Smart Cities as a Vehicle to Addressing Sustainable Development Goals in South Africa

Lawrance Seseni
Department of Business Management
School of Management
College of Business Management
University of Johannesburg
Auckland Park, Johannesburg, South Africa
lawrences@uj.ac.za

Sebonkile Cynthia Thaba
Department of Transport and Supply Chain Management
School of Management
College of Business Management
University of Johannesburg
Auckland Park, Johannesburg, South Africa
scthaba@uj.ac.za

Charles Mbohwa & Sizwe Nelson Madonsela
Department of Quality and Operations Management
Faculty of Engineering and Built Environment
University of Johannesburg
Auckland Park, Johannesburg, South Africa
cmbohwa@uj.ac.za

Abstract

The United Nations has set in place sustainable development goals (SDGs) aimed at addressing problems such as those South Africa faces. One of South Africa's challenges is the influx of people into her cities. This is also a global phenomenon, with 90% of the world's population expected to migrate to and stay in cities by 2050. This study conducted a desk review in which 125 journal articles were reviewed and used for semantic analysis, creating a word cloud and word frequencies using Atlas ti. The study found support available for the country to ensure that smart cities are developed, with four smart-city projects in progress, and that the SDGs are being addressed. This study proposes the development of smart cities as a vehicle for addressing the SDG Agenda 2030. Eleven SDGs are addressed by the four smart cities that the country is working on. The study recommends that meaningful collaborations between private and government institutions be set up so that funding can be secured to fast-track the completion of these cities. Future research could look at how citizens can be better prepared for living in smart cities by being able to use the technology they offer.

Keywords
Smart Cities, Sustainable Development Goals, Technology, South Africa

1. Introduction
It is believed that by 2050 the world will have seen an increase of 2.5 billion people from Africa or Asia. Furthermore, 90% of the population will be living in cities (Balkaran 2019). To meet the demands associated with large numbers of people moving to cities, city infrastructure will have to be increased by 60% (Hasbini et al. 2018). Cities cover only 3% of the world's surface area; however, they are considered to be the most populated areas. Despite the relatively

small area that they occupy, cities' energy usage is 78% of the total energy produced and the emission of greenhouse gases by cities is 60% of the total. Cities are also the biggest contributors to biodiversity loss and climate change, and this affects the quality of life of city dwellers (Saiu et al. 2022). This makes it evident that cities must be more environmentally friendly and address all the social issues where they are based.

South Africa is facing a range of challenges, one of which is the large number of African migrants that enter South Africa looking for socio-economic survival (Muchineripi et al. 2022). It has been reported that South Africa accounts for a large proportion of immigrants (including illegal immigrants) on the continent (Karagueuzian & Verdier-Chouchane 2015). South Africa has been deporting illegal immigrants, who then come back and are deported again. This creates a cycle of deporting the same people over and over as they keep coming back (Jackson & Hoque 2022). Another problem is that the economic growth of the country is very low, while the rates of unemployment and inequality, which are based on race, gender and class, are high. As a result of these problems, poverty is another big issue that is still a major concern in the country (Balkaran 2019). The roots of these challenges can be traced back to the legacy of the apartheid system that South Africans had to endure for many years (Tregenna et al. 2021). Sadly, in the post-apartheid era, South Africa is experiencing a very high crime rate. The country is on the list of countries with the highest crime incidents and rates as one of the most unequal societies in the world. Citizens are grappling with the reality of living in an unsafe country (Anna et al. 2022). In addition to these challenges, according to Samuels et al. (2022), climate change is another challenge that the country is grappling with. It has been reported that Southern Africa will see *"extreme climate driven events such as droughts, floods and sand and dust storms will likely increase in frequency, intensity and duration in drylands."*

To overcome issues such as those faced by South Africa and other countries across the globe, in 2015 the United Nations introduced 17 sustainable development goals (SDGs) and 169 targets (Hák et al. 2016). These goals and targets can be achieved by embracing the SDG Agenda 2030. Climate conditions are not the only things that need to be addressed by the SDGs. There are other factors such as economic growth, decent work, no poverty, industry innovation, quality education, life on land, peace and justice, good health and well-being, and sustainable cities and communities to name but a few (Mark & Gregory 2019).

The eleventh SDG calls for cities and communities to be sustainable and inclusive. Cities have been battling to achieve this global goal (Fernandez-Díaz et al. 2022). Different countries around the world have seen the opportunity to address challenges they encounter through introducing the smart-city concept (Ruhlandt 2018). The concept of the smart city has been recognised in international policies and systematic literature for the past 20 years and more (Rana et al. 2018). This area of research has been gaining substantial interest in the academic space and for practitioners globally (Ismagilova et al. 2019). Not only have academics and practitioners been showing interest in smart cities, but the concept has received much media attention as well. African cities are still behind in terms of the technology associated with smart cities when compared with cities such as London and New York. However, information management (IT) companies see African cities as the "next big thing". It is stated that African cities have the potential to innovate because their economies are fast growing (Deloitte 2014).

1.1 Objectives

With the above-mentioned challenges that South Africa is facing, this study posed the following three questions:
Q1: How can sustainable development goals address the myriad of challenges that South Africa faces?
Q2: How can smart cities be a vehicle for addressing sustainable development goals in South Africa?
Q3: Is South Africa ready to address the sustainable development goals as proposed by the United Nations?

The above-mentioned questions are addressed by the following four objectives:
- To determine the impact that the sustainable development goals will have on addressing the challenges that South Africa is facing.
- To explore the role that smart cities can play in addressing sustainable development goals.
- To evaluate if South Africa is ready to address the sustainable development goals as proposed by the United Nations.
- To identify the sustainable development goals that can be addressed by smart cities in South Africa.

2. Literature Review

This section reviews the literature that was used in this study. In this section, recent literature on the definition of smart city, types of cities, technologies that drive smart cities, and smart cities from the global and South African context. Finally, literature on the sustainable development goals from the context of smart cities is reviewed.

2.1. The Smart City

Karvonen et al. (2018) posit that the world is currently in the era of smart cities where all cities wish to be smart. The concept of a smart city aims to make the lives of urban residents simple and not to exclude anyone. This means that projects to build smart cities are widely accepted worldwide (Ahad et al. 2020). Although technology plays a crucial role in smart cities, there are other factors that contribute to a city being smart, such as people, communities, social equity and infrastructure (Fernandez-Díaz et al. 2022). Moreover, the technology used by smart city contributes to the cities becoming innovative (Romanelli 2020).

The definition of a smart city is very fuzzy, with Ruhlandt (2018) suggesting that an accepted definition is lacking. Table 1 outlines the different factors used to define smart cities with the literature that supports them.

Table 1. Factors defining smart cities

Technology		(Penco, et al., (Hasbini, et al. (Fernandez-Dí (Pinochet, et a (Romanelli, 20 (Traskman, 20 (Trunova, et al (Snis, et al., 20 (Deloitte, 2014 (Balkaran, 201 (Rana, et al., 2
Economy		(Penco, et al., (Hasbini, et al. (Romanelli, 20
People		(Penco, et al., (Hasbini, et al. (Fernandez-Dí (Pinochet, et a (Romanelli, 20 (Traskman, 20 (Snis, et al., 20 (Deloitte, 2014
Governance		(Hasbini, et al. (Pinochet, et a (Pratama & Im (Traskman, 20
Environment		(Hasbini, et al.
Sustainability		(Silva, et al., 2 (Romanelli, 20
Infrastructure		(Trunova, et al (Traskman, 20 (Deloitte, 2014 (Balkaran, 201

Source: Authors' compilation

Taking into account the above factors that describe smart cities, the definition of a smart city is captured well by Ryan and Anya as: *"A smart city is typically a city grounded on a drive towards technological innovation to improve the*

lives of city-dwellers." The concept of a smart city was first coined in 2008. A smart city's economy is driven by innovation, entrepreneurship and creativity and used by people who are regarded as smart (Mark & Gregory 2019). Currently, many cities are adopting smart-city innovations, focusing mainly on smart transport with the aim of improving the quality of the lives of their citizens through advanced networks such as big data, IT and Internet of Things (IoT) solutions **(**Begur et al. 2017).

Deloitte (2014) posits that there are three types of smart cities, as shown in Figure 1. The characteristics associated with these types of cities are explained below.
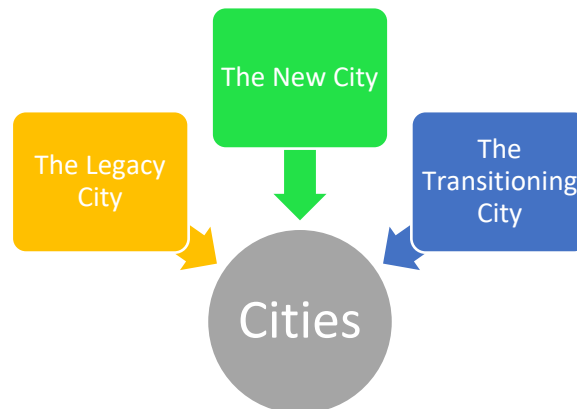

Figure 1. **Types of cities**
Source: Authors' compilation

The Legacy City
A legacy city is a city that was established a long time ago and consequently has aging infrastructure. The challenges that such a city encounters in implementing smart technologies involve acquiring funding and being able to upgrade facilities. The population in a legacy city has usually stabilised and is sustained by immigration (Deloitte 2014). Nassauer et al. (2021) suggest that United States of American cities have suffered depopulation as a result of racist housing policies and several years of a lack of investment in them. This has a negative impact on nearby residents, who depend on such cities for services. Legacy cities have far more usual challenges that they are dealing with (Patras et al. 2021).

The New City
A new city refers to an area that has been built through proactive planning and investment in safety, economy-related and political factors (Guo et al. 2021). More than 150 new cities have been built in the past 20 years in more than 40 countries. These cities have a greater focus on entrepreneurship than more traditional cities. New cities have been an area of research that has attracted the attention of many scholars (Moser & Côté-Roy 2021). New city investment projects are on the rise in Africa, with these cities being built entirely from scratch. The continent is believed to be the next world centre of urbanisation. The population of Africans is predicted to triple in the next 35 years, with 1.3 billion people living in cities by 2050 (Noorloos & Kloosterboe 2018).

The Transitioning City
Transitioning cities are typically found in countries that are facing population expansion and urbanisation and are forced to transition current cities to smart cities so that they can meet the demands of the growing population. South Asia and South Africa in Africa are currently dealing with this challenge. However, there are issues with acquiring the infrastructure and funding needed to implement a strategic plan for transitioning cities (Deloitte 2014).

Smart cities have been in existence for more than two decades. By 2012, 143 smart-city projects were in force. It is reported that 35 of these cities were in North America while 47 were in Europe (Rana et al. 2018). It is believed that in this year 30% of the world's population lived in urban areas, with this percentage rising to 55% in 2014. The perceived value of living in urban areas is expected to increase and the percentage of urban dwellers to reach 68% by 2050. The move from rural areas to urban areas is influenced by people seeking greener pastures that are presented by cities, which are expected to improve the quality of life (Sanchez-Corcuera et al. 2019). Smart cities will have to

respond to the challenges of supplying the multitudes who stay in these cities with enough clean energy, safe food and clean water, among other things (Lai et al. 2020). President Cyril Ramaphosa, in his State of the Nation Address (SONA) to South Africa in 2019, spoke of his dream of building smart cities in the country. In 2021, the country introduced three smart-city projects that are planned to be finished in 25 years (BusinessTech 2021) and recently introduced another one, which makes a total of four planned smart cities (BusinessTech 2022). It is worth noting that the concept of smart city is regarded as promising by addressing issues faced by residents in the city (Sanchez-Corcuera et al. 2019).

Technologies that Drive Smart Cities
Hasbini, et al. (2018) and Pratama and Imawan (2019) state that Information Communication Technology (ICT) such as big data, cloud computing and the IoT are technologies that are required to make a city smart. According to Calzada and Almirall (2020), Artificial Intelligence and sensors are also crucial for making a city smart. These authors further state that information security is of utmost importance when dealing with smart cities. Table 2 lists the technologies that are necessary for making cities smart, along with supporting studies.

Table 2. Technologies that drive smart cities

Technology	Authors and year
Big Data	(Hasbini, et al., 2018)
	(Pinochet, et al., 2018)
	(Pratama & Imawan, 2019)
	(Lafioune & St-Jacques, 2020)
Cloud Computing	(Hasbini, et al., 2018)
	(Pinochet, et al., 2018)
Internet of Things	(Hasbini, et al., 2018)
	(Pinochet, et al., 2018)
	(Pratama & Imawan, 2019)
Sensors	(Calzada & Almirall, 2020)
	(Trunova, et al., 2022)
Artificial Intelligence	(Calzada & Almirall, 2020)

Source: Authors' compilation

Table 2 highlights the technologies that drive smart cities. Different authors have outlined the significance of technologies for the effectiveness of smart cities. ICT plays a crucial role in smart cities. These technologies should also play a huge role in enhancing the quality of life of city dwellers (Toh et al. 2020). Several authors emphasise the significance of big data and the IoT when implementing smart cities.

Smart Cities around the World
Smart-city projects are being undertaken across the world. Amsterdam, Barcelona, Lisbon and Vienna have put in place smart-city policies with the aim of fostering urbanisation (Penco et al. 2021). Yogyakarta city received an award as the best smart-city adopter in 2017, then later received another award as best smart-city governance from city Asia. Indonesia has introduced 100 smart-city projects that will take place in the country, China has over 300 smart-city projects in progress, while India is working on 100 smart-city projects (Toh et al. 2020). With all of these smart-city projects in place, Fernandez-Díaz et al. (2022) suggest that smart cities can address the global goals proposed by the United Nations through the SDGs.

As mentioned previously, SDGs can be used to respond to the problems that countries are currently experiencing (Mark & Gregory 2019). Section 2.2 will review SDGs.

Smart-City Projects in South Africa
At the beginning of 2021, South Africa embarked on a project to construct three smart cities: Lanseria Smart City, Mooikloof Mega-City and Durban Aerotropolis (BusinessTech 2021). Lanseria Smart City is designed to accommodate both lower- and middle-income families. The planned smart city will house 3.5 million residents. Consequently, the municipalities in the area will not be able to finance the project to ensure that there is relevant infrastructure in the given timeframe. It has been proposed that the municipalities should find innovative ways of funding the project (Parker 2022). The Lanseria construction project is expected to take 25 years to complete. The

city will use rainwater harvesting and solar energy to minimise its carbon footprint. The city is planned largely to eliminate the need for residents to use their own cars. Instead, residents will be encouraged to walk or cycle and where necessary to use public transport. People should be able to walk to work, shopping centres and also to schools. Mooikloof Mega-City will start by constructing residential areas for people. Some 50 000 sectional title units will be set aside for schools, offices and shops. It is believed that the city may become the *"world's largest sectional property development"*. This project is a collaboration between public and private organisations. In the KwaZulu Natal province, a smart city called Durban Aerotropolis is intended to be the *"premier business and trade hub in Sub-Saharan Africa"*. This proposed smart city will increase the economy of the province, with 750 000 new jobs created and over 1.5 million residents accommodated. A world-class cargo hub is also expected to be developed. Potential investors have already expressed interest in this project (BusinessTech 2021).

South Africa's fourth smart-city project is a new smart city called African Coastal Smart City, which is planned for the Eastern Cape Province. The South African minister of cooperative governance and traditional affairs has stated that the new city will help alleviate the high unemployment in the area and also address semigration out of the area, where many people are leaving the area for larger cities to look for employment. The smart city is also expected to increase tourism and provide other opportunities. Investors have already expressed interest in the fourth smart city to become involved in constructing the smart city (BusinessTech 2022).

2.2. Sustainable Development Goals Agenda 2030 and South African National Development Plan 2030
"The SDGs are as much about development and transformation as they are about the restoration of the dignity of people around the world, more so in South Africa with its history of deprivation and exclusion of the majority of its people." – Jackson Mthembu, 2019

The South African government has held consultations with the United Nations to work on a framework to help South Africa achieve the SDGs. In 2019, a framework to follow from 2020 to 2025 was developed called: The United Nations Sustainable Development Cooperation Framework (UNSDCF). This framework was adopted by the United Nations and the government of South Africa (United Nations South Africa 2022).

Figure 2 below sets out the National Development Plan 2030 as proposed and adopted by the government of South Africa.
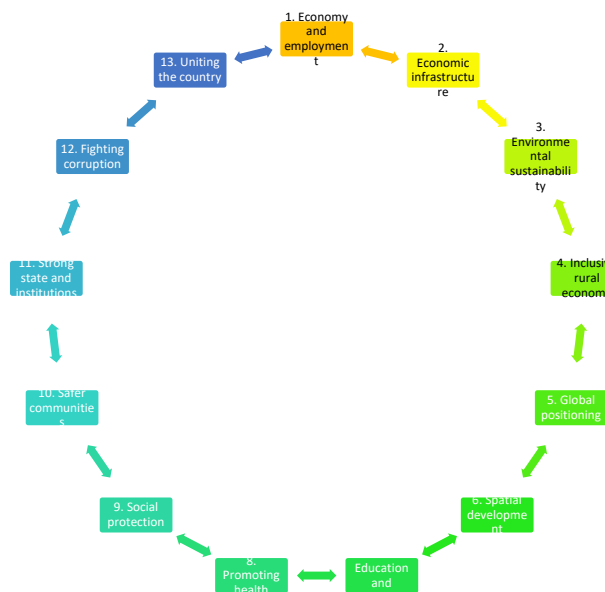

Figure 2. **South African National Development Plan 2030 Priority Areas/Goals**
Source: National Planning Commission (2012)

Figure 2 highlights some 74% of the SDGs are included in the National Development Plan 2030, which was released in 2011 and adopted in 2012. The plan serves as a blueprint for tackling South African problems (National Planning

Commission 2012). The SDGs can address social, economic and environmental issues (Mawonde & Togo 2019). According to the Domino Foundation (2022), the 13 National Development Plan priority areas or goals are as follows:

1. Economy and employment
2. Economic infrastructure
3. Environmental sustainability
4. Inclusive rural economy
5. Global positioning
6. Spatial development
7. Education and training
8. Promoting health
9. Social protection
10. Safer communities
11. Strong state and institutions
12. Fighting corruption
13. Uniting the country

In 2015, 193 participating countries adopted the global goals (SDGs). South Africa was one of the countries that adopted the SDG Agenda 2030, the agenda aimed at facilitating the achievement of the SDGs by 2030. The SDGs provide South Africa with the opportunity to solve problems that the country is facing (Stats SA 2019). According to United Nations South Africa (2022), the Sustainable Development Goals has the following 17 goals for Agenda 2030:

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnership for the goals

| 1. No poverty	2. Zero hunger	3. Good health and well-being	4. Quality education	5. Gender equality	6. Clean water and sanitation
7. Affordable and clean energy	8. Decent work and economic growth	9. Industry, innovation and infrastructure	10. Reduced inequalities	11. Sustainable cities and communities	12. Responsible consumption and production
	13. Climate action	14. Life below water	15. Life on land	16. Peace, justice and strong institutions	17. Partnership for the goals
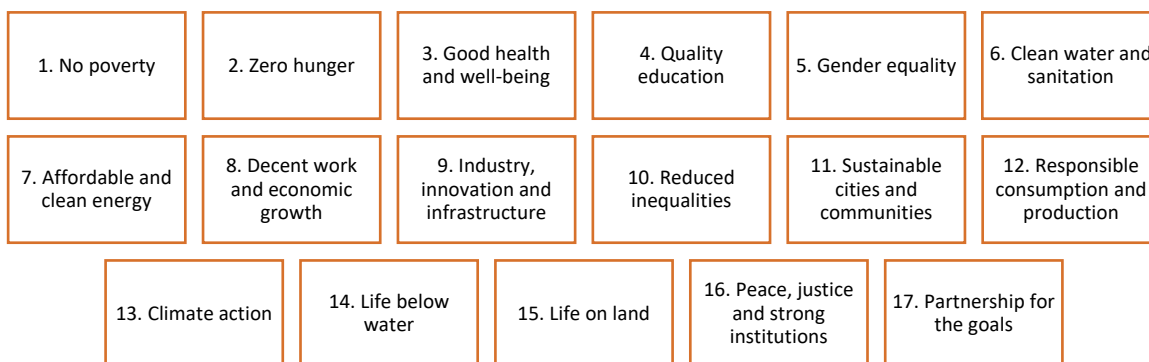
Figure 3. **Sustainable Development Goals Agenda 2030**
Source: United Nations South Africa (2022)

Figure 3 above sets out the 17 SDGs as proposed by the United Nations and adopted by 193 countries (Stats SA 2019). The South Africa government is attending to all these goals with the help of the United Nations and other institutions, such as institutions of higher learning (Mawonde & Togo 2019).

3. Methods

This study used a qualitative methodology in which an intensive desk review was carried out using journal articles, government reports and organisational websites to gather information on smart cities and SDGs. A qualitative approach was considered appropriate as this approach can be used to gather knowledge about a study's subject matter without imposing a predetermined measure on it. Qualitative methods are used to understand the human experience of those who are the specimens of the research and can be used to understand complex phenomena that affect behavoural and social norms (Woods-Hill et al. 2022).

The study made use of thematic content analysis of the documents retrieved through the desk review. This approach is used to triangulate the information gathered from documents and can provide information on what is happening in the environment, provide historical knowledge and assist with background information (Woods-Hill et al. 2022). Sentiment analysis was used for each document to understand the writer's attitude to smart cities and to build up a word cloud. According to Zhang et al. (2018), *"Sentiment analysis or opinion mining is the computational study of people's opinions, sentiments, emotions, appraisals, and attitudes towards entities such as products, services, organizations, individuals, issues, events, topics, and their attribute."* In this case, opinions, sentiments and emotions about the smart city topic were analyzed using Atlas ti which is a computer program for analyzing data. Atlas ti with deep learning technology was used to capture the sentiments of the authors of all of the 125 articles collected.

4. Data Collection

Reputable search engines were used so that only credible sources were interrogated to understand the research phenomenon. The following databases were used:

1. Google Scholar: 13 relevant articles were sourced from this database. However, this was not sufficient to write up a conceptual paper. Insufficient related articles were found.
2. Emerald: Eight relevant articles were sourced from this database.
3. Science Direct: 100 relevant journal papers from 2021 to 2022 were sourced and were used in the paper.

In this study, Atlas ti was used to visualize the results of the articles in terms of the frequencies of the words using Word Cloud and semantic analysis. All 125 articles were used for this analysis.

The following words were entered into the above search engines:
1. Smart city
2. Smart cities
3. Intelligent cities
4. Sustainable Development Goals
5. SDGs
6. National Development Plan
7. South Africa

The articles found as a result of the search were categorised by age from 2018 to 2022. This was carried out so that recent work could be used to understand and solve current problems.

5. Results and Discussion

From the 125 articles that were analyzed for sentiment analysis, a total of 28 148 proposed sentiment analysis results were found. On Atlas ti software using sentiment analysis, three automatic proposed quotes were used in analyzing the content for this study and obtained the following results:

1. Positive – 14 498
2. Neutral – 8 038
3. Negative – 5 882

These statistics illustrate the sentiments of the authors of the 125 journal articles regarding smart cities and SDGs. The results show that in these articles, most of the sentiment expressed about smart cities and SDGs was very positive, although some was negative at some point.

5.1 Smart Cities in South Africa

South Africa is embarking on building four smart cities. The country has already started constructing these cities; however, the completion is expected to take up to 25 years. Some of them are likely to be completed far sooner than 25 years. The smart cities identified in the study are based in four of the nine provinces in the country. Gauteng province has two of the smart cities: Mooikloof Mega-City and Lanseria Smart City, which it shares with North West province as it is on the border-line between Gauteng and North West. The other smart city, Durban Aerotropolis, is based in KwaZulu Natal province. The last city, called African Coastal Smart City**,** is based in the Eastern Cape Province. The identified cities are located in strategic areas so that they can have maximum economic growth and be easily accessible to tourists. For example, two of the cities are located next to airports (Lanseria airport near Lanseria Smart City and King Shaka International Airport near Durban Aerotropolis). Many challenges faced by the country, as outlined by the United Nations' SDGs, will be eradicated through these smart-city projects. The country is consulting with the United Nations to ensure that it does what is required to meet the SDGs and there are other institutions such as non-governmental, non-profit and private organizations (for profit) that are working hand in hand with the government to achieve these goals. The South African government, through Department Statistics South Africa, monitors and produces yearly reports on progress made in meeting the SDGs. The country also adopted her own national development plans in the national development plan of 2012. This plan addresses 74% of the SDGs.

Sustainable Development Goals addressed by South Africa's Smart-City Projects

Below are the SDGs that will be addressed by the four smart cities currently being constructed in South Africa.
1. SDG1: No poverty (jobs that will be created in the four smart cities will help eradicate the high and growing poverty rate in South Africa)
2. SDG2: Zero hunger (as people will be employed in the four cities, they will be able to maintain themselves and be able to have food on a daily basis)
3. SDG3: Good health and well-being (green cities contribute to good health; encouraging walking and cycling instead of using private cars will contribute to good health)
4. SDG4: Quality education (learners will attend the world-class schools that will be created)
5. SDG7: Affordable and clean energy (smart cities will invest in rainwater harvesting and solar energy, which will create green cities with affordable clean energy)
6. SDG8: Decent work and economic growth (more jobs will be created and the jobs that are created will be meaningful)
7. SDG9: Industry innovation and infrastructure (the world-class port in Durban will provide premium business and other structures that will be created across all the four cities)
8. SDG10: Reduced inequalities (mostly, opportunities are reserved for larger cities rather than small towns. The smart city in the Eastern Cape will bridge that gap)
9. SDG11: Sustainable cities and communities (the four smart cities and the residential areas in those cities will contribute to sustainable cities and communities since they will be using clean energy and rainwater harvesting and will be practicing sustainable living).
10. SDG13: Climate action (people will be encouraged to cycle or walk to work, or use public transport if necessary rather than using their own cars, and the use of solar energy with rainwater harvesting will contribute to climate action)
11. SDG17: Partnership for the goals (investors are keen to partner with the government in constructing the four smart cities)

5.2 Graphical Results

Figure 4. Word cloud

Figure 4 is a word cloud that outlines the word frequency in Table 3. The above word cloud illustrates all the words that were found from the 125 articles that were imported into Atlas ti. Table 3 shows the main words found in this study and their word frequencies.

Table 3. Word Frequencies

Word	Frequencies
Smart	23 619
City	14 853
Cities	12 353
SC (Smart City)	808
5G	842
Technology	3 207
Digital	2 094
Technologies	2 140
Innovation	1 934
Society	1 274
AI	676
Applications	1 634
Internet	1 316
Information	3 596
Sustainability	1 709
Sustainable	2 852
Governance	1 877
Government	1 749
Development	3 588
Urban	5 231
Citizens	1 946
Services	2 489
Security	1 652
ICT	837
Social	2 556
Systems	2 312
Learning	1 593
Impact	980

Table 3 above lists the words that appear in the word cloud that was created using Atlas ti, along with the frequencies of these words as the most important words of the study. Apart from the words "smart" with 23 619 words, "city" with 14 853 words, and "cities" with 12 353 words, other words that had a higher frequency in the articles analysed were "development" with 3 588 words, "services" with 2 489 words, "sustainable" with 2 852 words, "information" 3 596 words, "innovation" 1 934 words, "security" 1 652 words, "social" 2 556 words, "systems" 2 312 words, "citizens" 1 946 words, "governance" 1 877 words, "sustainability" 1 709 words, "digital" 2 094 words and "technology 3 207 words". This means that these words are important for smart cities. Based on the research, it is clear that smart cities lead to the development of the areas affected and ultimately the country. A smart city is important as it leads to innovation in their identified cities and sustainability. However, there must be some regulations for the technologies that will be used such as the collection, the management of data, and security. The systems used must comply with the governance that is put in place and the smart city project will have a social impact on its citizens.

5.3 Proposed Improvements

Since developing smart cities requires a lot of money that municipalities do not have, they should look for innovative ways to find funding. They have already established some relationships with property development companies. They need to strengthen these relationships and seek to establish more of them. This will also help to fast-track the construction of the projects. Smart-city investment seminars should be held so that many investors are informed about how they can invest, and where and when to invest. Municipalities also need to partner with institutions of higher learning so that they can help with research and the deployment of human capital from the best academic institutions that may be knowledgeable in the field. This will help to minimise the risk of failure of the smart-city projects and to develop the best roadmap. Institutions of higher learning can also help to train communities on how to use the infrastructure/ICT platforms. For smart cities to be effective, the communities that live in them will need to be able to use the technology embraced by these cities to deliver services. Infrastructure should be made available by both public and private institutions. The government must ensure that the smart-city infrastructure is not vandalised by citizens. This means that the community needs to be educated about the importance of looking after its own infrastructure and how to effectively and optimally use it to maximise its value.

6. Conclusion

This study looked at South African smart cities and their potential contribution to eradicating the challenges faced by the country. It also examined their importance in addressing the SDGs as proposed by the United Nations. This study developed the three research questions of Q1: How can sustainable development goals address the myriad of challenges that South Africa faces? Q2: How can smart cities be a vehicle for addressing sustainable development goals in South Africa? Q3: Is South Africa ready to address the sustainable development goals as proposed by the United Nations? These questions were addressed and answered in this study. In answer to Q1, it was found that the United Nations' SDGs can be used to address the challenges that South Africa faces. In fact, in addition to using the SDGs to address the country's challenges, the country had already developed its own national development plan about five years before the SDGs were developed. The national development plan has 74% similarity with the SDGs. In answer to Q2, it was found that South Africa is embarking and has already started working on four smart cities in four different provinces. Private investors have already expressed interest in partnering with the government to ensure that the dream of having smart cities becomes a success. It was found in this study that 11 sustainable goals (SDGs 1, 2, 3, 4, 7, 8, 9, 10, 11, 13 and 17) will be addressed by the development of these smart cities. Both the national development plan and South Africa's smart-city projects, along with the country's partnership with the United Nations to address the SDGs, suggest that South Africa is ready to address the SDGs, in answer to Q3.

It would be beneficial for future research to look at how citizens will be better prepared for the smart cities. Smart cities are defined from the concept of infrastructure but also from a concept of residents being able to use the technology offered in the city.

References

Ahad, M. A., Paiva, S., Tripathi, G. & Feroz, N., Enabling technologies and sustainable smart cities, *Sustainable Cities and Societies,* Volume 61, 2020.

Anna, B. M., Jörg, P. & Gareth, R., Weather and crime: Cautious evidence from South Africa, *RWI – Leibniz-Institut für Wirtschaftsforschung,* 2022.

Balkaran, S., Smart Cities as Misplaced Priorities in South Africa: A Complex Balance of Conflicting Societal

Needs, *Journal of Management and Administration,* Issue II, pp. 1-30, 2019.

Bruyn, C. d., *Creamer Media's Engineering News,* Available at: https://www.engineeringnews.co.za/article/at-least-50-of-lanseria-smart-citys-housing-will-need-to-be-subsidised-2022-06-09/rep_id:4136, October 2022.

BusinessTech, *Government announced plans for 3 new 'cities' in South Africa – what you should know,* Johannesburg: BusinessTech, 2021.

BusinessTech, *New coastal smart city to be built in South Africa,* Available at: https://businesstech.co.za/news/government/560274/new-coastal-smart-city-to-be-built-in-south-africa/#:~:text=%E2%80%9CThe%20development%20of%20the%20African,attraction%20throughout%20the%20Wild%20Coast, October 2022.

Calzada, I. & Almirall, E., Data ecosystems for protecting European citizens' digital rights, *Transforming Government: People, Process and Policy,* 14(2), pp. 133-147, 2020.

Deloitte, *Africa is ready to leapfrog the competition Through Smart Cities Technology,* Johannesburg: Deloitte & Touche, 2014.

Domino Foundation, *National Development Plan 2030,* Available at: https://www.dominofoundation.org.za/national-development-plan/, October 2022.

Fernandez-Díaz, E., Jambrino-Maldonado, C., Iglesias-Sanchez, P. P. & Heras-Pedrosa, C. d. l., Digital accessibility of smart cities - tourism for all and reducing inequalities: tourism agenda 2030, *Tourism Review,* 2022.

Guo, D. et al., Planning and application of underground logistics systems in new cities and districts in China, *Tunnelling and Underground Space Technology incorporating Trenchless Technology Research,* Volume 113, 2021.

Hák, T., Janousková, S. & Moldan, B., Sustainable Development Goals: A need for relevant indicators, *Ecological Indicators,* Volume 60, p. 565–573, 2016.

Hasbini, M. A., Eldabi, T. & Aldallal, A., Investigating the information security management role in smart city organisations, *World Journal of Entrepreneurship, Management and Sustainable Development,* 14(1), pp. 86-98, 2018.

Ismagilova, E., Hughes, L., Dwivedi, Y. K. & Raman, K. R., Smart cities: Advances in research - An information systems perspective, *International Journal of Information Management,* Volume 47, pp. 88-100, 2019.

Jackson, J. & Hoque, M., Effective Management of Deportation of Undocumented Migrants from SouthAfrica, In: M. Mohuiddin, B. Khalid, M. S. A. Azad & S. Ed-dafali, eds, *Leadership in a Changing World: A Multinational Perspective.* London: IntechOpen, p. 1, 2022.

Karagueuzian, C. & Verdier-Chouchane, A., Taking Africa's Irregular Migrants into Account: Trends, Challenges and Policy Options. *Africa Economic Brief,* 5(1), pp. 1-15, 2015.

Karvonen, A., Cugurullo, F. & Caprotti, F., Situating smart cities. In: A. Karvonen, F. Cugurullo & F. Caprotti, eds. *Inside smart cities: Places, Politics and Urban Innovation.* London: Routledge, p. 1, 2018.

Lafioune, N. & St-Jacques, M., Towards the creation of a searchable 3D smart city model, *Innovation & Management Review,* 17(3), pp. 285-305, 2020.

Lai, C. S. et al., A Review of Technical Standards for Smart Cities, *Clean Technologies,* Volume 2, pp. 290-310, 2020.

Mawonde, A. & Togo, M., Implementation of SDGs at the University of South Africa, *International Journal of Sustainability in Higher Education,* 20(5), pp. 932-950, 2019.

Moser, S. & Côté-Roy, L., New cities: Power, profit, and prestige, *GeographyCompass,* Volume 15, 2021.

Muchineripi, J., Chinyamurindi, W. & Chimucheka, T., African immigrants self-employment journey: navigating contextual challenges in South Africa, *Journal of Global Mobility,* pp. 2049-8799, 2022.

Nassauer, J. I., Webster, N. J., Sampson, N. & Li, J., Care and safety in neighborhood preferences for vacant lot greenspace in legacy cities, *Landscape and Urban Planning,* Volume 214, 2021.

National Planning Commission, *National Development Plan 2030,* Pretoria: The South African Government, 2012.

Noorloos, F. v. & Kloosterboer, M., Africa's new cities: The contested future of urbanisation. *Urban Studies,* 55(6), pp. 1223-1241, 2018.

Patras, E. S., Goebel, A. & Elam, L., *The Road to Revitalization: Equitably Developing America's Smaller Legacy Cities,* Pennsylvania: Land Lines, 2021.

Penco, L., Ivaldi, E. & Ciacci, A., Entrepreneurial ecosystem and well-being in European smart cities: a comparative perspective, *The TQM Journal,* 33(7), pp. 318-350, 2021.

Pinochet, L. H. C., Romani, G. F., Souza, C. A. d. & Rodríguez-Abitia, G., Intention to live in a smart city based on its characteristics in the perception by the young public, *Revista de Gestão,* 26(1), pp. 73-92, 2018.

Pratama, A. B. & Imawan, S. A., A scale for measuring perceived bureaucratic readiness for smart cities in Indonesia, *Public Administration and Policy,* 22(1), pp. 25-39, 2019.

Rana, N. P. et al., Barriers to the Development of Smart Cities in Indian Context, *Information Systems Frontiers,* Volume 21, pp. 503-525, 2018.

Romanelli, M., Analysing the role of information technology towards sustainable cities living, *Kybernetes,* 49(7), pp. 2037-2052, 2020.

Ruhlandt, R. W. S., The governance of smart cities: A systematic literature review, *Cities,* Volume 81, pp. 1-23, 2018

Ryan, M. & Anya, G., Ethics of Using Smart City AI and Big Data: The Case of Four Large European Cities, *ORBIT Journal,* 2(2), 2019.

Saiu, V., Blecic, I. & Meloni, I., Making sustainability development goals (SDGs) operational at suburban level: Potentials and limitations of neighbourhood sustainability assessment tools, *Environmental Impact Assessment Review,* pp. 1-15, 2022.

Samuels, M. et al., Climate vulnerability and risks to an indigenous community in the arid zone of South Africa, *Journal of Arid Environment,* Volume 199, pp. 0140-1963, 2022.

Sanchez-Corcuera, R. et al., Smart cities survey: Technologies, application domains and challenges for the cities of the future, *International Journal of Distributed Sensor Networks,* 15(6), 2019.

Silva, C. A. d., Santos, E. A. d., Maier, S. M. & Rosa:, F. S. d., Urban resilience and sustainable development policies An analysis of smart cities in the state of São Paulo, *Revista de Gestão,* 27(1), pp. 61-78, 2020.

Snis, U. L., Olsson, A. K. & Bernhard, I., Becoming a smart old town – How to manage stakeholder collaboration and cultural heritage, *Journal of Cultural Heritage Management and Sustainable Development,* 11(4), pp. 627-641, 2021.

Stats SA, *Sustainable Development Goals: Country report 2019,* Pretoria: Stats SA, 2019.

Toh, C. K., Sanguesa, J. A., Cano, J. C. & Martinez, F. J., Advances in smart roads for future smart cities. *The Royal Society Publishing,* 2020.

Traskman, T., Smartness and thinking infrastructure: an exploration of a city becoming smart. *Journal of Public Budgeting, Accounting & Financial Management,* 2022.

Tregenna, F., Ewinyu, A. K., Oqubayi, A. & Valodia, I., Challenges and Complexities of the South African Economy, In: A. Oqubayi, F. Tregenna & I. Valodia, eds, *The Oxford Handbook of the South African Economy.* Oxford: Oxford University Press, p. 3, 2021.

Trunova, O., Khodacheck, I. & Khodachek, A., Visualising and calculating the smart city: a dialogue perspective, *Journal of Public Budgeting, Accounting & Financial Management,* 2022.

United Nations South Africa, *Our Work on the Sustainable Development Goals in South Africa,* Available at: https://southafrica.un.org/en/sdgs, October 2022.

Woods-Hill, C. Z. et al., Numbers and narratives: how qualitative methods can strengthen the science of paediatric antimicrobial stewardship, *JAC Antimicrob Resist,* 4(1), 2022.

Zhang, L., Wang, S. & Liu, B., Deep learning for sentiment analysis:A survey, *WIREs Data Mining Knowl Discov,* pp. 1-25, 2022.

Biography

Lawrance Seseni is an Entrepreneurship Lecturer who teaches undergraduates and supervises honours and master's students at the University of Johannesburg. As part of his work in disadvantaged communities, he has initiated several developmental projects, such as conducting career exhibitions in those communities. He currently serves as the Primary Faculty Advisor of the Enactus University of Johannesburg, an international student organisation dedicated to solving societal problems through social entrepreneurship. In addition, he launched the Business Clinic at the University, as he believes that teaching students to take part in community service projects will create citizens of value. This initiative aims to help struggling SMEs in and around Johannesburg. Furthermore, he is the editor of the Department's newsletter and a houseparent in a mixed residence on campus. Among his commitments, he is the lab manager for the European Union's and Erasmus+'s Common Good First Digital Storytelling project. Participants in the Digital Storytelling Project are universities from Iceland, Norway, Denmark, Scotland, Spain, and South Africa. A major goal of this project is to showcase community-generated innovative content. As a researcher, he has had a number of his articles published in international conference procedures that are indexed by Scopus. His recent experience includes serving as a Session Chair at international conferences, reviewing conference papers, and serving as a Track Chair as well as presenting as a distinguished speaker at conferences. A Golden Key member, Lawrance Seseni is in the process of achieving his Ph.D. in Operations Management.

Sebonkile Thaba is currently a lecturer at the University of Johannesburg. She is a cited author in google scholar and Scopus. As the best paper award winner, she published more than 30 academic articles presented locally and internationally. Some of her duties in the University is to serve in Teaching and Learning, Community Engagement and Decolonization committees. She serves these committees with pride because she is passionate about contributing in enhancing the quality of tertiary education in South Africa. Her teaching and learning philosophy informs her curriculum to include decolonization, 4IR and community engagement. Her students participate is socio-economic driven community projects. Their involved resulted in more than 500 students being awarded 100 hours community services certificates from Enactus University of Johannesburg. During her spare time she mentors young people who aspires to be academics of which some of them are now lecturers and cited authors. With regard to her contribution of body of knowledge internationally; she serves as a track and session chair, reviewer, distinguish speaker in supply chain and served as panelist in inclusion and diversity in academia. Sebonkile Thaba is awarded Academic Doctorate Advancement Project towards Transformation (ADAPTT) Scholarship, which is a collaboration of University of Florida (USA) and South African Higher Education (SA-HE) Network (UJ) and is currently finalizing her doctoral studies.

Professor Charles Mbohwa is the former Pro-Vice Chancellor of the University of Zimbabwe. As an established researcher and professor in the field of sustainability engineering and energy, his specialisations include sustainable engineering, energy systems, life cycle assessment, and bioenergy/fuel feasibility and sustainability, with general research interests in renewable energies and sustainability issues. Professor Mbohwa has presented at numerous conferences and published more than 150 papers in peer-reviewed journals and conferences, six book chapters, and one book. Upon graduating with his B.Sc. Honors in Mechanical Engineering from the University of Zimbabwe in 1986, he was employed as a mechanical engineer by the National Railways of Zimbabwe. He holds a Master's degree in Operations Management and Manufacturing Systems from the University of Nottingham and completed his doctoral studies at the Tokyo Metropolitan Institute of Technology in Japan. Prof. Mbohwa was a Fulbright Scholar visiting the Supply Chain and Logistics Institute at the School of Industrial and Systems Engineering, Georgia Institute of Technology; is a fellow of the Zimbabwean Institution of Engineers; and is a registered mechanical engineer with the Engineering Council of Zimbabwe. He has been a contributor to the United Nations Environment Programme and Visiting Exchange Professor at Universidade Tecnológica Federal do Paraná. He has also visited many countries on research and training engagements, including the United Kingdom, Japan, Germany, France, the USA, Brazil, Sweden, Ghana, Nigeria, Kenya, Tanzania, Malawi, Mauritius, Austria, the Netherlands, Uganda, Namibia, and Australia.

Dr Nelson Sizwe Madonsela (ND: IT, BTech, MTech, Ph.D). Business Intelligence Analyst, Senior Lecturer, and Acting Head: Department of Quality and Operations Management, University of Johannesburg (UJ). He holds a doctoral degree (Ph.D. in Engineering Management) from UJ and obtained his Master of Technology degree in Operations Management from UJ. He received a Bachelor of Technology degree in Quality from the University of South Africa (UNISA) and a National Diploma in Information Technology (Software Development) from Tshwane University of Technology (TUT). His research focuses on Business Artificial Intelligence and operation management, focusing on operational excellence. He also focuses on areas such as quality management systems, digital transformation, and project management. He has presented at local and international conferences and authored book chapters. Dr. Madonsela has helped provide high-level strategic and technical guidance in quality management and advanced project management to upskill the workforce among industries within South Africa. Additionally, he serves as a National Advisor on curriculum development, teaching and learning methods, and best practices in quality and operations management in several South African universities.