International Journal of Multidisciplinary and Current Research ISSN: 2321-3124
Research Article Available at: https://ijmcr.com

The Benefits of Artificial Intelligence for Enhancing the Quality and Efficiency of Service Delivery in South Africa

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Received 10 May 2026, Accepted 30 May 2026, Available online 01 Jun 2026, **Vol.14, No.3 (May/Jun 2026)**

Abstract

The paper highlights the benefits of artificial intelligence for enhancing the quality and efficiency of social and municipal service delivery in South Africa. South African municipalities and Government Departments render routine municipal and social services to the South African population on a regular basis. Artificial intelligence methods and applications are used extensively for rendering reliable, efficient and affordable municipal and social services to residents and ratepayers of municipalities as well as business enterprises in the world's developed economies. The effective use of artificial intelligence at municipal level requires the installation and maintenance of digital infrastructure as well as the provision of skills-based training to public servants on a regular basis. The use of such methods greatly simplifies the task of resolving service-related queries from customers. It is also highly valuable for ensuring compliance with good corporate governance, ethical leadership and accountability at municipal level. Artificial intelligence processes and applications have been adopted and used successfully in the USA, United Kingdom, China, Singapore, India, Japan, Germany and South Korea for ensuring efficiency and affordability of municipal and social services. The paper draws valuable lessons from developed economies in which artificial intelligence methods and applications are used effectively and points out implications that are relevant to South African municipalities and Government Departments.

Keywords: *Artificial intelligence, Digital technology, Service delivery, Efficiency*

Introduction and background to study

The provision of service delivery can be greatly enhanced and simplified by utilising appropriate digital technological processes such as artificial intelligence (AI). Globally, the use of AI has been shown to be highly beneficial for enhancing the quality, efficiency and affordability of municipal services in countries such as the USA, the United Kingdom, China, Singapore, India, Japan, Germany and South Korea [42]. The study conducted by Lund *et al*. (2023) shows the numerous benefits of using digital technology and AI processes in the services industry of South Africa. Advances achieved in the fields of digital technology and AI in the developed world can also be achieved in developing nations such as South Africa by investing on digital infrastructure, skills-based training, and the acquisition of digital equipment and software [17]. The world's advanced economies have managed to acquire the capability to offer predictable, affordable and efficient municipal services to their communities by using digital technology and AI applications in the services sector.

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DOI: https://doi.org/10.14741/ijmcr.v.14.3.5

The common characteristic among these nations is their ability to adopt, master and internalise appropriate digital technologies for providing municipal services. In each one of these countries, formal education is provided to learners starting at an early age in which the curriculum used for teaching young learners includes the early adoption of digital technology and information and communication processes [18].

The use of AI processes and systems is highly beneficial for promoting good corporate governance and good leadership in South Africa's 257 municipalities. AI processes make it easy and convenient to render routine municipal and social services to people who require such services in all regions of South Africa. The use of AI and digital methods enables employees of municipalities and Government Departments to render efficient and affordable services to people who live far away from office locations. The use of such methods and processes is also highly valuable for ensuring service level agreements, norms and standards on a regular basis [51]. In cases where accountholders are capable of using digital methods and technologies, it is possible to institute and resolve service-related queries efficiently by using digital and AI processes.

Since the mid-1990s, South African municipalities have remained characterised by protests over poor municipal and social service delivery, the non-payment of municipal services, and deteriorating municipal infrastructure [35], [40], [50], [51]. South African public servants are required to render services to residents, ratepayers and social grant recipients by adhering to the Batho-Pele Principle, which requires South African municipal and civil servants to serve the people with humility, total commitment and with professional integrity. The basic principles of good leadership, accountability and good corporate governance apply to all social and municipal services. The adoption and use of digital technology and AI applications have been strongly recommended by researchers as a means of enhancing the level of service delivery at municipal level [6], [25].

Artificial Intelligence methods and processes are currently being used worldwide for cutting down operational cost, making service-related queries, instituting audits and inventories, and for distributing and supplying goods, services and products to local and global markets. The effective use of AI methods and processes depends on the ability to use digital technologies. It also depends on the availability of the necessary digital infrastructure, equipment and software. Artificial intelligence is helpful for simplifying the task of rendering routine services and activities and for assessing the level of efficiency and cost of service delivery. In the next decade, the use of AI systems and applications is expected to grow exponentially in all economic sectors. The implication is that firms that operate in developing nations need to meet infrastructural, human and technology related requirements as a matter of priority in order to benefit from the anticipated exponential growth and development in the field of AI processes and systems [10], [20].

Corporate artificial intelligence applications address a wide range of important societal challenges, including social fairness, economic vitality, and global security. Corporate governance is a collection of principles, processes, and structures that are key components of modern business and are meant to guarantee that a company is successfully managed and controlled [30]. Fraud, bad management, a deterioration in investor trust, and legal ramifications are just a few of the issues that can develop from a lack of corporate governance institutionalisation. The advancement of artificial intelligence gives new chances to improve corporate governance by automating operations, improving decision-making, and increasing transparency.

The key components of AI are learning, reasoning, problem solving, perception and using language. The main focus areas of AI are accountability, objectivity, adherence to the rule of law and good governance, inclusiveness, reliability, safety, the ease of use, transparency, fairness, robustness, the logical processing of scientific facts and managerial processes, capacity building, business ethics, and privacy and security [11]. Municipal and social services that are provided to the South African population are mostly routine services that are rendered to customers on a regular basis. South African Government Departments are responsible for ensuring the quality and efficiency of services that are rendered on a regular basis to the general population. People who are entitled to social and municipal services as well as stakeholders have the right to demand satisfactory service quality and efficiency at an affordable rate [27]. Service quality is governed by norms and standards. The quality, affordability and efficiency of social and municipal services that are owed to recipients is defined in gazetted acts and pieces of legislation and supported by duly defined norms and standards. In this regard, the mandate of Government Departments and municipalities is to ensure service level expectations of customers.

South African municipalities are who require municipal services require services that are based on expectations that are satisfactory or acceptable to customers who pay for such services. Government Departments are required to render routine social services that are owed to segments of the general population. The use of AI enables Governments to lower the cost of rendering such social services to deserving people and communities without lowering service quality standards [29].

AI services are most helpful and commonly used in the finance, automotive and automotive industries. However, AI services are also highly helpful for rendering e-government services to people who require services from the South African Government on a regular basis. This includes recipients of monthly social grants and municipal services. The use of AI services is most helpful for reducing the cost-of-service delivery and waiting time for routine services. AI allows service providers to innovate, enhance customer experience, and lower the cost-of-service delivery. AI enables people to make service-related queries and follow-up requests easily and efficiently. AI minimises the level of bureaucracy and the wastage of public sector resources in the course of service delivery [24].

South African Government Departments constantly aspire to enhance the level of service delivery to social grant recipients and residents and ratepayers who live in municipalities. One key benefit of enhancing the quality and efficiency of municipal services is that municipalities can attract viable business enterprises that are vital for growing local economies and for poverty alleviation and job creation. In this regard, the use of AI processes is highly beneficial for simplifying cumbersome bureaucratic processes that are related to business license applications, tax assessment and marketing activities. The use of AI processes is highly beneficial for instituting easy and user-friendly auditing and accounting processes in local municipalities [48]. Several Government Departments experience over-expenditure of budgets due to lack of managerial, auditing and accounting ability.

Social services are delayed due to lack of the ability to offer such services by using digital and online systems. The best interest of citizens can be ensured by way of using AI processes in cases where the infrastructure exists and public servants possess the required digital, AI and information and communication technology (ICT) skills. In the developed world, learners are exposed to digital and ICT skills at an early stage. The infrastructure allows learners and teachers to use digital and ICT skills. In most Sub-Saharan African countries, rural communities lack the infrastructure and skills and academic curricula [23].

Solutions based on artificial intelligence applications

AI solutions are pre-built and customisable solutions that are designed to address specific use cases and solve unique business challenges. AI combines computer science, data sets, and problem-solving programmes that are used in machines for providing practical solutions to project-based outputs. AI uses routine operations for establishing the order and precision in which operational tasks need to be executed. Computer programmes are designed to guide operational tasks and functions that are to be handled by machines [47]. These programmes are tailor-made to what is expected by end-users and stakeholders. AI enables service providers and their clients to agree on specific end results, the cost of operation, and the quality and efficiency with which these processes are expected to be delivered. It is possible to amend or alter such processes easily at any time of the operation. Most operational tasks are performed by machines that need to be maintained, monitored and evaluated by humans. As long as humans perform their duties precisely, machines operate normally by using AI principles [26].

AI systems and processes are used in all economic sectors and industry for carrying out routine operational tasks. The level of reliance on AI systems and processes is increasing significantly depending on the spread of digital technology worldwide. AI applications and processes are used extensively for providing business solutions in the public service delivery sector including the provision and assessment of routine municipal services. Examples of problems in which AI can provide affordable solutions are the distribution of social grants, the provision of routine municipal services to residents and ratepayers, the provision of administrative and financial services to business enterprises, the provision of health care services, the provision of transportation services, mining operations, the assessment of tax, auditing services, educational services and marketing services in the tourism sector [10]. AI processes are highly applicable to routine operations. This is true in all economic sectors and industries. For example, large scale manufacturing and industrial processes are ideal for applying AI processes for cutting down operational cost and for minimising delays and the production of defective products [27].

Labour-intensive and routine service delivery operations can be greatly simplified by using AI processes and applications without lowering quality specifications. The primary method of achieving an AI solution is reverse-engineering. Human capabilities and traits are reverse-engineered in order to enhance technology and minimise the cost of production without lowering the quality of products. Reverse-engineering enables computer systems to develop intelligent machines that are capable of performing routine tasks that are performed by humans with minimal error and a high level of efficiency. Routine activities and tasks are managed by machines that respond to computer-based programmes that instruct machines to carry out tasks and duties in specified manners [42]. The field of AI has advanced significantly in the past decade due to advances made in the field of reverse-engineering. The process of reverse engineering has enabled humans and machines to work closely in terms of reducing operational cost, enhancing the level of innovation, and seeking practical solutions that are quite easy to achieve. AI allows evolution and innovation. This motivates engineers to seek more efficient and easier solutions to production problems. AI processes are highly valuable for sustaining profitability in the tourism and hospitality industry [28].

Ensuring cyber security in the airline and shipping industries, commercial banks and financial institutions, the promotion of machine learning, the management of customer relationships, and searching the internet for up-to-date information are examples in which AI is used extensively in the global market on a daily basis. AI prevails in areas humans cannot withstand operational requirements. AI processes are driven by machines that are highly reliable, consistent and trustworthy. AI processes are easily verifiable by all stakeholders. AI processes have levels of integrity and objectivity. For this reason, they are acceptable to all parties [15].

AI is highly valuable for minimising the loss of valuable resources and assets in Government Departments. AI processes are commonly used for performing the analysis of past and historical data sets with a view to forecast or predict future potential trends and developments that affect institutions. As a result, AI processes are highly valuable for averting catastrophic outcomes [38].

The use of digital technology is highly helpful for enhancing the level of innovation in all economic sectors. Digital technology has transformed the service industry significantly. AI processes have been adopted by learners to simplify the task of production and distribution in all parts of the world on a 24-hour basis due to advances made in digital technology. Zhu *et al*. (2021) have shown that the 4th industrial revolution has produced technologies that are highly valuable to overcome geographical distances and contact-related difficulties such as communicable diseases. The successful adoption of digital technology has promoted reliance on AI systems and applications. The successful adoption of Industry 4.0 technologies has made it easy to stay digitally connected

to the workplace and production lines through digital technology, computer algorithms, robotics, virtual environments, and automated processes [32].

Theoretical framework of study

The theory that underpins the study is the strong theory of artificial intelligence proposed by John Searle (1992) in which the author has shown that computer programmes can be used for automating routine manually performed duties and activities by properly documenting patters that entail such duties and activities.

The survey carried out by Malaquias and Hwang (2019, p.133) shows that the fourth industrial revolution has brought about new scopes into practical teaching and learning strategies. By using digital technology, it is now possible to stay connected with production and distribution centres that are scattered in a wide geographical location efficiently. The traditional model of operation has been significantly altered due to advances made in AI processes and applications [46]. The digital platform enables workers to ask questions and seek clarification and obtain answers immediately. The digital model is speedy enough to cater for the needs of people who do not have time. The issue of connectivity and instant communication has been made possible by advancements achieved in 4IR (the 4th industrial revolution) technology [52]. Due to advances made in 4IR technology, traditional methods of teaching and learning have been significantly affected and transformed. The key challenge is in obtaining digital infrastructure, fibre optic cables, speedy internet access and affordable telecommunications services. The cost of data services in South Africa is expensive, and poor learners cannot afford to pay for costly data services. Also, in many rural regions, digital infrastructure does not exist. The South African Government needs to promote and expand digital infrastructural projects to rural and remote regions of South Africa so that learners can benefit from the expansion.

Advances made in the fields of AI and digital technology are highly valuable to production centre managers who are required to fulfil the global and local demands and needs of industry, business and commerce in a short space of time at an affordable cost. Advances in AI and digital technology have been adopted by workers in all economic sectors significantly since the early 2000s and this trend is continuing globally [26]. The development has enabled players in all economic sectors to overcome geographical separation and physical barriers. Employees and managers who rely on AI and digital processes stand to benefit from advances made in terms of mastering 4IR technologies and digital infrastructural upgrades. This development enables both employees and their line function managers who use traditional methods of production to use the internet for reaching out to their customers and stakeholders alike. The promotion of awareness about the benefits of AI processes is helpful for encouraging teachers and learners to adopt the use of digital technologies effectively [22]. By using digitalisation, it is possible to reach out to a wide variety of customers and stakeholders. Meetings can be held by using MS Teams online sessions and Zoom meetings. Digital equipment such as laptops, tablets and cell phones is equally valuable for simplifying the task of producing goods and services by using digital methods and processes.

Production managers should be equipped and trained well enough so that they reach out to customers and stakeholders alike who work far away from them. The ability to use digital technology well enough enables employees and their managers to remain actively engaged with each other closely and effectively. It also enables them to provide instant answers to questions and queries from customers and stakeholders. This shows that it is vital to arrange for skills-based training sessions on AI processes and systems. Such sessions are useful for learning how to use digital technology and gadgets that come along with them. This process enhances efficiency [3]. Senior administrators have a duty to arrange for training sessions for employees, line function managers and stakeholders.

Milly *et al*. (2021) have shown that the promotion of digital technology has led to various technology acceptance models (TAMs) which are used in various parts of the world for service delivery, production and distribution. Some of these TAMs have been found to be highly relevant and beneficial to Sub-Saharan African countries such as South Africa. These TAMs are highly valuable for saving time, lowering the cost of service delivery and for enhancing quality control and overall performance [44]. The other benefit of such TAMs is that manual and repetitive operations can be easily automated. Doing so reduces the cost of services and enhances efficiency [41]. The same process is also highly valuable for avoiding errors that occur in the course of service delivery, production and distribution. Communication among role-players can be held efficiently by using online meetings and email communication. Valuable notes and messages can also be uploaded on dedicated websites.

The ability to use AI methods and applications requires the ability to use digital technologies and methods. There is a significant benefit in providing training and skills development opportunities to Government and municipal employees who are required to render services to the public. Digital technology and AI applications evolve on a continuous basis, and it is essential to keep up with new methods and applications. The ideal method in which such employees can keep up with such changes in technology is to acquire skills-based training programmes from their employers at the workplace. Choudrie *et al*. (2018, pp.449-465) have shown that digital technology is highly valuable for minimising errors and avoiding delays. Digital technology is highly helpful for learning new concepts and sharing

new ideas with others. Comments and suggestions can be easily solicited from members who are in online classes or meetings. From these comments and suggestions, it is possible to generate new ideas and easier methods of accomplishing tasks. In South Africa, the use of cell phones is quite high.

The use of cell phone and electronic gadgets such as tablets encourages ordinary people to use AI and digital technology on a continuous basis. About 47 million of 61 million South Africans (77%) own cell phones. There are about 108.6 million cellular mobile connections in South Africa [17]. This shows that digital technologies can be used quite well with the correct application and support strategies [49]. Digital technology is evolving quite fast in all parts of the world. Digital technology is disruptive in the sense that it motivates learners to master new methods of learning by using digital gadgets and internet connections. The pace at which digital technology is evolving is quite fast and exhausting to some learners. It has become essential to keep up mastering new innovations and changes continually. It has also become essential to protect personal data and records that are related to finances and business transactions. The need to protect learners from hacking, virus infections, the theft of digital identity, and cyber-attacks has become paramount. The study conducted by Taherdoost and Madanchian (2023) has shown that it is essential to promote awareness about methods that are helpful for protecting digital information such as usernames, passwords and banking details. As digital technology evolves, the likelihood of threats has also become a reality that needs precaution and proper training.

The survey carried out by Blut and Wang (2020) shows that there are some people who resist change and innovation. Such people do not wish to make the effort to learn new methods and applications that are based on digital technology. The authors have suggested the use of incentives and rewards to such people. Showing resistance to change is human behaviour and needs to be properly managed. The main barriers are the loss of employee morale, lack of motivation, lack of practical support, lack of encouragement, lack of time, lack of computers, shortage of technicians who are prepared to help people, lack of money, and lack of commitment from principals and leaders. It is essential to promote awareness and good leadership to alleviate such administrative and human resources challenges in municipalities and service delivery institutions. Failure to do so results in the loss of resources, employee morale and manpower [14].

Ishengoma *et al*. (2022) have found that rapid advancements that have taken place in the ICT sector since the early 2000s have resulted in increased reliance on digital systems of communication, retail trade and production in which the role of humans has been significantly diminished due to computer programmes and robotic applications in which artificial intelligence plays a key role. This development has led to the loss of traditional jobs that are performed by humans. Advancements made in digital technology have shown that artificial intelligence applications are bound to grow exponentially in large-scale manufacturing and service delivery industries worldwide. Workers who are used to rendering services based on physical contact will be forced to communicate with their clients remotely, and not on a personal basis. Digital transformation will also shorten the gap arising from time differences. This means that employees of municipalities and Government Departments need to enhance their skills in the use of digital teaching technology on a regular basis. They also need to upgrade their digital equipment and software.

The application of digitalisation and automation may take over repetitive tasks from teachers and educators. Autonomous artificial intelligence (AI) applications could replace semi-skilled labourers and improve the efficiency of the remaining staff [24]. Job categories that involve repetitive and manual labour are being automated; this is expected to increase as computing powers continue to become stronger. The demand for professions involving online educators and tutors is likely to be enhanced. Administrative employees who do paper-based work may cease or become replaced. The growing dominance of digital and online methods of conducting business has led to greater reliance on AI processes and programmable machines in all economic sectors. The implication is that municipal employees and public servants who are responsible for rendering routine services to customers need to acquire the necessary digital equipment, software and training to remain relevant to society. Employees who have not been trained and equipped are unable to perform adequately because of their shortcomings in the use of advanced digital technology. This can have a huge impact on the way municipalities perform, and social services are provided to South Africans living in the nine provinces of South Africa.

The use of digital teaching methods and applications is growing at a rapid pace. Robotic machines are often used in risky and difficult working situations such as deep underground mining operations. Robots are also used for reducing reliance on humans. For example, robotic machines are used in operations such as mechanical cutting, grinding, deburring, polishing, industrial welding, handling large and heavy materials, tending machines, painting buildings, assembling parts of products, picking, and for packing and palletising heavy items. Learning activities that are based on machines are an application of AI. This is because computer programmes and mathematical models are used for using computers to simulate and perform activities that are normally performed by humans. AI focuses on enabling machines to develop the same intellectual capabilities as humans [28].

The adoption of digital technology and AI is a key requirement for rendering efficient and affordable municipal and social services to South Africans [36]. The provision of electronic government services is essential

for ensuring efficient and affordable municipal, social and government services to South Africans. Since April 1994 (when the first democratic South African Government was elected), the South African Government has made several attempts to help civil servants to adopt and effectively utilise digital methods for providing municipal and social services. In the next few years, the level of adoption of digital technology is expected to increase significantly in all parts of South Africa [8]. This is because it has become essential to reduce the cost of providing routine social and municipal services to people who live and work in the 257 South African municipalities. The use of digital methods reduces the task of resolving service-related queries. Worldwide, the most significant benefit of digital technology and AI processes is the reduction of the cost-of-service delivery, the reduction of the time taken to resolve service-related queries and enhancing the level of satisfaction of customers and clients alike with the quality and cost of service delivery [32]. To achieve this goal, local municipalities and provincial governments need to be able to invest on digital infrastructure and training. Investment in digital services is essential for cutting down operational cost without lowering service quality standards and market opportunities. This is applicable to all 257 South African municipalities and Government Departments that render routine services such as social grants, educational services and health care to South Africans.

Access to online municipal services in the rural parts of South Africa is limited due to infrastructural problems [32]. Lack of infrastructure makes it impossible for municipalities to offer online services to rural communities. In this regard, the key infrastructural problem is related to telecommunications, electricity and roads services. Service delivery institutions are unable to provide and maintain services in areas where there are infrastructural problems due to problems such as poor communication, the absence of reliable telephone lines, the absence of power lines, lack of access to the internet, and lack of security to costly digital equipment [2]. Routine municipal and social services cannot be provided digitally unless there is access to electricity, the internet, telecommunications services, and the necessary digital equipment, software and trained employees.

A major obstacle to the effective utilisation of digital technologies and AI is the absence of suitably trained and experienced ICT personnel in rural and semi-rural regions of South Africa. Rural Government Departments often fail to retain the services of talented ICT staff due to inability to pay them market-related salaries and employee benefits. This problem is experienced in municipalities in all Sub-Saharan African countries including South Africa [15]. In most Sub-Saharan African countries, digital, ICT and telecommunications infrastructure is poorly developed and maintained. Civil servants are not adequately equipped and trained to use digital methods of service delivery at municipal levels. They also lack basic training on how to use digital technology and social media applications. IT systems and the use of computers are poorly developed and maintained. These facts indicate that national governments need to prioritise the need to invest on digital infrastructure and training activities. There is a dire need for capacity building and skills-based training programmes. Civil servants need education on the benefits of upgrading their technical skills. Several surveys conducted by economists have outlined the benefits of adopting digital teaching technology [7].

The ability of municipalities and Government Departments to attract a large number of highly talented ICT employees determines their capacity to provide quality and affordable services to residents and ratepayers [43]. The provision of limited or poor-quality services to learners has the potential for adversely affecting the profitability of business enterprises. A study carried out by Worku (2023) has found that the profitability of business enterprises that operate in South African cities and towns is dependent upon the quality of municipal services that are rendered to them by municipal employees. The research work carried out by O'Connor, Yan, Thilo, Felzmann, Dowding and Lee (2023) shows that there is a significant benefit in investing on the installation of digital infrastructure and AI platforms at municipal level. Examples of notable benefits are lowering operational cost by adopting digital processes and AI technologies, simplifying the arduous task of instituting service-related queries, and the provision of highly efficient social, health care, educational, financial and municipal services to ordinary people and business enterprises. Commercial banks are using digital technologies and AI applications for cutting down operational cost without lowering the level of service quality.

The need for adopting digital technology and AI processes has increased since the outbreak of Covid-19 in early 2020. The outbreak of Covid-19 and the resulting lockdown has shown the need for training municipal and Government employees on how to use digital and AI technology. The level of reliance of business enterprises, municipalities and Government Departments has increased significantly following the outbreak of Covid-19. The efficient utilisation of digital services and AI processes has enabled service providers and businesses to reduce waiting time and operational cost in most parts of the world [29].

The ability of public sector service providers to manage their budgets appropriately depends on the extent to which they utilise appropriate technology [9]. The research work carried out by Aly (2020) shows that digital transformation and the pace of overall economic growth, development and productivity are significantly interdependent upon each other in developing countries. Not enough is known or understood about the level of readiness of employees of South African municipalities and Government Departments on the effective utilisation of digital technology and AI applications for providing essential social and municipal services. Not enough is

known about how effective it is to provide tailor-made training opportunities to South African municipal and Government employees.

Aly (2020) has shown that digital transformation is a wise investment for rendering efficient social and municipal services in developing nations. Bhalerao, Kumar, Kumar and Pujari (2022) have found that the adoption of artificial intelligence in small and medium enterprises reduces the cost of business operation significantly in developing nations of the world. Fosso Wamba, Queiroz, Guthrie and Braganza (2022) inform us that digital methods are bound to overwhelm and replace traditional methods of conducting business operations in all parts of the world. Enholm *et al*. (2022) indicate that the speedy adoption of artificial intelligence processes is highly beneficial for reducing the cost of doing business in all parts of the world. The authors argue that it is the duty of national and regional governments as well as municipalities in invest on digital infrastructure and training activities. The authors point out that the digital model is customer-centric, facilitated by mobile connectivity and 4IR technology. The availability of relevant aptitude and attitudes in a teaching institution greatly influences the successful transition to digital learning. From digitisation came digitalisation, which leverages digitisation to implement processes that deliver faster results and allow immediate and enhanced access to data [52]. Through digitalisation, it is possible to offer a wide variety of applications by using computers, cell phones, smart phones, tablets and applications that are based on the internet.

The capability of a workforce to utilise appropriate technology for rendering services to learners is a key determinant of efficiency in the markets. This means that any capable workforce must be familiar with the latest tools and technologies that are required for rendering efficient services to learners [3]. Employees working in municipalities and Government Departments must master current digital applications and processes that are used for providing municipal and social services to people who deserve the services. Milly *et al*. (2021, pp.397-398) have assessed technology acceptance models that are commonly used in Uganda for providing digital services. The authors have found that the use of digitalisation and similar technologies has proven to improve the efficiency and performance of employees. Yadav *et al*. (2017) [52] point out that the main benefit of AI is that repetitive and manual tasks could be automated by using AI processes with a view to reduce reliance on humans. Guopong *et al*. (2017, p.626) point out that AI processes enable humans to achieve their intended production and service-related goals at a minimal cost without lowering service level agreements and quality. Employees can instruct machines from anywhere at any time of the day. Doing so is helpful for meeting due dates and for avoiding delays. The adoption of newer technologies and IT systems is influenced greatly by the attitude of people towards digitalisation and readiness to adopt innovative digital methods [16].

Blut and Wang (2019, p.649) have shown that employees working in the public service sector and municipalities often need to upgrade their skills in the use of computers and the internet. They need to have the ability to use the email to exchange messages with customers. They need to be able to look for valuable information on the internet. They also need to acquire the skills needed to assess the level of satisfaction of customers with the level of services that are provided to them by Government and municipal employees. Digital technology skills, access to the internet and equipment are essential for using online systems such as MS Teams and Zoom meetings for resolving service-related queries from customers. These skills are quite fundamental to the effective delivery of online services [1].

Zhu *et al*. (2022) [53] point out that embracing digital methods and AI applications requires skills-based training and investment on digital equipment and software on a regular basis. South African Government Departments and municipalities need to budget appropriately for these needs. Employees working on service delivery must be allowed to attend and benefit from training services as well as supervision, monitoring and evaluation. Such training services need to be provided to employees on a regular basis as the technology keeps evolving all the time. Digital processes rely much less on physical meetings and traditional teaching methods. The effective use of digital services enables municipal offices to be less crowded by customers who seek services. Digital municipal services enable customers to be assisted remotely. They no longer need to come in person and demand services as such services can be readily provided to them by using online and digital systems.

The application of digitalisation and automation may take over repetitive tasks from municipal and Government employees. Autonomous artificial intelligence (AI) applications could replace semi-skilled labourers and improve the efficiency of the remaining staff [15]. Job categories that involve repetitive and manual labour are being automated. This is expected to increase as computing powers continue to become stronger. The demand for online teaching and learning services is expected to increase significantly in the coming years and decades. This change is going to influence both customers who seek services from municipalities and South Africans who rely on social services and grants from the South African Government. Customers and social grant recipients will be able to make account and service-related queries by using email, telephone calls and online meetings at any time. It will be much easier to assess and evaluate the level to which people are satisfied with the quality and efficiency of municipal and social services that are provided to them by municipal and Government employees. Digital methods enable learners to benefit from recorded training sessions and practical demonstrations. Industry related lessons are going to be video recorded and virtual practical lessons are going to be used instead of actual laboratory-based experiments.

Digital technology and its influence on service delivery

Civilisation has gone through three industrial revolutions over the past 300 years. At the moment, the fourth industrial revolution (4IR) is taking place. Digital technology is being used extensively in all economic sectors including public service [39]. Artificial intelligence is being used in automated machines to perform activities that used to be performed by humans with growing ease and efficiency. In the health care industry, telemedicine is thriving due to advances made in digital technology and AI applications. Building on their predecessors, 4IR applications and processes have enabled people to receive highly efficient and affordable services from their local Governments and municipalities [41]. Meetings and lectures are being carried out by using online methods such as MS Teams and Zoom meetings with great convenience and ease. It is possible to readily exchange data sets, reports and financial information by emails. Cloud storage has enabled commercial banks and businesses to store their valuable data sets and financial information in the cloud, where it is secure and convenient [49]. By using digital methods, actual laboratory demonstrations can be replaced by virtual demonstrations that are video-recorded and sent out to learners. Industry 4.0 will harness the wide availability of digital technologies developed during the Digital Revolution to close the gap between the virtual and physical spheres and speed up technological change [47]. Radical technological developments such as digital machines and automated manufacturing equipment are now relying on machine-based programming, robotic applications and AI processes.

Robotic engineering, the Internet of Things, 3-D printing and AI processes are all examples of 4IR and have eased the task of production and service delivery in all economic sectors. The cost of doing business and the cost of production and distribution has decreased as a result of advancements achieved in digital technology. The fourth industrial revolution has brought about both disruption and opportunities to businesses and governments in all parts of the world [44]. Digital methods of service delivery have enabled municipal employees and service delivery specialists to carry out essential duties and activities in all parts of the world efficiently at an affordable cost. This trend is likely to grow in the coming years and decades. As Information Technology (IT) keeps evolving, there will be a need for abandoning traditional methods of teaching and adopting digital modes of teaching and learning [24]. As local municipalities and Government Departments embrace digital technology and AI applications, assessments and evaluations of service delivery will also be made digital. Actual laboratory-based experiments in engineering will be replaced by virtual laboratory experiments [22]. Advancements made in the fields of digital technology and AI show that the growing level of reliance on digital technology and AI is likely to accelerate remarkably in the global manufacturing and service industry in the coming years.

This Fourth Industrial Revolution (4IR) presents radical changes to the workplace, organisations, and society as a whole [19]. Emerging technologies can be highly disruptive in developing nations, especially when no training opportunities are provided to learners. As a result of the emergence of technologies such as artificial intelligence, big data, Internet of Things (IOT), and robotics in the 4IR, corporations are forced to rethink their strategies and metamorphose their business models to a digital approach [17]. In addition to introducing new competitive platforms, disruptive technologies can create new markets and change an organisation's technological capabilities, ultimately changing the way an industry competes, creating strategic challenges and risks. A benefit of digitalisation is that certain products and services can be made available on digital platforms such as smart phones, tablets and computers.

The Fourth Industrial Revolution (4IR) requires businesses to use digital platforms to facilitate interactions with their customers. Ali *et al*. (2023) inform us that digital equipment such as smartphones and tablets is now being used for managing routine banking and retail functions and duties in the service industry. The ease of using such gadgets depends upon the availability of electricity, access to the internet, and software that are specific to services. Such gadgets combine computer power and internet access to seek and acquire access to municipal, social, health care, banking and retail services at any time and from anywhere. As the daily lives and activities of people become increasingly interconnected, people will come to rely on a variety of devices, including cell phones, cars, light switches, home security cameras, and smart speakers [7]. As enterprises undergo digital transformation, they are forced to alter traditional business strategies and adopt advanced technologies such as AI, fundamentally transforming the workplace as we know it.

Digital technology and AI processes have led to the development of five different types of business model reinvention: the reinvention of entire industries, service and product substitutions, creation of new digital businesses, reconfiguration of the value delivery model and rethinking of value propositions. From these five models, digitalisation augments the traditional business model, rather than transforming it completely. Furthermore, improvements in data storage and transmission have enabled smartphones to collect data on customer habits, which can then be aggregated in specialised locations on the “cloud”, used to tailor special offers to clients [9].

The successful adoption of digital technology and AI has the potential for ensuring sustainable profitability and viability in service-sector enterprises [12]. The likelihood of sustained viability and profitability in service delivery institutions is heavily dependent upon the pace of transformation of traditional methods of service delivery

operations into digital platforms. By leveraging digital technology, it is possible to create and upgrade existing processes to meet the changing needs of customers and society in general [14]. The flexibility provided by digital technology and AI processes encourages customers to remain loyal and satisfied. Various aspects of service delivery can be rendered by using online methods and applications. Customers do not have to appear in person to demand services. Almost all services can be rendered by using online methods effectively. Customers do not have to spend time making appointments with municipal employees and employees of Government Departments. Advances made in digital technology and AI are the main drivers of digital transformation in the public services industry.

Ahmed *et al*. (2022) point out that the speedy adoption of digital technology and AI applications is a way of preparing for future modes of service delivery to the general population. The authors state that practical demonstrations and lessons can be provided to learners by using digital platforms and AI applications. The use of appropriate technology and flexible methods such as Zoom meetings and MS Teams online meetings is a way of saving valuable resources. The use of such digital platforms is a key competitive advantage in the services industry. New models of service delivery are emerging, and information about digital methods is readily available. Although digitalisation in the services industry has been prevalent for years, the use of mobile devices and online and email communications has accelerated its pace of change by introducing newer and more convenient platforms. Corno, La Ferrara and Burns (2022) point out that service delivery employees and customers benefit from the use of digital and AI applications as valuable time is saved and the cost-of-service delivery is minimised. Digital methods enable trainees to use recorded lectures to refresh their memories about steps to follow. Employees can easily watch video recordings and master practical lessons and demonstrations at their convenience. These benefits are likely to grow in future as digital technology evolves even further. The cost of municipal and social service delivery is also bound to decrease as the pace of adoption grows faster in the coming years.

AI processes and applications are highly valuable for ensuring satisfactory compliance with financial and administrative guidelines to be followed by people who are responsible for rendering social and municipal services to South Africans who live and work in urban and rural areas. To achieve this goal, it is essential to promote awareness about the relationship between AI processes and good corporate governance [11]. AI technologies have been used worldwide to ensure satisfactory compliance with regulations and guidelines. This development has enabled the world's largest municipalities to render essential municipal and social services to their citizens at an affordable cost and a high level of efficiency. However, most Sub-Saharan African countries have not been able to achieve this goal due to lack of awareness about the benefits of AI processes, lack of digital infrastructure, and lack of practical and technical skills in digital technology and AI technology.

In the developed world, AI methods and processes are commonly used for automating and optimising municipal service delivery. For example, AI applications are used commonly for automating and optimising the task of scheduling, routing, dispatching, and tracking messages and deliveries to end-users and recipients of service delivery. Such tasks can be performed much more efficiently by machines and coded programmes in comparison with civil servants [10]. AI processes can be used for analysing data from a wide variety of sources to determine potential trends and likely obstacles to operation and production. Such applications are highly applicable to sectors such as transportation, shipping, road traffic, weather, customer preferences, and the transfer of goods and services.

AI systems are used commonly for safe storage by large corporations. For example, the cloud storage system of Google is used commonly by commercial banks, insurance companies, and financial institutions for storing sensitive and costly data sets that belong to customers and account holders worldwide. Cloud storage makes it easy to store, retrieve, transfer and share valuable data efficiently among various role-players and stakeholders worldwide. Participants of a cloud storage system are not constrained by geographical distance and physical separation. Cloud storage is based on AI systems and applications. AI processes are closely associated with computer programming and machine learning tools such as the Tensor Processing Unit (TPU). The TPU system is essential for accelerating the pace of training on artificial intelligence. AI systems and applications have enabled large corporations such as Google and Amazon to provide global services to customers in areas such as bank loans, and the transfer, storage and delivery of commercial products and goods worldwide.

Side effects of artificial intelligence

Applications of digital technology and AI processes must be used and managed with due ethical considerations (Roberts *et al*., 2023). Commonly acknowledged side-effects of using AI methods and applications in the services industry include the abuse of privacy laws and regulations, the unethical use and sharing of personal data and records for scrupulous marketing and financial gain, the loss of jobs by employees, excessive reliance on digital processes, difficulty in ensuring transparency and adequate consultation with stakeholders, difficulty in avoiding bias and discrimination, the invasion of privacy, inability to ensure compliance with ethical guidelines and principles, vulnerability to work-related risks, difficulty in ensuring participation in decision-making processes, and the high cost of keeping up with technological advancements, training, the upgrade of digital equipment and software and infrastructural upgrades [23], [29].

There is a significant relationship among digital technology, artificial intelligence applications and electronic service delivery. In all three cases, digital and ICT infrastructure, skills training, infrastructural upgrading and maintenance are required for ensuring efficiency [19]. The key elements of a successful operation are awareness about the benefits of digital technology, ICT and AI, the provision of skills-based training to employees on a regular basis. Digital equipment needs to be upgraded on a regular basis. Software applications need to be installed on digital equipment and upgraded. There is a need for adequate security from hackers and intruders. Information belonging to customers must be kept safely enough in order to comply with privacy legislation and the basic legal and human rights of customers [44].

The extensive use of AI systems and applications results in the automation of jobs that are performed by humans based on traditional manners. There are concerns about job losses, the loss of employee morale, ethical concerns about the abuse of privacy and traditional security procedures and guidelines, the proliferation of bias, the likelihood of digital fraud and hacking, the theft of data and personal information, and lack of respect for human efforts and values including natural creativity and the expression of empathy for people who require assistance from others. The proliferation of AI methods processes has resulted in diminishing human influence in assessment and decision-making processes.

The pace of adopting electronic service delivery processes in South Africa has been hampered by lack of digital infrastructure, lack of technical skills in engineering, ICT and AI, inability to provide adequate security for ICT, telecommunications and electricity infrastructure, the high cost of telecommunications services, cumbersome bureaucratic processes and regulations, and lack of good leadership. It is possible to significantly reduce the cost of essential services such as health care by promoting the effective utilisation of digital technology and AI applications [39]. Electronic, digital and AI services are highly valuable for rendering efficient and affordable social and municipal services to deserving recipients on a regular basis. South African municipalities experience protests over poor municipal service delivery on a regular basis. Municipal employees and officials need to be able to resolve service-related queries from customers efficiently and promptly by using appropriate digital and AI processes and applications [6]. Digital and AI processes and applications have been used worldwide successfully for enhancing the quality and efficiency of health care, educational, agricultural, farming, construction, banking services as well as retail and business activities. The use of such methods greatly simplifies the task of resolving service-related queries from customers. It is also highly valuable for ensuring compliance with good corporate governance, ethical leadership and accountability at municipal level. The same can be achieved in South Africa by taking valuable lessons from global leaders such as the USA, China, Singapore, India, Japan, Germany and South Korea with the right set of ethical guidelines and principles that govern the appropriate use of AI processes and applications in the service sector [18].

Conclusion

The numerous benefits of embracing digital technology and artificial intelligence (AI) have been shown in the paper. A review of the literature shows that digital technology and AI processes have been successfully utilised in the world's advanced economies for reducing the cost of municipal and service delivery. South Africa's 257 municipalities are characterised by protests over poor municipal service delivery, deteriorating municipal infrastructure and the nonpayment of municipal services. The paper shows that these problems can be successfully alleviated by way of embracing and adopting digital technology and AI applications at municipal level in all nine South African provinces and Government Departments. To achieve this goal, it is essential to invest in digital infrastructure, the training of municipal employees and Government employees, and the purchase of digital equipment and software. In the developed economies of the world, digital technology and AI applications have been used successfully for rendering reliable, efficient and affordable municipal and social services to residents and ratepayers of municipalities as well as business enterprises. The effective use of digital technology and AI processes at municipal level requires the installation and maintenance of digital infrastructure as well as the provision of skills-based training to public servants on a regular basis. Doing so is highly valuable for resolving service-related queries from customers at municipal and regional levels. It is also highly valuable for promoting good governance, good leadership, sound ethical leadership and accountability at municipal and regional levels. There are valuable lessons to be learned from developed economies in which digital technology and AI applications can be used effectively for ensuring service excellence in South African municipalities and Government Departments.

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