

# A digital procurement framework for South African public sector: A content analysis approach

**Authors:**Lawrence M. Mojaki<sup>1</sup> Tite Tuyikeze<sup>2,3</sup> Nkanyiso K. Ndlovu<sup>2</sup> **Affiliations:**

<sup>1</sup>NWU Business School,  
Faculty of Economic and  
Management Sciences,  
North-West University,  
Mahikeng, South Africa

<sup>2</sup>NWU Business School,  
Faculty of Economic and  
Management Sciences,  
North-West University,  
Potchefstroom, South Africa

<sup>3</sup>Department of Computer  
Science and Information  
Technology, Faculty of  
Natural and Applied Science,  
Sol Plaatje University,  
Kimberley, South Africa

**Corresponding author:**

Lawrence Mojaki,  
moetapelemj@gmail.com

**Dates:**

Received: 17 Apr. 2024

Accepted: 24 June 2024

Published: 24 July 2024

**How to cite this article:**

Mojaki, L.M., Tuyikeze, T. &  
Ndlovu, N.K., 2024, 'A digital  
procurement framework for  
South African public sector: A  
content analysis approach',  
*South African Journal of  
Information Management*  
26(1), a1871. [https://doi.org/  
10.4102/sajim.v26i1.1871](https://doi.org/10.4102/sajim.v26i1.1871)

**Copyright:**

© 2024. The Authors.  
Licensee: AOSIS. This work  
is licensed under the  
Creative Commons  
Attribution License.

**Read online:**

Scan this QR  
code with your  
smart phone or  
mobile device  
to read online.

**Background:** Public procurement plays a pivotal role in the South African economy and accounts for a significant portion of public expenditure. The effective management of procurement processes is crucial for ensuring that money is spent wisely and there is an efficient service delivery. However, the paper-based procurement systems have been plagued by inefficiencies.

**Objectives:** To address the challenges of paper-based procurement systems, the study developed a digital procurement framework. The development of a digital procurement framework for the South African public sector represents a strategic response to these challenges and aims to leverage cutting-edge digital technologies to revolutionise the way that the government procures goods and services.

**Method:** The study followed a qualitative research methodology in which content analysis was used to identify themes. Subsequently, a thematic analysis was conducted to formulate the components of the proposed framework. The study facilitated an understanding of the Internet of Things (IoT) and cloud computing.

**Results:** The literature revealed that Industry 4.0 technologies are crucial as they present opportunities which are consistent with legislation like scalability, cost efficiency, collaboration, transparency, accountability and process efficiency.

**Conclusion:** Implementing procurement reforms effectively will result in a public sector procurement system that is responsible, offers value for money and ensures high-quality service delivery.

**Contribution:** The study contributed to the body of knowledge by providing a guide for a digital procurement of South Africa's public sector and impact of technology on public procurement.

**Keywords:** digital procurement; public procurement; Internet of Things; cloud computing; Industry 4.0; technology; public sector.

## Introduction

In South Africa (SA), public procurement is governed mainly by Section 217 of the Constitution, *Public Finance Management Act (PFMA) 1 of 1999* and the *Preferential Procurement Policy Framework Act (PPPFA) 5 of 2000* and its associated regulations, as well as various other government policies and guidelines. As a key part of public service delivery, procurement can be regarded as a crucial indicator of a government's performance (Fourie & Malan 2020:5). In the modern era of digital transformation, governments around the world are increasingly recognising the need to embrace technology to enhance efficiency, transparency and accountability in their public procurement processes. South Africa, a nation with a diverse and growing economy, is no exception.

According to Dzukey and Naude (2015:1), public procurement plays a significant part in the effectiveness of government departments and public bodies in terms of both the supply of services and their overall performance. On the other hand, Tjahjono, Espluges, Ares, and Pelaez (2017:1176) assert that the Fourth Industrial Revolution (Industry 4.0) has ushered in unprecedented connectivity and robust data exchange in procurement and supply chain activities. As a concept of the next business operations paradigm shift, Industry 4.0 is anticipated to aid purchasers in acting on this real-time data to make more informed sourcing and contract management decisions and to boost their reactivity with its digital tools (Morse et al. 2018). The term 'Industry 4.0' refers to a development that has emerged as a

result of technical progress and disruptive improvements that have occurred in the industrial sector all over the world over the previous few years (Koh, Orzes & Jia 2019:3).

The public sector continues to fall behind the commercial sector in terms of scientific analysis and the vast amount of knowledge that has been acquired (Manyathi 2017:11). As a result, public sector administrators are required to alter their processes to keep up with innovations brought by private sector (Naude, Ambe & Kling 2013). Manyathi (2017:12) further submits that little is known of digital procurement in most public organisations. Although there is a discourse arguing that challenges associated with digital implementation are still rising in both the private and public sectors (Tshibanda & Pradhan 2021), this study assumes that the private sector is leading when it comes to flexibility and adoption of new methods of procurement and new technologies to enhance procurement processes.

The relevance of Industry 4.0 in business has been acknowledged by various scholars such as Anthony (2018), Boafo, Ahudey and Darteh (2020), Dalenogare et al. (2018) and Liao et al. (2017). However, relatively little consideration has been given to these topics by conventional journals, especially on Industry 4.0 technologies' disruption on procurement, particularly in the South African public sector. Adoption of Industry 4.0 technologies is a rigorous effort that the government needs to consider in training its workforce for the changing requirements and managing its potential repercussions to get the best outcome (Boafo et al. 2020:235).

Although global adoption of electronic public procurement is widespread on the African continent, electronic procurement methods are not widely utilised (Kramer 2016:1). A study conducted by Osir (2016:68) on public procurement in Kenya revealed that state corporations have still not yet adopted and utilised digital procurement to its full potential; this is despite the development of the implementation of digital procurement in recent years. Also, Addo (2019) highlighted the same issues in the study conducted on the challenges of digital procurement adoption in Ghana's public sector. In SA, Modiba, Kekwaletswe and Komati (2020:24) have acknowledged that there is a digital transformation knowledge gap in terms of the South African context. Likewise, Boafo et al. (2020:236) emphasises that the actual potential of digital procurement has not been fully realised in SA. Additionally, Tshibanda and Pradhan (2021:261) suggest that the public sector is underprepared for digital conversion and would need substantial investment in innovative technologies and infrastructure to catch up. Similarly, Modiba et al. (2020:24) argue that while there has been a noteworthy revolution in digital adoption over the past years in the developed countries, within developing countries like SA, challenges associated with establishing digital transformation still prevail.

Therefore, despite the benefits that technology has presented in the private sector, digital procurement in the public sector

remains a challenge. According to Kramer (2016:4), there was an attempt by the public sector to adopt technological innovation to establish an electronic procurement system. However, the e-tender portal and central supplier database (CSD) that were created by the National Treasury (NT) are merely for the publication of notices and digitisation of supplier information, respectively (National Treasury 2017). Therefore, they became part of a fragmented manual system.

These gaps necessitated a study that is focused strongly on digital procurement in the public sector. It is against this background that the study seeks to develop a digital procurement framework for the South African public sector using Industry 4.0 technologies. This article begins with a review of the literature on public procurement in the South African context, then explores Industry 4.0 technologies with special attention to the Internet of Things (IoT) and cloud computing. Furthermore, the article discusses the methodology that was followed, which is followed by the discussion of the results. Ultimately, the researcher develops a digital procurement framework through the use of IoT and cloud computing. To achieve this main objective of the study, the research investigated the benefits of IoT and cloud computing and how they can be used to address the setbacks presented by legacy systems. Further, the study presented the outputs from these technologies, which serve as a strategic response to challenges facing public procurement in SA.

## Literature review

### Public sector procurement in the South African context

Public procurement is an essential strategic development instrument for promoting good governance and institutionalising the effective and efficient use of public resources, which eventually leads to greater levels of service delivery (Fourie & Malan 2020:2). On the other hand, Mpehle and Modugwa (2020:3) highlight that digital procurement is a web-based system that streamlines commercial transactions between organisations and provides purchasing, payment, ordering and handling solutions.

Procurement in SA incorporates abundant rules and regulations derived from the country's National Treasury. The reformation of public procurement in 2003 aimed at promoting good governance principles and implementing a preference point system to achieve socio-economic goals (Selomo & Govender 2016:1). However, the reformation with its laudable policy framework is frequently undermined by a lack of compliance with the policy framework (Johnston 2018:52; Mhelembe & Mafini 2019:1). As procurement became central to SA's system of delivering government services to the public, it became an instrument of strategic development for promoting good governance and institutionalising the effective and efficient use of public resources, which must eventually result in greater service delivery levels (Fourie & Malan 2020:1). However,

the researcher posits that this conversion is necessary for institutions to optimise their business operations in Industry 4.0 dispensation.

The prescribed flow of government procurement currently in SA involves demand management, acquisition management, logistics management, disposal and supply chain performance management (National Treasury 2017). The objective of these elements is to provide high-quality services to the citizens. For any government to improve the economic development of its citizens and the country's economic growth, it needs a good procurement system that will enable it to acquire goods and services effectively and efficiently (Mpehle & Mudogwa 2020:2). It is then important for the South African government to introduce digital procurement because the old traditional system is plagued by a lack of compliance, and therefore digital procurement is envisaged to promote transparency and faster turnaround time. Further, the research submits that the conversion is necessary for the government to optimise its procurement operations in Industry 4.0 dispensation.

### Significance of Industry 4.0 technologies on public procurement

The daily lives of citizens and the economy are being transformed by digital technologies. The rise of complicated technologies such as machine learning, blockchain and the IoT presents both legal and economic issues and opportunities. While the technological changes in the external business environment are eliciting various responses from supply chain and procurement actors in the public sector, the utilisation of Industry 4.0 technologies in procurement enables the enhancement of end-to-end procurement process (Koskin & Van Nguyen 2021). According to Tjahjono et al. (2017:1176), the evolution of information technology systems over the past three decades has affected every area of daily life. It is without a doubt that technology has affected the livelihood of people across the globe in one way or the other.

There is a debate that asserts that Industry 4.0 encompasses not only the integration of technology, but also the overall notion of how to obtain, distribute, utilise and organise data and resources to produce products and services in a faster, more cost-effective, efficient and sustainable manner (Piccarozzi, Aquilani & Gatti 2018). Admittedly, Naseem and Yang (2021) concede that Industry 4.0 is a forward-looking concept that provides a systematic approach for utilising emerging technology to revolutionise the existing production processes, transitioning from a machine-centric model to a digital production paradigm. The global coronavirus disease 2019 (COVID-19) pandemic influenced and disturbed all sectors of the global economy in 2020 and brought the realities of Industry 4.0 to light (Moloi & Salawu 2022:204). It is for that reason that the public sector must adjust to keep up with the pace of the private sector. The public sector cannot address its business needs in isolation as in many instances has to collaborate with the private sector. Therefore, the

public sector must adopt technology to enhance its procurement processes.

### Implementation of Internet of Things and cloud computing in procurement

The collaboration of IoT and cloud computing as indicated in the literature offers benefits that lead to cost savings through better resource management. Khan et al. (2020:3) allude that IoT and cloud computing enable real-time tracking of goods and materials across the supply chain. It can be argued that this enhanced insight allows procurement teams to detect and resolve obstacles, streamline logistics and guarantee punctual deliveries, leading to a more effective procurement process. The traditional Internet enables communication between a limited number of devices and humans, whereas the IoT integrates many interconnected 'Things' into a comprehensive network of computing intelligence without human intervention (Kumar, Tiwari & Zymber 2019:1). This can help businesses develop cutting-edge IoT-based goods and services. The integration of IoT technology, therefore, offers enterprises the ability to effortlessly expand their infrastructure to handle the increasing volume of data, hence facilitating the development of powerful market analysis capabilities (Mohungoo, Brown & Kabanda 2020). However, the integration of this technology in certain industries has presented several issues, such as the need for efficient data storage and administration, seamless data transmission between devices, ensuring security and privacy, and ensuring universal and widespread access (Dang et al. 2019:1). For this reason, the use of cloud computing technology is one potential solution that has the potential to address these difficulties.

According to Godavarthi et al. (2023:5), cloud computing is a significant catalyst for the emergence of novel business models across various industries. Although Dang et al. (2019:39) argues that an attempt by organisations to integrate it with IoT faces the challenge of obsolete infrastructure, Petla (2023:946) contends that there are network objects embedded with sensors and software that collect and communicate data over the Internet. Therefore, the obsolescence of the infrastructure is not a challenge, as cloud computing is mainly web-based and does not rely much on physical equipment.

For increased supply chain integration, IoT bridges the gap between the physical and digital worlds by synchronising the flow of information with the physical flow (Morssi, Elhousseiny & Hammad 2020:2879). On the other hand, cloud computing offers the advantageous capability to adjust computing resources in response to demand fluctuations, thus ensuring the sustained efficiency of market analysis operations, even during moments of heightened activity (Naseem & Yang 2021). Also, the IoT facilitates the integration of data into collaborative platforms, thereby guaranteeing that all stakeholders have access to the most current information during discussions pertaining to the needs and requirements (Ben-Daya, Hassini & Bahroun 2019). Moreover, Dang et al. (2019) submit that cloud-based

platforms facilitate real-time cooperation among procurement teams, suppliers and stakeholders. In conclusion, the integration of cloud computing is essential in procurement as it enhances efficiency. Furthermore, the accessibility of this system enhances the efficiency of communication, promotes the sharing of data, and expedites the process of decision-making (Yengula, Sahoo & Goswami 2023:194). This is consistent with SA's legal framework which seeks to enhance fairness, equitability, cost efficiency, transparency and competitiveness.

## Research methodology

This research study follows the six-stage data collection and content analysis as proposed by Braun and Clarke (2006), Creswell (2013), Merriam (2009), Miles et al. (2014) and adapted by Peel, Karen L. (2020). The sections below explain how the six stages were applied to this study.

### Collect the data

The first stage involves the collection of the data. The research for this article was conducted using secondary research methods to develop a digital procurement framework. The sources of data were drawn from journal articles, treasury regulations and legislation enacted by the South African government that were relevant to the procedures of government procurement. The procedure that was utilised for this study began with the search of key topics for this research on the database. To ensure the reliability of the results, only relevant topics with sufficient data to produce significant results were included in the final analyses. The stage of data collection was thoughtfully conducted by searching the titles, guaranteeing a selection of precise journals. During this process, certain papers were excluded to ensure that only relevant papers are considered that will have an impactful contribution to what the study wants to achieve. The exclusion criteria included incomplete papers, lacking abstract and full-text, and not fully aligned with the research topic and objectives. Furthermore, the researchers excluded papers that were not written in English. To detect the most appropriate and compelling articles, the researchers explored the databases by complying with rigorous selection criteria. On these databases, a literature search was carried out with the keywords 'digital procurement', 'Internet of Things', 'cloud computing' and 'public sector'. The search was limited to the period between 2017 and 2023. The preliminary search conducted in the databases is presented in Table 1.

The total number of papers retrieved was 256 papers. After removing the duplicates, a total number of 94 papers were used to answer the research questions posed in this study.

Also, four legal documents that govern South African public procurement were studied to link constructs, and themes with legal provisions.

### Engage with the data

The second stage requires that the authors engage with the data by reading and re-reading the data to become deeply immersed and familiarised with its content under study (Braun & Clarke 2006). This stage was critical for this study to present a review of literature that is related and relevant to South African public sector procurement. The literature reviewed looked at the general procurement in the public sector across the globe and subsequently reduced to the South African context. The study also carefully examined the legislation that governs public procurement in SA. This integration considered legislation's four key documents namely, the Constitution which is the supreme law, and primary legislation which is *PFMA*, *PPPFA* and *NT* regulations which serve as complementary legislation.

### Code the extracts from the data

The third stage deals with categorising the elements of information that are potentially meaningful segments to reveal information relevant to address the research objectives (Merriam 2009). This stage included the use of content analysis that was conducted on data collected from Scopus and Web of Science databases whereby the journal articles that were extracted from these databases were analysed. To represent information accurately, the constructs which are technological factors were categorised as enablers, the outputs which are the benefits that these technologies bring were classified as outputs, and the legal provisions were named guidelines. These will be presented later on the diagram of the conceptual framework.

### Generate the code categories from the codes

According to Braun and Clarke (2006), this stage entails searching for themes that are coherent and meaningful in the data and also defining the nature of each theme in the existing literature. Qualitative data were analysed using qualitative thematic approaches to discover themes and constructs within the qualitative data. The constructs that were used are cloud computing and IoT, while the key themes identified are presented in Table 2.

### Conceptualise the themes from the categorised coded extracts

This stage involves consolidation and reducing data to make a meaningful contribution by linking interrelated elements in the data. Thus, in this section, the researcher linked the

**TABLE 1:** Literature search.

| Keywords                                                                                 | Scopus                                                                | Web of Science                                                      | Total                                                                                        |
|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 'digital procurement' AND 'internet of things' AND 'cloud computing' AND 'public sector' | Database search: <i>n</i> = 157<br>Duplicates removed: <i>n</i> = 106 | Database search: <i>n</i> = 99<br>Duplicates removed: <i>n</i> = 56 | Database search <i>n</i> = 256<br>Papers removed <i>n</i> = 162<br>Papers used <i>n</i> = 94 |



**TABLE 2:** Identification of themes.

| Theme              | Source                                                                                                                                                                                             |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cost efficiency    | Allioui and Mourdi (2023); Khan et al. (2023); Koh et al. (2019); Sima et al. (2020); Yenugula, Sahoo and Goswami (2023); Mircea, Stoica and Ghilic-Micu (2022); Moodley (2019); Addo (2019)       |
| Process efficiency | Allioui and Mourdi (2023); Khan et al. (2023); Sima et al. (2020); Moodley (2019); Amron et al. (2018)                                                                                             |
| Collaboration      | Allioui and Mourdi (2023); Khan et al. (2023); Koh et al. (2019); Kumar et al. (2019); Moodley (2019)                                                                                              |
| Accountability     | Allioui and Mourdi (2023); Adane (2018)                                                                                                                                                            |
| Scalability        | Allioui and Mourdi (2023); Yenugula et al. (2023)                                                                                                                                                  |
| Inclusivity        | Kumar et al. (2019); Moodley (2019)                                                                                                                                                                |
| Transparency       | Yenugula et al. (2023); Adane (2018)                                                                                                                                                               |
| Internet of things | Allioui and Mourdi (2023); Khan et al. (2023); Koh et al. (2019); Sima et al. (2020); Yenugula et al. (2023); Mircea et al. (2022); Moodley (2019); Addo (2019); Kumar et al. (2019); Adane (2018) |
| Cloud computing    | Allioui and Mourdi (2023); Khan et al. (2023); Koh et al. (2019); Sima et al. (2020); Yenugula et al. (2023); Mircea et al. (2022); Moodley (2019); Addo (2019); Kumar et al. (2019); Adane (2018) |

construct with the themes to provide a meaningful data presentation. This conceptualisation will later be used to develop a proposed initial framework based on the results of the content analysis categories. Table 3 depicts the conceptualisation of the constructs and the themes.

### Contextualise and represent the findings (A conceptual digital procurement framework for South African public sector)

Based on the content analysis, this study proposes a digital procurement framework for the South African public sector. As highlighted earlier, the result of the content analysis revealed three categories, namely enablers, benefits and guidelines. The legal factors are the policy provisions prescribed by the SA government to guide procurement officials on what legal issues are to be considered when undertaking the procurement process. These legal documents include Section 217 of the Constitution of SA, *PFMA*, *PPPFA* and NT regulations. Enablers, on the other hand, are technological factors availed by Industry 4.0 to improve public procurement. These are IoT and cloud computing. The benefits that are discussed under the analysis of themes are outputs derived from the technological factors taking into consideration legal factors that govern procurement processes in SA. Figure 1 presents a proposed digital procurement framework for the South African public sector based on IoT and cloud computing.

The following sections discuss the elements of the construct identified in the proposed digital procurement framework.

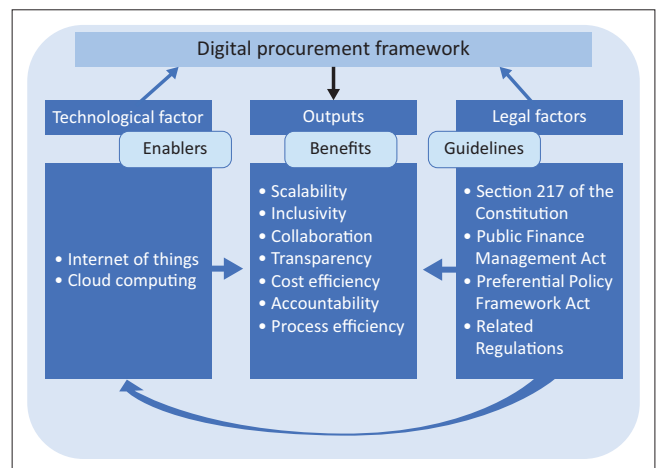
### Scalability

According to Godavarthi et al. (2023:5), there is an incomparable scalability that cloud platforms offer to enterprises. This aids them to easily alter the scale of their operations following fluctuating demands. In agreement, Petla (2023:946) confirms that there are excellent scalability solutions that are offered by cloud computing to assist the public sector to work remotely. Scalability refers to the ability of organisations to alter their systems or operations to address fluctuations in demands. The integration will be made possible by the IoT which connects the physical and cyber world. This unrivaled scalability offered by both cloud computing and IoT provides opportunity for adjustment of

**TABLE 3:** Conceptualisation of the themes.

| Constructs                   | Themes                                                                                                                 |
|------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Benefits                     | Cost efficiency<br>Process efficiency<br>Collaboration<br>Accountability<br>Scalability<br>Inclusivity<br>Transparency |
| Legal factors and guidelines | Section 217 of the RSA Constitution<br>PFMA<br>PPPFA<br>National Treasury Regulation                                   |
| Enablers                     | IoT<br>Cloud computing                                                                                                 |

IoT, Internet of Things; PFMA, Public Finance Management Act; PPPFA, Preferential Procurement Policy Framework Act.

**FIGURE 1:** Digital procurement framework: South African public sector.

the procurement system to address the ever-changing demands of the stakeholders. Further, scalability enhances other factors of the procurement framework towards an overall improvement of the procurement system.

### Cost savings

The concept of cost efficiency in public procurement refers to the optimum result attained when all applicable costs are taken into account during the entire procurement process. One of the benefits of implementing digital procurement is reductions in transaction costs that emanate from less paperwork, decreased mistakes and a more effective

procuring process (Addo 2019:44). In consistence with Section 217 of the Constitution and *PFMA*, cloud computing offers cost-saving benefits for enterprises by abolishing the need for large-scale data centres and servers (Godavarthi et al. 2023:5). The traditional procurement technique incurs several charges, including the placement of advertisements in newspapers, the printing costs of tender documents, the expenses associated with travelling for bid assessment committee meetings, and other relevant costs. The introduction of IoT and cloud computing in public procurement will reduce these costs at the establishment of digital procurement.

### Collaboration and interconnectivity through cyber-physical systems

Sonavale and Londhe (2019:4) assert that it is imperative to ensure the seamless integration of relevant systems and procedures to enhance its operation. Consequently, Addo (2019:45) highlights that the implementation of IoT and cloud computing will result in enhanced collaboration and integration within the supply chain. Automation of the system does not necessarily mean a complete elimination of humans in the procurement process. Thus, through IoT, all things cyber-physical systems (CPS) collaborate to make the procurement process seamless.

### Transparency

In South African public procurement, the concept of transparency refers to a clear and competitive procedure. According to Mathiba (2020:642), this denoted a procurement process that is open to public scrutiny and should be regulated by rules of accessibility to any qualifying bidder. Addo (2019:55) argues that easy access to information within digital procurement allows all stakeholders to directly obtain information linked with each tender and award process. Transparency can be ensured as both the evaluation and awarding processes are conducted online. According to Mpehle and Mudogwa (2020:3), the implementation of digital procurement processes has been found to have a beneficial impact on curbing corruption. This includes enhancing cost-effectiveness and accountability, while simultaneously reducing instances of collusion among suppliers. The utilisation of IoT devices and cloud computing facilitates the establishment of a complete record of events undertaken throughout the procurement process (De Vass, Shee & Miah 2018:3).

### Accountability

A digital procurement system will be a breakthrough in the government bidding system, acquitting the process from exploitation and aggravations (Mpehle & Mudogwa 2020:3). Addo (2019:56) agrees that the attainment of openness and accountability coming from the implementation and adoption of the technology greatly addresses corruption in public procurement. Accountability that has been achieved by technology has been evident in metropolitan areas such as the City of Tshwane and the City of Cape Town which

have already made strides in harnessing Information Communication Technology (ICT) to ensure access to the general citizenry. Thus, it can be inferred that implementing this measure will significantly mitigate unethical behaviours and promote social responsibility on the part of the government.

### Inclusivity

In its capacity as a developing nation, the South African government is obligated to facilitate accessible business transactions for all suppliers, with a particular focus on historically disadvantaged groups. Therefore, by digitalising the procurement system, even small enterprises will find it simpler to gain entry to economic prospects (Mpehle & Mudogwa 2020:5). According to Mahat et al. (2022:347), digital procurement implementation in government not only allows contracting authorities to digitally acquire the goods or services, it further allows service providers to exhibit their products on the web. Inclusive procurement is consistent with the *PPPFA*, which aims to ensure that previously disadvantaged citizens are considered when procurement opportunities arise. In agreement, Mpehle and Mudogwa (2020:5) conclude that the digitalisation of the procurement system would facilitate the accessibility of economic opportunities, even for small businesses.

### Process efficiency

The main aspect of security in cloud computing is its extensive use by enterprises, as it offers convenient and immediate network access to a vast array of customisable processing resources (Godavarthi et al. 2023:1). According to Mukwawaya, Emwanu and Mdakane (2018:1589), Industry 4.0 technologies in a product-oriented industry can customise and design them according to the preferences. Conversely, in the service-oriented sector, this can be attributed to the customisation of services to meet demand. Therefore, the South African public sector must harness Industry 4.0 technologies to improve its procurement processes.

### Summary

The main objective of this study was to develop a digital framework for the public sector in SA using Industry 4.0 technologies. In the literature above, the authors have highlighted the efficiency of IoT and cloud computing in procurement processes. The benefits presented become possible even for procurement in the South African public sector. Thus, this study proposes an automation of the processes in public procurement. The framework is presented in Figure 1. The establishment of the digital framework through themes identified from literature is not in isolation but blended with IoT and cloud computing. The goal was to gain an understanding of the flow of government procurement, and the existing systems for digital procurement, and to discover the issues as well as the weaknesses of the existing systems. In addition, the plan called for the creation of a structure that would be able to

compensate for these deficiencies. The themes emerged from the literature that was extracted from the database. These themes were discussed to address the challenges identified in the problem statement. In addition to that, the themes are consistent with the provision of the legislative framework that governs public procurement in SA, that is, Section 217 of the Constitution of SA, *Public Finance Management Act No 1 of 1999*, *Preferential Procurement Policy Framework Act No 5 of 2000*, and its accompanying regulations.

## Recommendations

In a recent study conducted by Bou-Ghanem (2021) in Lebanon, it was found that the government has taken steps to address the issue of transparency by implementing a public procurement law that specifically regulates digital procurement. According to Mathebula (2021), China, which is SA's partner in the Brazil, Russia, India, China and South Africa (BRICS) alliance, is among the countries that have embraced technology and achieved notable success in this domain. Moreover, a recent study conducted by Amron et al. (2019) in Malaysia demonstrated that the Malaysian government successfully achieved substantial cost savings, amounting to 50% of the initial expenses associated with the establishment and upkeep of traditional data centres.

To effect positive change, the South African government should draw lessons from the successful experiences of other nations in the realm of technological integration into their administrative procedures. These advantages will guarantee that all public procurement activities and relevant parties are equipped with electronic access to comprehensive data and information, hence facilitating the detection and mitigation of fraudulent practices. It is therefore recommended that the South African government harness the Industry 4.0 technology to enhance process efficiency in procurement.

Furthermore, in this new era characterised by a complex and dynamic environment and a competitive business marketplace, digitalisation has emerged as a new phenomenon that affected several aspects of life all over the world. The dispensation of digital transformation has seen governments around the world increasingly recognising the need to embrace technology to enhance efficiency, transparency, and accountability in their public procurement processes. South Africa, a nation with a diverse and growing economy, is no exception. Thus, the adoption of digital processes is recommended.

## Contribution

The current study presented theoretical insight that contributed to the body of knowledge in the existing literature on public procurement and the Fourth Industrial Revolution in the context of SA. This study will be used by policymakers in the government of SA. This will contribute to the improved

process efficiency in the public procurement space. Furthermore, this research study will benefit academic researchers to intensify their diverse debate in this field. Practically, the study provides valuable insights into how IoT and cloud computing can be utilised to improve public procurement. This leads to the results, which are subsequently used to develop a public procurement framework for South Africa.

## Conclusion

To address the challenges and opportunities presented by the digital age, this research embarked on a transformative journey by developing a digital procurement framework for the public sector in SA. The literature review explored existing literature on the adoption and implementation of Industry 4.0 technologies in public procurement. It further analysed studies, reports, and case studies to identify key findings, best practices and challenges encountered in various contexts. Subsequently, special attention was given to research conducted in South Africa and with relevance to the South African context.

The development of a digital procurement framework for the South African public sector represents a strategic response to these challenges. Electronic procurement is the automated procurement of goods and services by an organisation employing web-based applications, and it should become the most important system of an organisation in this technological era (Anthony 2018). This framework aims to leverage cutting-edge digital technologies to revolutionise the way the government procures goods and services. Based on the reviewed literature, the benefits of digital procurement are manifold. This article aimed to develop a digital framework for public procurement in SA. The article discussed the contextual setting. Further, the article analysed the current procurement set-up in the public sector. The study then delved into conceptual mapping where the linkage between IoT, cloud computing and digital procurement was discussed. Finally, the study developed a digital framework through the linkage of all the themes and constructs discussed. In conclusion, the constructs identified were discussed in contrast with the research objectives.

## Acknowledgements

The author would like to thank Dr Tite Tuyikeze and Dr Nkanyiso Kaizer Ndlovu for their mentorship, supervision, support and guidance in writing this article. This article is based on the author's thesis entitled 'Developing a Digital Procurement Framework based on Industry 4.0 Technologies for the Public Sector in South Africa' towards the degree of Doctor of Philosophy in Economic and Management Sciences with Business Administration in the North-West University Business School, North-West University, South Africa, with supervisors Dr Nkanyiso Kaizer Ndlovu and Dr Tite Tuyikeze. The url for this thesis is currently unavailable.

## Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

## Authors' contributions

T.T. and N.K.N. provided guidance and supervision to L.M.M. reviewed and recommended improvement where necessary. Also, T.T. and N.K.N. were responsible for editing the final manuscript submitted to the journal.

## Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

## Funding information

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

## Data availability

The data that support the findings of this study are available from the corresponding author, L.M.M., upon reasonable request.

## Disclaimer

The views and opinions expressed in this article are those of the authors and are the product of professional research. It does not necessarily reflect the official policy or position of any affiliated institution, funder, agency or that of the publisher. The authors are responsible for this article's results, findings and content.

## References

- Adane, M., 2018, 'Cloud computing adoption: Strategies for Sub-Saharan Africa SMEs for enhancing competitiveness', *African Journal of Science, Technology, Innovation and Development* 10(2), 197–207. <https://doi.org/10.1080/20421338.2018.1439288>
- Addo, S.K., 2019, 'Challenges of e-procurement adoption in the Ghana Public Sector: A survey of in the Ministry of Finance', *Scholarly Journal of Arts & Humanities* 1(7), 44–80.
- Alliou, H. & Mourid, Y., 2023, 'Exploring the full potentials of IoT for better financial growth and stability: A comprehensive survey', *Sensors* 23(19), 8015. <https://doi.org/10.3390/s23198015>
- Amron, M.T., Ibrahim, R., Bakar, N.A. & Chuprat, S., 2019, 'Acceptance of cloud computing in a Malaysian public sector: A proposed model', *International Journal of Engineering Business Management* 11, 1–9. <https://doi.org/10.1177/1847979019880709>
- Anthony, A., 2018, 'The use of e-procurement in South African public procurement law: Challenges and Prospects', *Law Democracy and Development* 22(1), 39–47. <https://doi.org/10.4314/idd.v22i1.4>
- Ben-Daya, M., Hassini, E. & Bahrour, Z., 2019, 'Internet of Things and supply chain management', *International Journal of Production Research* 57(15–16), 4719–4742.
- Boafo, N.D., Ahudey, E. & Darteh, A.O., 2020, 'Evaluating e-procurement impact in the public sector', *Archives of Business Research* 8(5), 235–247. <https://doi.org/10.14738/abr.85.8268>
- Bou-Ghanem, D.N., 2022, 'Public procurement law regulating e-procurement, a reform tool for Lebanon', *Technum Social Sciences Journal* 28(1), 778–788. <https://doi.org/10.47577/tssj.v28i1.5714>
- Braun, V. & Clarke, V., 2006, 'Using thematic analysis in psychology', *Qualitative Research in Psychology* 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Dalenogare, L.S., Benitez, G.B., Ayala, N.F. & Frank, A.G., 2018, 'The expected contribution of Industry 4.0 technologies for industrial performance', *International Journal of Production Economics* 204, 383–394. <https://doi.org/10.1016/j.ijpe.2018.08.019>
- Dang, M., Piran, J., Han, D., Min, K. & Moon, H., 2019, *A survey on internet of things and cloud computing for healthcare*, s.n., s.l.
- De Vass, T., Shee, H. & Miah, S., 2018, 'The effect of "Internet of Things" on supply chain integration and performance: An organisational capability perspective', *Australian Journal of Information Systems* 22, 1–29. <https://doi.org/10.3127/ajis.v22i0.1734>
- Dzuke, A. & Naude, M., 2015, 'Procurement challenges in the Zimbabwean public sector: A preliminary study', *Journal of Transport and Supply Chain Management* 9(1), 1–9. <https://doi.org/10.4102/jtscm.v9i1.166>
- Fourie, D. & Malan, C., 2020, 'Public procurement in the South African economy: Addressing the systemic issues', *Sustainability* 12(20), 8692. <https://doi.org/10.3390/su12208692>
- Godavarthi, B., Narisetty, N., Gudikandhula, K., Muthukumaran, R., Kapila, D. & Ramesh, J.V.N., 2023, 'Cloud computing enabled business model innovation', *Journal of High Technology Management Research* 34(2), 1–10. <https://doi.org/10.1016/j.hitech.2023.100469>
- Johnston, M., 2018, 'Reforming reform: Revising the anticorruption playbook', *Daedalus* 147(3), 50–62. [https://doi.org/10.1162/daed\\_a\\_00502](https://doi.org/10.1162/daed_a_00502)
- Khan, Y., Su'ud, M.B., Alam, M.M., Ahmad, S.F., Ayassrah, A.B. & Khan, N., 2023, 'Application of Internet of Things (IoT) in sustainable supply chain management', *Sustainability* 15(1), 694. <https://doi.org/10.3390/su15010694>
- Koh, L., Orzes, G. & Jia, F.J., 2019, 'The fourth industrial revolution (Industry 4.0): Technologies disruption on operations and supply chain management', *International Journal of Operations & Production Management* 39(6/7/8), 817–828. <https://doi.org/10.1108/IJOPM-08-2019-788>
- Koskin, V. & Van Nguyen, T., 2021, *The Impact of Industry 4.0 on supply chain management*, LAB University of Applied Sciences, s.l.
- Kramer, G., 2016, 'Electronic public procurement as a tool of reform in South African public procurement', *African Public Procurement Law Journal* 3(1), 1–41. <https://doi.org/10.14803/3-1-16>
- Kumar, S., Tiwari, P. & Zymbler, M., 2019, 'Internet of Things is a revolutionary approach for future technology enhancement: A review', *Journal of Big Data* 6, 111. <https://doi.org/10.1186/s40537-019-0268-2>
- Liao, Y., Deschamps, F., Loures, E. & Ramos, L., 2017, 'Past, present and future of Industry 4.0 – A systematic literature review and agenda proposal', *International Journal of Production Research* 55(12), 3609–3629. <https://doi.org/10.1080/00207543.2017.1308576>
- Mahat, N., Bohari, A.A., Azman, M.A., Khalil, N., Adnan, A.S. & Malek, M.I., 2022, 'E-Procurement adoption in the Malaysian construction sector: Integration diffusion of innovations and theory of planned behaviour framework', *Jurnal Kejuruteraan* 34(3), 347–352. [https://doi.org/10.17576/jkukm-2022-34\(3\)-01](https://doi.org/10.17576/jkukm-2022-34(3)-01)
- Manyathi, S., 2017, 'An analysis of various types of supply chain management systems: Case of global public sector versus private sector procurement', *Asian Journal of Social Sciences and Management Studies* 4(1), 10–19. <https://doi.org/10.20448/journal.500/2017.4.1/500.1.10.19>
- Mathebula, N.E., 2021, 'Public administration in the fourth industrial revolution: Implications for the practice', *Gender and Behaviour* 19(2), 18199–181205.
- Mathiba, G., 2020, 'Corruption, public sector procurement and COVID-19 in South Africa: Negotiating the new normal', *Journal of Public Administration* 55(4), 642–661.
- Merriam, S.B., 2009, *Qualitative research: A guide to design and implementation. Revised and expanded from qualitative research and case study applications in education*, Jossey-Bass, San Francisco, CA.
- Mhelembe, K. & Mafini, C., 2019, 'Modelling the link between supply chain risk, flexibility and performance in the public sector', *South Africa Journal of Economic and Management Sciences* 22(1), 1–12. <https://doi.org/10.4102/sajems.v22i1.2368>
- Mircea, M., Stoica, M. & Ghilic-Micu, B., 2022, 'Analysis of the impact of blockchain and internet of things (IoT) on public procurement', *Open Access Journal* 10, 63353–63374. <https://doi.org/10.1109/ACCESS.2022.3182656>
- Modiba, M.M., Kekwaletswe, R. & Komati, M.D., 2020, 'IT capability framework for digital transformation in South African financial service providers', *International Journal of Computer & Organization Trends* 10(2), 24–39. <https://doi.org/10.14445/22492593/IJCOT-V10I2P305>
- Mohajan, H., 2017, 'Two criteria for good measurements in research', *Validity and Reliability* 17(3), 28–82. <https://doi.org/10.26458/1746>
- Mohungoo, I., Brown, I. & Kabanda, S., 2020, 'A systematic review of implementation challenges in public e-procurement', *International Federation for Information Processing* 1(1), 46–58. [https://doi.org/10.1007/978-3-030-45002-1\\_5](https://doi.org/10.1007/978-3-030-45002-1_5)
- Mojaki, L.M., 2024, 'Developing a Digital Procurement Framework based on Industry 4.0 Technologies for the Public Sector in South Africa', PhD thesis, Dept. of Economic and Management Sciences, North-West University Business School, North West University, South Africa.
- Moloi, T.S. & Salawu, M.K., 2022, 'Institutionalizing Technologies in South African economies towards the Fourth Industrial Revolution', *International Journal of Emerging Technologies in Learning (IJET)* 17(03), 204–227. <https://doi.org/10.3991/ijet.v17i03.25631>
- Moodley, A., 2019, 'Digital transformation in South Africa's short-term insurance sector: Traditional insurers' responses to the Internet of Things (IoT) and Insurtech', *The African Journal of Information and Communication (AJIC)* 24, 1–16.
- Morse, J., Boyd, S., Smith, M., Tavernor, J., Eagle, M., Bousfield, M. et al., 2018, *An overview of Industry 4.0*, Chartered Institute of Procurement and Supply, s.l..
- Morssi, M.A., Elhusseiny, H.M. & Hammad, D.A., 2020, *The impact of internet of things on supply chain performance*, pp. 2879–2887, IECOM Society International, Harare.



- Mpehle, Z. & Mudogwa, R., 2020, 'Utilisation of digital central supplier database in enabling electronic procurement in the Limpopo provincial departments', *Africa's Public Service Delivery and Performance Review* 8(1), 1–10. <https://doi.org/10.4102/apsdpr.v8i1.356>
- Mukwawaya, G., Emwanu, B. & Mdakane, S., 2018, *Assessing the readiness of South Africa for Industry 4.0 – Analysis of government policy, skills and education*, pp. 1587–1603, IEOM Society International, Johannesburg.
- Naseem, M.H. & Yang, J., 2021, 'Role of Industry 4.0 in supply chains sustainability: A systematic literature review', *Sustainability* 13(17), 1–23. <https://doi.org/10.3390/su13179544>
- National Treasury, 2017, *National treasury*, viewed 30 March 2019, from <http://www.redirect2.gpg.gov.za/e-tenders/Publications/Implementation%20Guide%20-%20Preferential%20Procurement%20Regulations%20March%202017.pdf>.
- Naude, M., Ambe, I.M. & Kling, R., 2013, 'Supplier relationship management – Anathema for the South African public procurement sector', *Journal of Transport and Supply Chain Management* 7(1), 93. <https://doi.org/10.4102/jtscm.v7i1.93>
- Osir, E.O., 2016, 'Role of e-procurement adoption on procurement performance in the state of corporations in Kenya: A case of Kenya Utalii College', *International Academic Journal of Procurement and Supply Chain Management* 2(1), 66–100.
- Petla, J.R.K., 2023, 'Cloud computing technologies transforming public sector remote work standards post COVID-19', *International Journal of Creative Research Thoughts* 11(4), 944–952.
- Piccarozzi, M., Aquilani, B. & Gatti, C., 2018, 'Industry 4.0 in management studies: A systematic literature review', *Sustainability* 10(10), 3821. <https://doi.org/10.3390/su10103821>
- Republic of South Africa (RSA), 1996, *Constitution of the Republic South Africa, Act No 108 of 1996*, Government Printing Works, Pretoria.
- Republic of South Africa (RSA), 1999, *Public Finance Management Act, No 1 of 1999*, Government Printing Works, Pretoria.
- Republic of South Africa (RSA), 2000, *Preferential Procurement Policy Framework Act, No 5 of 2000*, Government Printing Works, Pretoria.
- Selomo, M. & Govender, K., 2016, 'Procurement and supply chain management in government institutions: A case study of select departments in the Limpopo province, South Africa', *Dutch Journal of Finance and Management* 1(1), 1–8. <https://doi.org/10.20897/lectito.201637>
- Sima, V., Gheorghe, I.G., Subic, J. & Nancu, D., 2020, 'Influences of the Industry 4.0 revolution on the human capital development and consumer behavior: A systematic review', *MDPI Sustainability* 12, 1–28. <https://doi.org/10.3390/su12104035>
- Sonavale, S. & Londhe, B.R., 2019, 'Factors influencing the success of electronic reverse auditors in public procurement in India', *International Journal of Management Social Sciences* 7(5), 1–9.
- Tjahjono, B., Esplugues, C., Ares, E. & Pelaez, G., 2017, *What does Industry 4.0 mean to supply chain?*, pp. 1175–1182, Elsevier, Vigo.
- Tshibanda, G.M. & Pradhan, A., 2021, *Investigating the challenges of information technology on the supply chain of the pharmaceutical industry*, pp. 250–266, s.n., s.l.
- Yenugula, M., Sahoo, K.S. & Goswami, S.S., 2023, 'Cloud computing in supply chain management: Exploring the relationship', *Management Science Letters* 13, 193–210. <https://doi.org/10.5267/j.msl.2023.4.003>