, 39-68. https://dx.doi.org/10.28945/5078

Marzouki, A., Chouikh, A., Mellouli, S., & Haddad, R. (2023, September). Barriers and actions for the adoption and use of Artificial Intelligence in the public sector. In *Proceedings of the 16th International Conference on Theory and Practice of Electronic Governance* (pp. 94-100).

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, *9*(6). 1-20. https://doi.org/10.1016/j.heliyon.2023.e16348

Ndubuisi, G., Otioma, C., & Tetteh, G. K. (2021). Digital infrastructure and employment in services: Evidence from Sub-Saharan African countries. *Telecommunications Policy*, *45*(8), 1-9. https://doi.org/10.1016/j.telpol.2021.102153

Okocha, D. O., & Edafewotu, E. (2022). Bridging the digital divide in Nigeria. *The Journal of Development Communication*, *33*(1), 45-54.

Oloba, P. B., & Ramhurry, C. (2024). Exploring the relevance and 4IR implementation of postal services in developing countries: A case study of South Africa. *Social Sciences, Humanities and Education Journal (SHE Journal) Online) Social Sciences, Humanities and Education Journal*, (53), 393-410. https://hdl.handle.net/10210/512420

Pattanayak, S., & Verdugo-Yepes, C. (2020). Protecting public infrastructure from vulnerabilities to corruption: A risk-based approach. In M. Schwartz & M. Fouad (Eds.), *Well spent: How strong*

infrastructure governance can end waste in public investment (pp. 175–200). International Monetary Fund.

Popoola, J. (2020). Globalisation and Nigeria's economic development—a study of the interconnectedness. *Open Journal of Political Science*, *10*(03), 460–480. http://creativecommons.org/licenses/by/4.0/

Ramolobe, K. S., & Khandanisa, U. (2024). The role of public-private partnership in achieving local government sustainable development. *Africa's Public Service Delivery & Performance Review*, *12*(1), 1-6. https://doi.org/10.4102/apsdpr.v12i1.816

Richards, K. A. R., & Hemphill, M. A. (2018). A practical guide to collaborative qualitative data analysis. *Journal of Teaching in Physical Education*, *37*(2), 225–231.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Rotatori, D., Lee, E. J., & Sleeva, S. (2021). The evolution of the workforce during the fourth Industrial Revolution. *Human Resource Development International*, *24*(1), 92–103. https://doi.org/10.1080/13678868.2020.1767453

Scholkmann, A. B. (2021). Resistance to (digital) change: Individual, systemic and learning-related perspectives. *Digital transformation of learning organisations*, 219-236. https://doi.org/10.1007/978-3-030-55878-9_13

Schwab, K. (2024). 8. The Fourth Industrial Revolution-What It Means and How to Respond. In *Handbook of Research on Strategic Leadership in the Fourth Industrial Revolution* (Vol. 29). Edward Elgar Publishing.

Sehgal, N. K., Bhatt, P. C. P., & Acken, J. M. (2020). *Cloud computing with security and scalability*. Springer. https://doi.org/10.1007/978-3-031-07242-0

Shibambu, A. (2024). Transformation of digital government services in the public sector in South Africa. *Africa's Public Service Delivery & Performance Review*, *12*(1), 1–7. https://doi.org/10.4102/apsdpr.v12i1.753

Sutherland, E. (2020). The fourth industrial revolution–the case of South Africa. *Politikon*, *47*(2), 233-252. https://doi.org/10.1080/02589346.2019.1696003

Theodorakopoulos, L., & Theodoropoulou, A. (2024). Leveraging big data analytics for understanding consumer behaviour in digital marketing: A systematic review. *Human Behavior and Emerging Technologies*, *2024*(1), 1–21. https://doi.org/10.1155/2024/3641502

Thusi, X., & Selepe, M. M. (2023). The impact of poor governance on public service delivery: A case study of the South African local government. *International Journal of Social Science Research and Review*, *6*(4), 688–697. http://dx.doi.org/10.47814/ijssrr.v6i4.993

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889-901. https://doi.org/10.1016/j.jbusres.2019.09.022

Ukoba, K., Medupin, R. O., Yoro, K. O., Eterigho-Ikelegbe, O., & Jen, T. C. (2024). Role of the fourth industrial revolution in attaining universal energy access and net-zero objectives. *Energy*, *360*(1), 1-12. https://doi.org/10.1016/j.energ.2024.100002

Zervoudi, E. K. (2020). Fourth industrial revolution: opportunities, challenges, and proposed policies. *Industrial Robotics-New Paradigms*. 1-51

Zhu, Q., Huang, S. Z., & Koompai, S. (2024). Digital transformation as a catalyst for green innovation: An Examination of high-tech enterprises in China's Yangtze River Delta. *Sustainable Futures*, *8*, 124–142. https://doi.org/10.1016/j.sftr.2024.100277