Inclusive smart cities

appropriate to the South African context

Key findings of a CSIR study

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PREAMBLE

In his State of the Nation Address (SONA) in June 2019, the President of South Africa, Mr. Cyril Ramaphosa, expressed his dream of building a South African smart city. In the February 2020 SONA, the President announced more concrete plans to develop a smart city in the country. These statements ignited various debates regarding the notion of smart cities within the South African context. What emerged from these debates is the lack of a common understanding of the concept of a smart city amongst different stakeholders. Even though the concept has been part of the urban discourse for more than 20 years, there is no universally accepted definition of a smart city.

In 2019/20 the CSIR conducted a study in an attempt to clarify some of the misconceptions surrounding smart cities. The purpose of the study was to develop a deeper understanding of smart cities in South Africa. The intention was furthermore to identify opportunities and challenges that may influence decisions when considering the development of settlements that are not only smart, but also inclusive. In conjunction with this CSIR funded study, the CSIR team also examined "smart cities for a sustainable future" for the South African Local Government Association (SALGA) with funding from the GIZ Natural Resource Stewardship Programme (NatuReS).

This booklet summarises the results of the CSIR study. The aspects that are addressed include an international perspective on smart cities, a South African interpretation of a smart city, factors to consider when planning smart cities, and an outline for a draft smart-readiness decision-making framework.

ABBREVIATIONS / ACRONYMS

4IR	Fourth Industrial Revolution
BSI	British Standards Institute
CCTV	Closed Circuit Television
CSIR	Council for Scientific and Industrial Research
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICT	Information and Communication Technologies
IDP	Integrated Development Plan
IoT	Internet of Things
ISO	International Standards Organisation
IUDF	Integrated Urban Development Framework

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AN INTERNATIONAL PERSPECTIVE ON SMART CITIES

The world is becoming increasingly urbanised, and across the globe people are moving to cities in large numbers. If cities are to overcome the challenges that accompany rapid urbanisation, climate change and general resource constraints, they have to become centres of innovation and creativity. Responding to challenges such as congestion, rising crime, growing urban poverty and the need for more efficient service delivery practices, an increasing number of cities have made the choice to use smart technologies and encourage innovative practices as part of their efforts to become more resilient and liveable.

1.1 Background to the smart city concept

The concept of smart cities originated in the early 1990s with cities starting to label themselves as "smart" upon introducing ICT infrastructure, embracing e-governance and attempting to attract high-tech industries to encourage economic growth. Incidentally, in the wake of the Brundtland report, the 1990s also saw a growing global concern regarding the pressure on and the management of natural resources. The origins of the smart city concept have therefore been linked to North American "smart growth" theories of the 1990s – a community-driven reaction to address traffic congestion, air pollution, etc. through improved development practices[1]. A link has also been established between the uptake of smart cities and the ratification of the Kyoto Protocol in 2005[2], which was a global commitment by world leaders to limit and reduce greenhouse gas emissions in accordance with agreed country targets.

> The idea of applying a smart city approach at a city-wide scale became popular towards the end of the 1990s, with early examples including a proposal for a "City of the Future" in the Australian city of Adelaide[3], the 1997 re-planning of the two cities of Cyberjaya and Putrajaya in Malaysia as intelligent garden cities[4] and Singapore's vision of becoming an intelligent island.

The World Forum on Smart Cities estimated in 1997 that within a decade approximately 50 000 cities around the world would be launching smart city initiatives[5]. Well-known and celebrated examples from the first two decades of the century include Barcelona, Amsterdam, Chicago, Seoul, Vienna, Shanghai, Shenzhen, Birmingham, Copenhagen, Bangalore and Hong Kong.

However, some concerns were raised about the broad uptake of the smart cities concept. For instance, Hollands[6] accused the movement around smart cities of "definitional impreciseness", having "numerous unspoken assumptions" and being "self-congratulatory". The global conversation on smart cities changed somewhat around 2005 with the large-scale entrance of major IT companies into the field[7]. Government, and specifically municipalities, were identified in the early 2000s as an untapped market for companies selling so-called "urban technologies"[8]. Large multi-national companies launched campaigns, published guidance documents[i] and formed councils and coalitions[ii] to drive the smart city agenda, often in support of their market expansion strategies.

In recent years, many literature reviews were conducted on smart cities[9]. Key themes which emerged explored smart cities as cities using smart technologies (a technological focus), smart cities as cities with smart people (a human resource focus) and smart cities as cities with smart collaboration (a governance focus)[10]. Further research identified three dominant discourses, namely one focusing on *infrastructure-based services*, particularly using ICTs; the second discourse concerning *business-led urban development* – focusing on creating conditions conducive to business development; and a third discourse where *social inclusion, learning and development* are central to better meeting community needs[11].

Commentators agree that global research interest in smart cities has increased rapidly, especially in the last five years[12]. While the uptake of smart cities in the Global South has been steady, with countries such as Brazil, India, Rwanda and South Korea launching national initiatives, the literature and research on smart cities have been dominated by Global North examples and initiatives. Research in the Global South has only recently turned to the theme of smart cities[13].

1.2 What is a smart city?

1.2.1 Defining smart cities

A wide range of definitions of the term "smart city" has been developed by various people and organisations. There do not seem to be a universally accepted definition of a smart city. However, ICT is a recurring theme in most descriptions of smart cities[14]. For instance, Batty et al[15] describe the term as "a fusion of ideas about how information and communication technologies might improve the functioning of cities, enhancing their efficiency, improving their competitiveness, and providing new ways in which problems of poverty, social deprivation, and poor environment might be addressed."

[i] For instance, since launching their mission to create smarter cities in 2009, IBM's Institute for Business Value published a range of documents to provide "strategic insights for senior executives". Cisco is another multi-national that published, among others, a range of 'white papers' on issues related to smart cities.

[ii] For instance, the Smart Cities Council is an industry coalition formed to accelerate the move to smart, sustainable cities. So-called global lead partners include AT&T, Microsoft, Cisco, and Dow. In June 2019 the World Economic Forum launched the G20 Global Smart Cities Alliance which promises to unite municipal, regional and national governments, private-sector partners and cities' residents around a shared set of principles for the responsible and ethical use of smart city technologies.

The term "smart cities" seems to predominantly describe cities that deploy technology to transform core systems (people, business, transport, communication, water and energy) and optimise returns from finite resources[16].

The use of ICT is in particular promoted by large technology companies who may have a specific commercial perspective. For instance, according to Cisco, a multi-national technology conglomerate, "a smart city uses digital technology to connect, protect, and enhance the lives of citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions[17]."

While early definitions of smart cities tended to emphasise the technologies to be used, there seems to be a growing realisation that 'smart' technologies should not be prioritised at the expense of issues such as social inclusion and sustainability. Recent definitions of smart cities tend to highlight the need for smart cities to improve people's quality of life. Examples of some international definitions are presented below.

ITU, the United Nations specialised agency for information and communication technologies analysed nearly 100 definitions of smart cities to develop the following definition:

> ***A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects.***

The British Standards Institute (BSI) defines smart cities as follows:

> ***The effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens[18].***

According to the website Techopedia, a smart city can be described as follows:

> ***A smart city is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs. The overarching aim of a smart city is to enhance the quality of living for its citizens through smart technology[19].***

The Smart Cities Strategic Advisory Group of the International Standards Organisation (ISO) formulated the following definition of a smart city:

A "smart city" is one that increases the pace at which it improves social, economic and environmental sustainability outcomes, responding to challenges such as climate change, rapid population growth and political and economic instability by improving how it engages with society, how it applies collaborative leadership methods, how it works across disciplines and city systems, and how it uses data information and modern technologies in order to provide better services and quality of life to those in, and involved with, the city, now and for the foreseeable future, without unfair disadvantage to others or degradation of the natural environment.

1.2.2 Related terminology

The concept of smart cities has been used interchangeably or complementary with a range of terms such as "wired cities", "techno-cities", "digital cities", "creative cities", "knowledge-based cities", "intelligent cities", "innovative cities", "information cities" and "future cities"[20]. It is not always easy to make a clear distinction between the different terms as they often share certain assumptions and, in some cases, are conflated[21]. Nam and Pardo[22] describe and discuss the difference between smart cities and its closest related terms. They categorised 11 of these concepts into three dimensions, namely technology, people and community (see Table 1).

	Dimensions		
	Technology	**People**	**Community**
Concepts	Digital City	Creative city	Smart community
	Intelligent city	Learning city	
	Ubiquitous city	Humane city	
	Wired city	Knowledge city	
	Hybrid city		
	Information city		

Table 1: Conceptual relatives of the smart city[23]

In Nam and Pardo's analysis, the terms that view the city from a technology perspective tend to be used (rightly or wrongly) interchangeably with smart cities, albeit with changing emphasis on different aspects. For instance, the creation of an environment for information-sharing, collaboration, interoperability for all inhabitants everywhere in the city (digital city), or the collection of information from communities and delivering it to the public via web portals (information city) or using information technology to transform life and work in significant and fundamental rather than incremental ways (intelligent city). The term "smart city" has, however, become significantly more popular than the other interchangeable terms over the past decade[24]. The terms that are related to the human

dimension (e.g. creative, humane, learning, innovative) are usually complementary to the smart cities concept, implying that a smart city should actually by default be creative, humane, innovative and learning. Recent usage of the term "smart communities" generally tries to emphasise the importance of smart city governance with multiple stakeholders.

Other terms associated with smart city debates include "digital urbanism" and "smart urbanism". These concepts have a particular focus on the use of ICT in the urban context. For instance, "smart urbanism" refers to "a loosely connected set of confluences between data, digital technologies, and urban sites and processes[25]."

1.2.3 Different interpretations of the smart city concept

Both components of the smart city concept could be interpreted in different ways:

- **Smart:** The term "smart" is most commonly associated with a range of technological and digital concepts and interventions, including the Internet of Things, Artificial Intelligence, Big Data, sensors and various other ICTs. To a certain extent, the different meanings that are attributed to the word "smart" demonstrate the conflicting interests of different stakeholders (municipalities, research institutions, grassroots movements, technology vendors, property developers, etc.). Smart city vendors (ICT companies) often tend to promote the notion that smart equals ICT. Others argue that the understanding of smart should move beyond the focus on technology as the "solution" to all urban "problems". McFarlane and Söderström contend that "… we need to return to the original meaning of smart and move from a technology-intensive to a knowledge-intensive smart urbanism[26]." While acknowledging the notion that the term "smart" refers to technology, and in particular ICT, there do not seem to be clarity on what could be regarded as technology in the wider sense of the word. For instance, innovative approaches and processes, and non-conventional methods may also be regarded as smart.
- **City:** The word "city" has multiple meanings in the smart city discourse. It is a catch-all phrase that includes various types of settlements, or parts of settlements. It could refer to an entirely new, custom-built city on a greenfield site not linked to an existing city (e.g. Belmont in Arizona, USA planned by Bill Gates and partners). It could also be a large new (precinct) development linked to an existing city, such as Songdo International Business District in South Korea. Often a smart city initiative involves the 'retrofitting' of an existing city (or parts thereof) such as the smart city programmes of Amsterdam or Rio de Janeiro[27]. The term could also be used when referring to a new (usually mixed use) development within a city. Sometimes private gated community developments (residential, commercial or mixed use) are also marketed as "smart cities".

Smart cities are often described as a combination of various smart components. These components could refer to, for instance, infrastructure elements, or they could be different operational areas that are central to a city's functioning. Giffinger et al[28] identify the following areas: economy, people, governance, mobility, living and environment. Examples of possible smart initiatives that could be implemented in support of each of these areas are illustrated in Figure 1. Different cities would identify different areas which may include some or all of these examples, but could also include other areas such as health and safety and security.

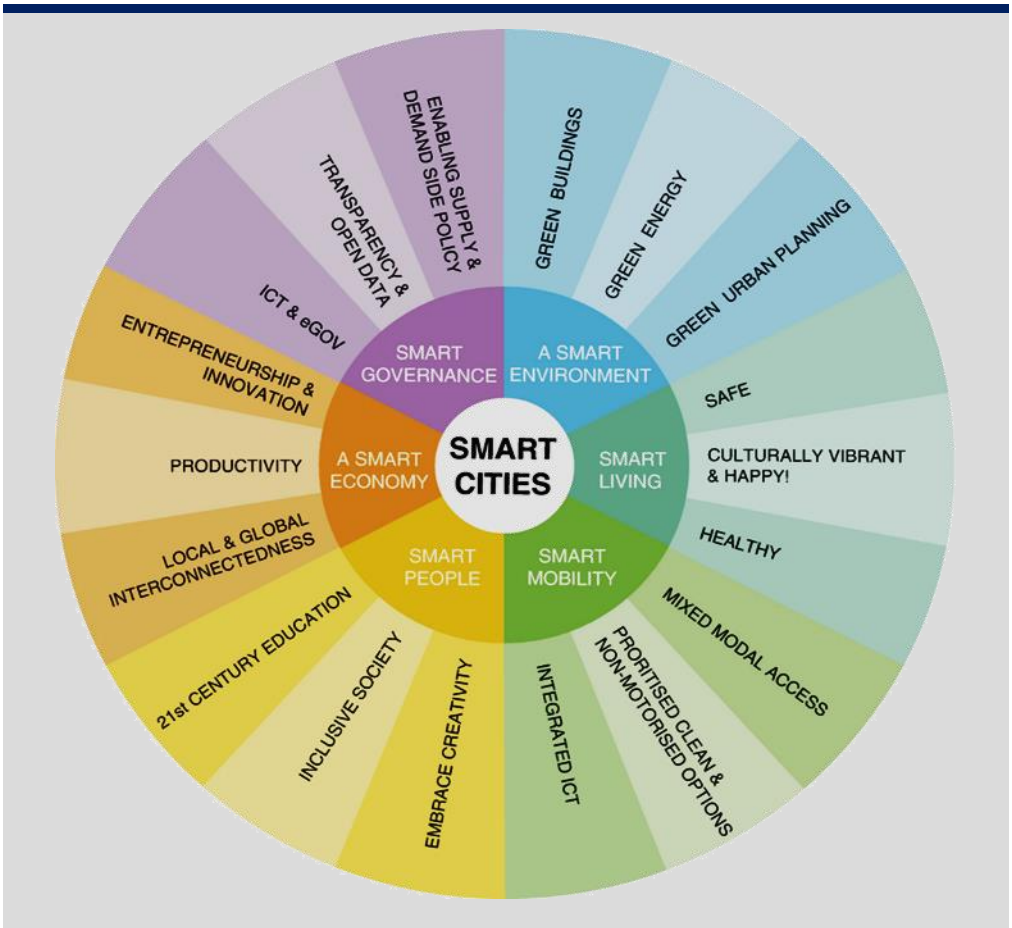

Figure 1: Examples of possible smart city components and initiatives[29]

1.3 Smart city promises and opportunities

The benefits of smart cities are extensively promoted on the websites of smart cities vendors and smart cities coalitions and councils. The Smart Cities Council, for instance, promises the following on its website:

> ***From reducing energy use to accelerating economic development, from making neighbourhoods safer to helping people get to their destinations faster, Smart Cities Solutions offers practical advice to help solve your city's biggest pain points.***

While concerns can be raised that the smart city benefits that are widely promoted are not always well-defined, tested or measured[30], it is still useful to have a broad understanding of the opportunities that can be created by an integrated, digitally-enabled and data-driven city. Although the smart city can mean different things to different cities, the concept is ultimately based on the promise of addressing some of the most critical issues that cities have to deal with, including climate change, urbanisation, citizen engagement and resource efficiency[31]. The ways in which smart cities could create and spread public value are described below.

1.3.1 More effective, data-driven decision-making

Smart cities promise to change the way cities are planned and managed. Long term planning can be enhanced through geospatial modelling and analysis, assisting with predicting droughts and other disasters. Continuous reflection in the short term could potentially enable cities to become smarter over the long term[32]. The Internet of Things (IoT), in particular, enables real-time, uninterrupted communication between humans and objects (both static and mobile). This allows municipal officials to comprehensively manage and monitor critical assets.

> The workings of existing infrastructure can be optimised by using sensors that monitor the functioning of the infrastructure and feed real-time data into a central system. This constant stream of high-quality and relevant information on the operations and condition of for example a water and wastewater system can potentially improve the management of the entire system, especially by more focused maintenance and planning practices.

Maintenance can be planned because failures can be predicted and technical problems could be addressed in time through early detection. Planning for extensions and new infrastructure can also be improved, as a better understanding of water flows and consumption can assist with anticipating future needs.

1.3.2 Reduced environmental footprint/impact

The environmental challenges associated with climate change and rapid urbanisation are well-known: carbon emissions resulting from severe traffic congestion, limited and vulnerable water resources, enhanced threats of extreme weather events and ever-increasing solid waste. Smart cities promise to address these challenges at various scales. For instance, improved planning and improved analytics could result in consumption reduction and more efficient resource management and the elimination of wasteful leaks. By making real-time measurement of nutrients in water and wastewater more visible, chances are improved to address the challenges associated with the dumping of contaminated water in carefully balanced ecosystems. Smart city efficiency can also support the implementation of alternative approaches to water infrastructure design and management. A better understanding of water flows and consumption can, for instance, inform and support the implementation of Water Sensitive Urban Design initiatives and Sustainable Urban Drainage Systems. Furthermore, through information-sharing and awareness raising, data created by the system can be utilised to engage citizens and encourage more ecologically friendly behaviours. By improving the efficiency of municipal operations and services, energy consumption can be lowered, traffic and congestion can be reduced (and in turn carbon emissions), and waste management practices can be improved.

1.3.3 New economic development opportunities

Another proposed benefit of smart cities is that they tend to attract more businesses, thereby boosting city economies and reducing unemployment.

> Techno parks and start-up hubs are popular manifestations of the smart city idea, but the attractiveness of smart cities is not limited to high-tech businesses. Ordinary businesses are attracted to cities with well-functioning smarter infrastructure because it lowers their operating costs, thereby improving their profit margins and opportunities for growth.

Smart buildings, for example, may save businesses huge costs on electricity for cooling and lighting. There are also indirect benefits of smart cities that may help to boost the economy. Smart initiatives in, for example, education, help to train residents to become more appropriately skilled for the job market. Smart interventions may also have positive economic impacts through innovative practices such as energy-efficient or water-efficient practices or by means of industrial symbiosis – finding ways to use the waste from one company as raw material for another.

1.3.4 Improved quality of life

Smart cities can impact on people's quality of life when, for instance, commuters spend less time sitting in traffic, when emergency-response times are cut or when residents have 24/7 access to potable water. There are also smart city technologies that have a different direct impact on citizens' lives because they are created specifically with people's needs and experiences in mind. Digitised government services will make transacting far easier and allow citizens to report incidents and issues in their local area to the municipality through their smartphones. Initiatives such as public Wi-Fi and street furniture with charging points and queue management systems have a direct positive impact on people's quality of life.

1.3.5 Safer communities

Smart city technologies that are often promoted to curb criminal behaviour include CCTV cameras, face and license plate recognition and various forms of access control. In addition to crime prevention and detection, community safety can also be improved by smart systems that assist with mitigating risks and reducing damages in case of a disaster. Early hazard detection is central to this approach. Rainfall can, for instance, be monitored and flooding can be predicted with a higher level of accuracy. Smart city technologies can also be used to install automated flood control measures.

1.3.6 Enhanced resident and municipal engagement

Through collaboration tools, modern and intuitive websites, mobile applications, self-service portals and online accounts, smart cities improve the communication between municipalities and residents. Residents become a source of information (e.g. through accident reporting) to the municipality and

at the same time residents are empowered with gaining access to municipal data, interactive maps, government performance dashboards. Residents can then also make better-informed decisions regarding their own consumption of resources and the trade-offs that are available to them. The continual interaction between the physical and digital worlds enables the decision-making processes to be much more open and inclusive, so that citizens, policy makers and businesses can work together effectively to manage the life of the city for the benefit of all.

1.3.7 Cost savings

Although there will be initial investment costs associated with smart cities, long-term cost saving is one of the prime selling points of smart cities. The city could be automated to enable appropriate city functions to be delivered reliably, and effectively, without the need for direct human intervention. With Artificial Intelligence and IoT technologies automating certain functions, water and electricity service delivery could become more efficient, particularly concerning energy-usage and resource-management, saving time and money. Through eliminating redundancies, finding ways to save money and streamlining workers' responsibilities, municipalities can provide higher-quality services at lower costs, targeting the specific needs of individual groups. Mitigating risks and reducing damages in case of a disaster is another way in which a smart city can cut down expenses, as well as increase safety. For South African cities one of the most important possibilities of cost saving would be through leapfrogging traditional trajectories of technological advancement.

> Boyle[33] explains that South African cities can possibly "…invest in cutting-edge telecommunications and bypass investments in older technologies." Bypassing investment in obsolete technology such as landlines mean that resources can be allocated to more recent and appropriate technology.

1.4 Concerns surrounding the smart city concept

Plans for more wired, networked, connected urban areas face challenges if they fail to account for existing, local, non-digital elements such as governance, socio-economic conditions, politics and finances. Researchers studying the phenomenon of smart cities have raised several concerns. Issues that have been raised are described below.

1.4.1 Context considerations

While smart city initiatives may share many commonalities, the settings where these ideas are to be implemented more often than not differ considerably. Many of the assumptions about smart cities seem to be based on Global North perspectives on what cities consist of. In the cities of the South the existence of, for instance, engineering service delivery infrastructure should not be taken for granted. The functioning of existing systems may also differ from cities in other regions. Bakker[34] explains the pitfalls of making certain assumptions about cities of the South by presenting the following example:

> ***The term "network" and the interconnectedness it evokes is a poor descriptor of water supply systems in many cities. Rather, the metaphor of the archipelago - spatially separated but linked "islands" of networked supply in the urban fabric - is more accurate than the term "network".***

Often the most basic infrastructure is lacking, or the existing infrastructure has not been maintained for many years, make use of outdated technologies and may even be beyond repair. The functioning of the existing infrastructure may be severely slowed or may have become hazardous due to multiple illegal connections. Engineering infrastructure in cities of the South is often only provided to formal parts of the city. In addition, cities are places with complex organisational and investment arrangements and places where politics are often volatile. Concerns are raised that smart city ideas are implemented without due consideration of local contexts and priorities. The city is not a blank canvas where sophisticated and expensive technologies can simply be overlain[35]. The smart city presented on websites is often "deeply decontextualised and strangely 'placeless'"[36]. Although the smart city rhetoric is one of resource efficiency and inclusion, the images generally do not portray, for instance, mixed-income neighbourhoods, social housing or informal markets and networks. According to Aurigi and Odendaal[37] "the smart city is too often framed as a general construct responding to generalized challenges and conditions – and often offering generalized products as 'solutions' to these." If a smart city innovation has been applied and piloted in one city, it does not necessarily mean that it can be rolled out universally. A thorough understanding of a place and its specific requirements remain essential. The challenges that cities face, and will continue to face in the future, are complex and diverse. They are also very context-specific – no two cities are the same. Responses therefore need to take this into account.

1.4.2 Vested corporate interests

Who decides what the city really needs and how it will operate in the future? With a smart city comes a significant amount of decision-making on what to do, who will do it, why and when to do it. Who will cover upfront costs and who will pay for continued operations? The answers to the questions are not easy and can have serious implications. Although the importance of the private and public sector as partners in urban development cannot be over-emphasised, certain challenges should be highlighted. The impact that vested corporate interests have had on the global smart city dialogue has been discussed extensively[38]. The global market for smart city solutions and services is expected to grow from $40.1 billion in 2017 to $94.2 billion by 2026. Being a lucrative industry, the competition among large multi-national IT companies have been fierce and concerns have been raised that these companies are positioning themselves to create skewed financial dependencies. These companies are also sometimes allowed (maybe unwittingly) to set agendas in the urban debate and to influence urban experiments, leaving little room for ordinary people to participate in the smart city[39]. The challenges associated with vested interests are already evident when cities or projects are labelled as "smart". The label can, for instance, be used to describe a number of cities in the Global

North or it can be used for high-end property developments in Africa. "This labelling is problematic and is often misused, thus it is important to interrogate claims and labels of 'smartness' as they are often appropriated to serve other agendas[40]". Finding ways to figure out what the public wants from its city (and perhaps more importantly, what it does not) is critical.

1.4.3 Technology as a starting point and not an enabler

Smart cities promote the potential of technology to address urban challenges. Governments have been accused[41] of being more focused on the smart city technologies of the future than on present development challenges.

> In addition, the role of technology is sometimes emphasised at the expense of other essential elements in the drive to address complex urban challenges. Although technology is a core aspect of a smart city, technology alone is not enough to create and spread public value for residents[42].

Changing behaviour - the way we live, work and play - will be critical for cities if they are to become smart. By applying the smart city as a "technological fix" or a "technical solution to political and environmental issues"[43], the digital divide that exists in many cities of the Global South may even be widened. This excessive emphasis on the latest technology may have other unintended consequences as well. Boyle[44] warns that although there are evident benefits of bypassing older technologies, cities may unwittingly limit their ability to build their own technological capabilities. While the leapfrogging of technologies may be useful and save costs over the short term, the leapfrogging of skills are far more complex and the latest technology as a starting point may yet again widen the digital divide.

1.4.4 Understanding and defining a city

Although smart cities will be digitally-enabled and data-driven, they remain cities. Proposing smart solutions for urban problems, smart city literature has to make sense of what the city is.

> Smart city approaches often tend to frame all urban questions as essentially engineering problems, with the accompanying solving through empirical, often quantitative, methods[45]. Urban management seems to be portrayed as a technocratic function that can be addressed simply through better data and appropriate software to analyse the data.

The reason for this over-simplification of urban problems may have its origins in the definitions that are provided for the "city" in smart cities. For instance, IBM's smart cities approach rests on two main assumptions. First, the city is based on three main pillars: planning and management services; infrastructure services; and human services. Each of these pillars is sub-divided into three sub-pillars:

"Planning and management services" into public safety, smarter buildings and urban planning, government and agency administration; "Infrastructure services" into energy and water, environment and transportation; "Human services" into social programmes, health care and education. The sum of these nine pillars makes "the city". This systems approach to cities is not new to urban planning (refer to Figure 2 for an illustration of the city as a system of systems) and may be useful in designing the "architecture" of a smart cities system, but these systems may not fully grasp the complexity of even small cities and towns.

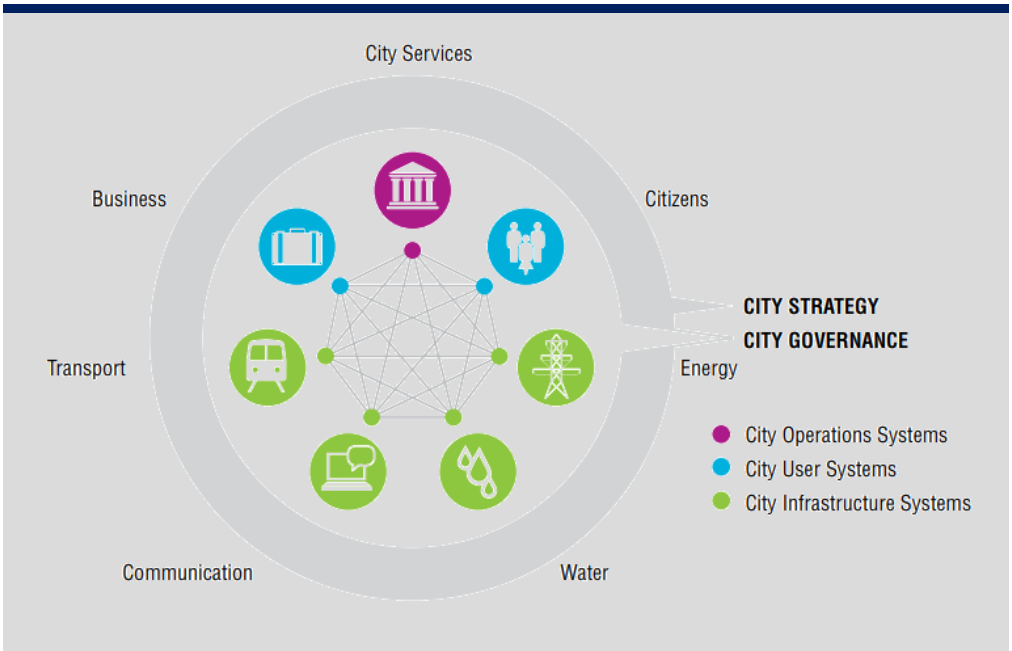

Figure 2: The city as a system of systems[46]

1.4.5 Ethical concerns

The mass proliferation of connected devices, systems and services in the smart city inevitably raises ethical questions. Top of mind is the erosion of privacy through continuous mass surveillance, but there are other issues as well, including procurement of expensive smart city systems - who decides which technologies are selected?

> Systems that are automated and are dependent on algorithms often lack transparency and may complicate oversight and ownership. Smart city narratives often tell of places where people will thrive. However, without efforts to implement projects in inclusive ways, existing institutional privileges and protections can be reinforced.

Furthermore, smart cities run the risk of relying only on data collected from tech-savvy users, and this could lead to the exclusion of certain groups. The system itself may also treat groups differently or exclude some as a result of automated decisions based on predictive profiling.

What is the digital divide?

The digital divide can be described as the gap between those individuals, households, businesses and geographic areas who have access to modern information and communication technology and those who lack access. Although public discourse is often pre-occupied with whether people can afford access to computers, cellular phones, network connections and internet data, a lack of skills, opportunities and even confidence can also contribute to the widening of the digital divide[47]. Stephen McNair of the University of Surrey describes the challenges associated with the digital divide as follows:

Just as the industrial revolution made some level of literacy and numeracy a requirement for all, so the electronic revolution within contemporary society makes digital literacy essential. People who lack access to relevant hardware and software, and a basic understanding of ICT, will also lack the confidence that they can continue to learn as the technologies evolve; they will remain digitally illiterate. As the technologies become ever more embedded in everyday life – and increasingly taken for granted by those with relevant equipment, skills and understanding – so the exclusion of those without this new literacy deepens. Such exclusion is a major policy concern in all countries. It poses a dynamic problem, in that the very concept of ICT literacy is itself constantly changing as new technologies emerge[48].

2

SMART CITIES AND THE SOUTH AFRICAN CONTEXT

The need to address challenges facing the country with respect to poverty, inequality, unemployment, crime, the lack of service delivery, unreliable electricity supply etc. are at times cited as more critical than the quest to develop so-called smart cities and the deployment of more high-tech interventions and technologies that may be out of reach of most people.

2.1 South African realities

2.1.1 Socio-economic characteristics of South African society

Several socio-economic characteristics that need to be taken into consideration in the South African smart city debate, and especially when making decisions about technology interventions, are briefly discussed below.

i Poverty

The challenges created by the extreme levels of poverty in South Africa could not be underestimated. More than 30 million people (56% of the population) live below the upper bound poverty line (less than R1 227/month). Approximately one quarter of South Africa's population (almost 14 million people) live below the food poverty line (less than R561/month)[49].

In a working paper prepared for the United Nations University World Institute for Development Economics Research (UNU-WIDER), the distinction between the chronic poor and the transient poor and vulnerable, rather than between the poor and non-poor, is highlighted. The chronic poor are trapped in poverty, while the transient poor and vulnerable are more likely to experience poverty as a temporary state. While social grants play a key role in the survival of the chronic poor, they do not address the structural barriers to upward mobility. In the UNU-WIDER paper it is also stated that a large share of the population remains locked in persistent poverty with very low chances of being fruitfully integrated into the labour market. Furthermore, social grants will remain an indispensable source of income for many of the chronic poor[50].

> ***Certain technologies may not appropriately address the priority needs of the poor, particularly the chronic poor, due to the additional financial burden they may place on them.***

Figure 3: The needs of the poor should inform technology interventions

ii Inequality

South Africa is often portrayed as the most economically unequal society in the world. Usually such statements are based on the Gini coefficient or index[iii], developed by the World Bank. It should be noted that the Gini coefficient has numerous limitations, for instance, it does not nearly include all the countries in the world, it is not completely comparable across all countries, and it does not incorporate all information about inequality[51]. Despite the shortcomings, the Gini coefficient does provide some indication of relative economic inequality. Recent research indicates that one of the main reasons for the high level of inequality in South Africa is that top income earners have thrived, while everyone else has not[52]. Between 2003 and 2015/2016, the real incomes of SA's top 1% of income earners almost doubled. By contrast, the incomes of 95% of the population stagnated, or for those at the bottom showed only slight growth, in their case mainly because of social grants. Nearly 60% of the population earned no taxable income at all during this period. This means that the wealthiest South Africans are doing well, while the middle class and the poor are struggling more and more. According to Prof Murray Leibbrandt, of the Southern Africa Labour and Development Research Unit (Saldru) at the University of Cape Town, "such high levels of inequality threaten the social fabric, increase the risks of political and economic upheaval and prevent the majority from living up to their full potential. All of these are likely to harm the country's long-term developmental prospects[53]."

[iii] The Gini coefficient attempts to measure income inequality. In essence, it can range from 0 to 1, where 0 reflects an equal distribution of income (where everyone has the same income) and 1 reflects absolute inequality (where one person has all the income and no-one else has anything)

Figure 4: Inequality could complicate decisions regarding technologies

iii Unemployment

The unemployment rate for the third quarter of 2019 is 29.1%. This means that more than 6.7 million people were unemployed, while almost 16.4 million are employed. Almost 40% of these unemployed South Africans have not worked before. For the same period, the expanded unemployment rate, which includes people who have stopped looking for work, is 38.5%. Of particular concern is the youth unemployment rate of 58.2%[54]. More than 60% of all young unemployed South Africans have never worked before[55]. Furthermore, more than 13% of South Africans have not been employed at all over the past ten years, while it is estimated that half of the unemployed are practically unemployable[56].

> ***These unemployment figures underline the immense challenges the country is facing with respect to job creation. Against this backdrop, it could be argued that smart cities, ICT and other technologies (including 4IR technologies) may not create job opportunities for a large proportion of the unemployed population.***

Reasons include the lack of appropriate knowledge and experience, and skills gaps that render upskilling of many virtually impossible. The 4IR may very well provide new employment opportunities and create jobs that do not even exist at the moment, but it may also result in the destruction of certain job types and could add to the numbers regarded as unemployable.

Figure 5: Sprawl and fragmentation characterise South African cities

2.1.2 The nature of South African cities and towns

Many parts of South African cities and towns – particularly those developed specifically for poor communities – are still characterised by a lack of adequate infrastructure, facilities and amenities, low levels of service and few or undesirable public spaces. These areas are often located on the periphery of cities and towns, and therefore residents generally have to travel long distances to and from their places of employment, shops and social, recreational, healthcare or other facilities. This negatively affects the quality of life of those living in these areas and has significant financial implications. It also results in the inefficient utilisation of resources.

> "Although the Apartheid urban planning system began to crumble in the late 1980s with urbanisation and economic pressures and resistance, its legacy is still evident today. South Africa's urban areas, after 22 years of democracy, are still characterised by spatial inequality: jobs and economic activity are generally concentrated around 'urban cores', a disproportionately white elite residing in well-located city cores, with proximity to economic activity and social amenities and a disproportionate black South African population living on the urban peripheries in dense and poorly serviced settlements, far from economic opportunities."
>
> - *High Level Panel on the Assessment of Key Legislation and the Acceleration of Fundamental Change, 2017*[57]

South African human settlements are inextricably linked to the country's socio-economic context. This means that poverty, unemployment, inequality, crime and violence and other challenges have an impact on the sustainability of cities and towns. Digital access of urban residents also tends to follow current patterns of spatial fragmentation (informed by both public and private investment patterns), reinforcing social and economic inequalities[58].

Informality as it relates to settlement and housing form, the way income is generated and how people live in and interact with cities and towns is a worldwide phenomenon that seems to become more and more prevalent in the Global South. Informality is often associated with illegitimate behaviour and with marginalised people and communities, but arguments have been made for it to be acknowledged and accommodated in the planning and design of cities. Informal settlements are a common feature of many South African towns and cities. In many cases they provide new migrants and the urban poor an affordable point of access into towns and cities. However, they are also associated with high degrees of physical and social vulnerability, which add to the challenges faced by residents and authorities. The upgrading of these settlements is often a contentious issue.

Figure 6: Informality in South African cities

2.1.3 Municipal challenges in South Africa

Various challenges exist with respect to municipal engineering infrastructure. In the most recent SAICE scorecard (2017), public infrastructure received an overall grade of D+[59]. The state of South African municipalities is very concerning. In his budget speech in 2018, the then Minister of Cooperative Governance and Traditional Affairs, Dr Zweli Mkhize, said that 87 municipalities – about a third of South Africa's total of 257 – "remain dysfunctional or distressed". He identified two problems. One is systemic and relates to the size and structure of municipalities, while the other is mismanagement due to

"political instability or interference, corruption and incompetence[60]." The Auditor-General of South Africa (AGSA) has also highlighted severe shortcomings. Out of the 257 municipalities audited, only 18 municipalities produced financial statements and performance reports of acceptable quality, and complied with all key legislation, thereby receiving a clean audit[61].

Since 2015, member states of the United Nations have been expected to frame their agendas and political policies for a period of 15 years according to *Transforming our World: the 2030 Agenda for Sustainable Development*. Commonly referred to as the 17 Sustainable Development Goals, it is a "*plan of action for people, planet and prosperity.*" Many of the goals are relevant to human settlements, but Goal 11 deals specifically with sustainable cities and communities: "*Make cities and human settlements inclusive, safe, resilient and sustainable.*"

At the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) held in Quito, Ecuador, in October 2016, a document known as the *New Urban Agenda* was adopted. The purpose of this agenda is to guide national and local policies on the growth and development of cities up to 2036. It shares "*…a vision of cities for all, referring to the equal use and enjoyment of cities and human settlements, seeking to promote inclusivity and ensure that all inhabitants, of present and future generations, without discrimination of any kind, are able to inhabit and produce just, safe, healthy, accessible, affordable, resilient and sustainable cities and human settlements to foster prosperity and quality of life for all.*"

The aspects highlighted above clearly demonstrate the need for a new approach to the development of cities, towns and neighbourhoods that will transform South Africa's apartheid spatial geography and result in inclusive and liveable settlements.

2.2 National policies and initiatives

Although South Africa's 2012 National Development Plan does not specifically promote the concept of smart cities, the plan identifies ICT as a critical enabler of economic activity and envisage an amplified role for ICT.

> "By 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is inclusive and prosperous. A seamless information infrastructure will be universally accessible and will meet the needs of citizens, business and the public sector." "This ecosystem of digital networks, services, applications, content and devices, firmly integrated in the economic and social fabric, will connect public administration and active citizens; promote economic growth, development and competitiveness; drive the creation of decent work; underpin nation building and strengthen social cohesion; and support local, national and regional integration."
>
> - *National Development Plan, 2012, page 190*

Manda and Backhouse[62, 63] identified a number of policy documents that were published in this period that relate to a shift to e-governance and efforts to improve digital access (see Table 2). For more detail on the ICT ecosystem, a supply and demand analysis and an assessment of ICT policy and regulatory outcomes, refer to Gillwald et al[64].

Policy/Strategy document	Date	Content/Aim
Electronic government: The digital future: a public service IT policy framework	2001	This policy document related the South African e-government vision, defined clearly how progress is to be measured and set priorities for ICT in government.
Public Service Corporate Governance of ICT policy	2012	The aim of this policy is to strengthen the governance of ICT as an important resource in the public service. Among others, the framework stipulates that all ICT decisions of importance should come from senior political and managerial leadership and should not be delegated to technology specialists.
National Broadband Policy	2013	Referred to as SA Connect, the broadband policy's objective is to ensure affordable broadband access for all by addressing both supply-side issues such as e-readiness, skills and availability and demand side issues such as infrastructure, regulation and competition.
Cyber-security Policy Framework	2015	The framework aims to strengthen security and improve trust in the cyber environment by providing a safe and secure space for society, business and government to thrive.
National Integrated ICT Policy White Paper	2016	The policy outlines the overarching policy framework for the transformation of South Africa into an inclusive and innovative digital and knowledge society

Table 2: Digital transformation policy and strategy documents[65, 66]

3

A SOUTH AFRICAN INTERPRETATION OF SMART CITIES

A South African interpretation of the smart city concept needs to be informed by the local realities as outlined in Section 2. Smart city initiatives need to respond appropriately to the country's challenges rather than being based on generic models that may not be suitable to the conditions experienced in South Africa. Aurigi and Odendaal caution against pre-packaged, product-like versions of smart cities, referred to by them as a "smart in a box" approach aimed at providing technology-driven solutions to complex social issues[67].

3.1 Understanding 'smart' and 'city'

The international interpretation of the two components of the smart city concept, namely "smart" and "city", is to some extent also applicable to the South African context. Examples of local smart city initiatives demonstrate the focus on (or even fixation with) ICT and related technologies. There also seems to be different interpretations of the term "city". Many metropolitan areas have embarked on some form of city-wide smart city retrofitting initiative. The mechanisms for implementing these initiatives differ, but in many cases they involve the local government in partnership with a multi-national technology company. Furthermore, a number of private developments are being marketed as being smart, while a number of city precinct developments are also being referred to as smart cities.

As mentioned in Section 1.2, many of the international definitions include references to the quality of life. On the surface, the notion of smart cities potentially leading to an improvement in the quality of life of those inhabiting the city may seem noble. However, this promise, or assumption, needs to be interrogated carefully when debating smart cities in the South African context.

> ***It should not be assumed that smart city initiatives would improve the quality of life of all people and communities in the city. Some sectors of society may not gain any value from certain technological 'solutions' due to factors such as the inability to pay, limited technological understanding, mobility challenges and informal living conditions.***

> "What is most problematic with this narrow, sanitized interpretation of the future city is its exclusionary rhetoric. Smart city-in-the-box solutions that envisage a seamless urban experience from the connected home, to the use of Wi-Fi-enabled transport, to the hyper-connected workplace, assume a particular digital citizen who bears little resemblance to those living at the margins."
>
> - *Aurigi and Odendaal*[68]

3.2 The characteristics of an inclusive smart city

It is proposed that the South African understanding of a smart city should be based on the principle of inclusivity. In essence, this means that a smart city initiative should ultimately benefit all people and all communities in the city and improve the well-being of the entire city. The extent to which a smart city initiative would be able to, or be obliged to, benefit different sectors of society will of course depend on the type of "city" being developed. For instance, municipal-driven initiatives may have to address the needs of the entire city, while private sector driven smart developments would have a different target market. However, no smart city initiative should have an adverse effect on certain communities or parts of the community. They should all contribute to the well-being of the relevant municipal area and support the national human settlement visions and objectives outlined in, for instance, the National Development Plan (NDP), the Integrated Urban Development Framework (IUDF), and The Neighbourhood Planning and Design Guide (Red Book). An inclusive smart city would involve the interaction of a number of characteristics, including the following:

i. An inclusive smart city is smart for all.
ii. An inclusive smart city uses ICT as an enabler rather than a driver.
iii. An inclusive smart city is shaped by, and responds to, the local context.
iv. An inclusive smart city is co-produced by the community.
v. An inclusive smart city embraces appropriate partnerships and innovation.
vi. An inclusive smart city is a sustainable and resilient city.

i An inclusive smart city is smart for all

An inclusive smart city should incorporate a portfolio of smart technologies and initiatives that would collectively contribute to improving the well-being of the city as a whole. Many aspects should be considered, including the following:

- Do not assume that all people are "tech-savvy" digital citizens that have the knowledge and skills to effectively use digital technologies to communicate with others, participate in society and create and consume digital content[69]. If a municipal service can only be accessed or provided via a smart technology (ICT), some sectors of society may be negatively affected and further disadvantaged or marginalised. For instance, if appointments to make use of a service can only be made online, those who may not be computer literate or do not have access to a computer or similar device will be unable to make use of the service.

- Accommodate the needs of people with disabilities. A smart technology or initiative should be accessible to the widest possible range of users including people with illnesses or disabilities (temporary or permanent) that affect aspects such as their mobility, balance, sight, hearing, touch, memory, strength, stamina, etc. Adhere as far as possible to the principles of universal design (see The Neighbourhood Planning and Design Guide[70] for more information).
- Incorporate the needs of marginalised sectors of society such as immigrant communities and those living in informal settlements when implementing smart technologies and initiatives at a municipal level. People living in backyard shacks or in overcrowded accommodation in the city centre and other parts of the city may also influence the way in which a smart city should be conceptualised.
- Be aware of the challenges faced by those who are entirely dependent on public transport and who do not have access to a private vehicle to move around in the city. Without a safe, reliable, effective and efficient public transport system, a smart mobility initiative may not be successful. Without first addressing the basic needs of these commuters, smart technologies and initiatives may have a negative effect on their quality of life.
- Poverty could exclude a substantial section of society from the benefits of a smart city if only those with adequate financial resources can make use of the smart technologies and initiatives available. For instance, if a service made available to people require them to have access to an electronic device with sufficient data, a significant proportion of a city may not be able to utilise the service due to financial constraints.
- The lack of access to adequate education could exclude a section of society from participating in smart city initiatives if a certain level of literacy is required. Certain smart technologies and initiatives can only be used by, or be of use to, people with a certain level of basic education and the resultant intellectual abilities.
- The role of the informal economy in the city should not be underestimated. Informal traders and service providers may make a significant contribution to the well-being of the city as a whole. Smart city initiatives could play a meaningful role in supporting informal economic activities.

> Smart city initiatives should not be implemented at the expense of, or to the detriment of, certain parts of the city or certain sectors of society. This means that a smart city should ultimately benefit all those residing in the city, not only those with sufficient financial and other resources and enough of an understanding of technology to allow them to make use of smart initiatives.

ii An inclusive smart city uses ICT as an enabler rather than a driver

Smart city initiatives should make use of ICTs as enablers rather than an end in itself. Smart responses to urban challenges are not limited to the application of digital technologies only. Opportunities should be identified to incorporate innovative and intelligent approaches involving a range of technologies and appropriate interventions.

> "A city is not smart because it uses technology. A city is smart because it uses technology to make its citizens' lives better."
>
> - *Smart Cities Council, 2015*

Care should be taken not to utilise technologies that would further marginalise the poor and vulnerable groups. Ignoring the fact that many people may, for instance, not have the financial means to make use of ICT-based initiatives, or may not be IT literate, or may not have access to ICT equipment and services, may contribute to a widening of the digital divide (see Section 1.4.5). Opportunities to include all communities in all aspects of the city should be explored. For instance, technologies could be utilised to improve the lives of all, not just the more affluent.

> ***Questions, therefore, remain on how distributed the benefits of smart technologies are. Material solutions such as smart grids and water consumption monitoring devices provide innovative operational solutions but largely bypass those falling outside the ambit of networked infrastructure[71].***

iii An inclusive smart city is shaped by, and responds to, the local context

A smart city in Rwanda will not look similar to a smart city in South Africa, nor should they. Likewise, a smart city in Gauteng may look different to a smart city in KwaZulu-Natal. This can be partially ascribed to the fact that the settings where smart city initiatives are implemented differ considerably. Challenges that cities face are not only complex and diverse, but also very specific. The development of different smart cities therefore each represent a particular journey, informed by a range of factors rather than a predetermined vision of what an "ideal" smart city should look like.

When planning any form of smart city, the local conditions need to be carefully considered to ensure that appropriate technologies and initiatives are implemented. The local context includes country-wide factors such as poverty, inequality and unemployment. Other challenges experienced throughout South Africa relate to the characteristics of South African cities (e.g. informality) and municipal capacity (e.g. the lack of infrastructure maintenance) as discussed in Section 2.1.

In addition to the macro-level context, decisions regarding a smart city initiative should be informed by the characteristics of the specific city or municipal area for which the smart city initiative is planned. Micro-level features (physical, social, cultural, etc.) should be acknowledged, as should the needs, priorities, aspirations and resources of the people who will inhabit the city.

> "The conceptualisation of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents."
>
> - *Smart Cities Mission, Ministry of Housing and Urban Affairs, Government of India*[72]

iv An inclusive smart city is co-produced by the community

The active participation of the community in the identification, development and implementation of smart city initiatives could contribute significantly to the success of the initiative. The following aspects need to be considered:

- Active participation means more than mere consultation. The Red Book describes community participation as follows: "When implementing a project, a consultative process often merely involves asking key stakeholders for their opinions about proposed interventions. This does not allow for meaningful involvement in the decision-making process. A participatory process, on the other hand, requires people to be actively involved in decision-making from the very beginning of a project that would affect them. They should participate in the planning, design implementation and management aspects, rather than only being involved after most of the critical decisions have been made[73]."
- Community participation is not an event such as a workshop that needs to be completed before a next step could be taken. It should be seen as an integral part of the entire process and the fundamental approach that governs all aspects, from inception through to implementation. This approach requires the community to be involved in all aspects of the development and implementation of an initiative (including the conception, planning, design, delivery and management phases) rather than being mere passive recipients. This is often referred to as co-production.

> "The concept of co-production can be described in various ways. Essentially it means that those providing a service, and the citizens who make use of the service, all have contributions to make. The process is based on the notion that those who make use of a service are often in the best position to assist with the development of the most appropriate service."
>
> - *The Neighbourhood Planning and Design Guide (Red Book)*[74]

- The term community could refer to all role players, stakeholders and affected parties relevant to the proposed initiative. These include residents, the business community (formal and informal), universities, research organisations, government departments and industry.

- Another aspect of community participation relates to the contribution that the community could make once an initiative has been implemented. They could provide feedback to assist with the improvement of the initiative, they could contribute by sharing information and data, and they could assist with monitoring and evaluation processes.

v An inclusive smart city embraces appropriate innovation and partnerships

Linked to the participatory approach described above, collaborating with appropriate partners could play a significant role in the success of smart city initiatives. The key is to establish partnerships that will contribute to the success of the initiative and support the overall aim of creating an inclusive smart city. It is therefore important to identify reliable partners that share the same values and objectives. Partners would have different motivations for participating in a smart city initiative, and it may sometimes be difficult to reconcile, for instance, the purely commercial intentions of some partners with more benevolent intentions of others. Partners could represent a range of interest groups, including the ICT industry, business (often technology companies), academia and the research fraternity.

A smart city should ideally be a collection of several projects, initiatives and actions that originate from both the public and the private sector and from citizens themselves[75]. Some initiatives may be implemented at a municipal level, focusing on providing city-wide access to technology; implementing new thinking to the provision of engineering services; or integrating data from different systems into a central operations centre. Other initiatives may be aimed at the neighbourhood level, involving citizens through social media and mobile applications to create responses to issues that matter to them and that may enable behaviour change. Local knowledge can be used to develop simple but innovative responses to everyday challenges.

Regardless of the level of implementation, partnerships could foster innovation and creativity and allow for the testing of new ideas. Smart city initiatives could unlock opportunities to approach urban challenges in innovative ways, apply new thinking to old problems, or use ICT to allow for efficient operations. Smart cities could allow for the testing of new ideas, a notion that is reinforced by Taylor Buck and While:

> ***Whilst critiques of the smart city as discourse are well-founded, there is a danger that they overlook the necessarily experimental and emergent nature of smart city restructuring[76].***

Partnerships need to be carefully managed, and roles and expectations should be clearly understood by all partners. Rightly or wrongly, smart city agendas may sometimes be driven by the private sector rather than by the government. However, it is the role and duty of local government to ensure that smart city initiatives are guided by the relevant urban development and planning policies, strategies, plans and frameworks.

vi An inclusive smart city is a sustainable and resilient city

There are various definitions of a sustainable city. For instance, the South African Cities Network describes it as "…an urban form of development that meets the needs of the present without sacrificing the ability of future generations to meet their own needs. It is characterised by low ecological footprint, lowest quantity of pollution possible, efficient use of land, recycling and re-use of materials and conversion of waste to energy[77]."

> A smart city should also be a sustainable city. Smart technologies and initiatives should contribute to the development of sustainable human settlements in South Africa as described in The Neighbourhood Planning and Design Guide (Red Book):
>
> *Sustainable human settlements are liveable, vibrant, diverse, resilient and valued; they are socially integrated, economically inclusive places where residents feel safe and in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence*[78].

A resilient city has the ability to deal with and prevent chronic stresses and acute shocks. Chronic stresses could be caused by longer-term disasters such as extreme levels of crime and violence, poverty and inequality. Acute shocks could be the result of floods, storms, fires, disease outbreaks, droughts and earthquakes. Extreme weather conditions often cause sudden, devastating disasters, and due to climate change these conditions are becoming more and more common. Cities need to be prepared for these disasters and be able to withstand the consequences. A resilient city has the ability to survive different stresses and shocks, can adapt to the changing conditions, and can recover from such catastrophic disruptions.

Smart technologies and initiatives do not necessarily ensure a city's sustainability and resilience. Similarly, a smart city is not inevitably also a sustainable and resilient city. It is therefore important to consciously incorporate the principles of sustainability and resilience into smart city initiatives.

4

FACTORS TO CONSIDER WHEN PLANNING SMART CITY INITIATIVES

4.1 What is your interpretation of a smart city?

It is apparent that the term "smart city" means different things to different people. Furthermore, the manifestation of smart city initiatives differs vastly between cities and countries. Therefore, the key to interpreting the concept of a smart city in South Africa lies in understanding the particular local context. An intervention could then be developed that responds appropriately to the specific needs, challenges and opportunities as well as the aspirations of the local authority and all the people it serves.

Be clear on what your understanding of a smart city is, and what would be the most appropriate interpretation for your context.

> Do you want to introduce city-wide changes that will improve the effectiveness and efficiency of services or systems at a municipal level? Do you want to develop a smart precinct for the affluent? Do you want to improve services to create better living conditions for the poor? Is it merely a city that incorporates various technologies, including ICT? Alternatively, is it a city that functions effectively and efficiently, and the use of technology, including ICT, contributes to this where appropriate?

A shared understanding of the aims and objectives of your smart city initiative is critical. As a start, you need to agree on the interpretation of "smart" and "city" (see Section 1.2.3).

4.1.1 What is smart?

Be clear on what you regard as "smart". The term "smart" is commonly associated with a range of technological and digital concepts and interventions (especially ICT) and early definitions of smart cities tended to emphasise the technologies to be used.

There seems to be a growing realisation that 'smart' technologies should not be implemented without considering its impact on issues such as social inclusion and sustainability. In addition, there is not always agreement on what could be classified as "technology" in the wider sense of the word. For instance, innovative approaches and processes, and non-conventional interventions may also be regarded as "smart".

A shared understanding of "smart" should be developed in collaboration with all relevant role players. Role players may have different motivations for participating in a smart city initiative, and it may sometimes be difficult to reconcile, for instance, the purely commercial intentions of some entities with more altruistic intentions of others.

4.1.2 What is a city?

Agree on the meaning of the word "city" for a specific smart city project or initiative. Smart city interventions can be aimed at a part of the city (e.g. a precinct upgrade or a new gated community), the city as a whole (e.g. providing city-wide access to a smart transportation system) or a greenfield development outside of an existing city (which may or may not be linked to an existing city).

> Agreement on what a "city" means will not only inform the scope of your smart city project or initiative, but will also ensure a better understanding of the role of your project within the wider city. Whether an initiative will be implemented municipality-wide or within a neighbourhood or precinct, it is essential to determine how the initiative will relate to other (smart or conventional) projects.

Another aspect that could be considered relates to the nature of the smart city initiative. For instance, do we want to identify a theme or focus area for our smart city initiatives? How do we decide which theme would be the most appropriate to focus on? E.g., do we want to focus on becoming a connected city by, for example, providing free Wi-Fi to all communities? Whichever theme we choose to focus on we need to ask ourselves whether we have the capacity, resources and capabilities to implement and maintain such an initiative.

4.1.3 How do we ensure that we create inclusive smart cities?

An inclusive smart city should ultimately benefit all people and all communities in the city and improve the well-being of the entire city. While different initiatives would be focused on benefitting different target markets (e.g. municipality-driven smart city initiatives may have to address the needs of the entire city, while private sector-driven smart city initiatives will likely focus on a portion of the city population), no smart city initiative should have an adverse effect on certain communities or parts of the city population.

An inclusive smart city would involve the interaction of the following characteristics (as discussed in Section 3.2):

- An inclusive smart city is smart for all.
- An inclusive smart city uses ICT as an enabler rather than a driver.
- An inclusive smart city is shaped by, and responds to, the local context.
- An inclusive smart city is co-produced by the community.
- An inclusive smart city embraces appropriate partnerships and innovation.
- An inclusive smart city is a sustainable and resilient city.

4.2 Ask the right questions to make smart decisions

The following questions are often asked in discussions about smart cities: How smart is our city? How do we make our city smarter? How can we measure how smart a city is? What smart technologies could we implement? These questions may result in responses that focus on smart for the sake of being smart, or employing technology for technology's sake. Being smart should not be an end in itself, it should be the means to an end.

> ***Smart city initiatives should first and foremost be aimed at improving the lives of the people residing in the city.***

To ensure that this remains the focus, the right questions need to be asked to determine what the motivation is of those wanting to make a city smarter. At the most basic level, it is suggested that a smart city initiative should be informed by the answers to the following questions:

- Are the people living in our city or town satisfied with the services we (local government) provide? If not, improving the delivery of basic services should be the first priority, rather than a smart city initiative that may not satisfy people's most pressing needs.
- How can the city become smarter and use smart technologies to enhance the effectiveness and efficiency of the services we deliver to improve the quality of life of those we serve as a local government?

Start with identifying the challenge you need to address and the results you would like to achieve. Then consider the various options that could assist you, including adjusting a process or procedure, or adopting new ways of dealing with challenges.

4.3 A smart-readiness decision-making framework

The decision-making framework summarised below provides municipalities and other role players with guidance on the planning of smart cities. The framework is structured as a two-pronged assessment and decision-making process to determine the readiness of municipalities to become smarter, involving the following:

- **Pre-conditions** for becoming smarter: The first step is to assess the municipality and the current situation to gain an understanding of the ability of the municipality to provide services under current conditions. The intention is to establish whether there is a strong foundation on which to build a smart city initiative, or, phrased differently, whether the basics are in place.
- **Enablers** for implementing smart city technologies: The second step is to assess where the municipality could improve its ability to deliver services. The purpose of this assessment is to establish whether the municipality has the means and ability (or can acquire the ability) to harness and leverage smart technologies and initiatives to improve the effectiveness and efficiency of the services delivered.

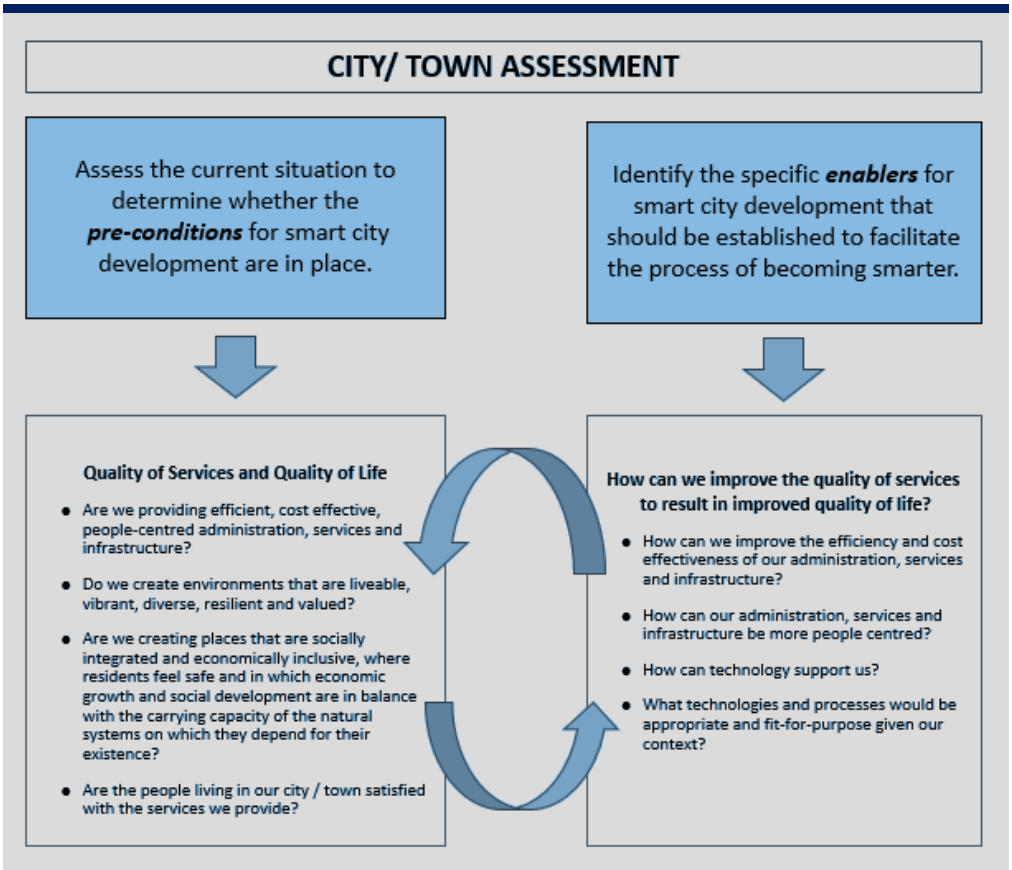

Figure 7: A smart-readiness decision-making framework

4.3.1 Pre-conditions for becoming smarter

This component of the smart-readiness framework involves an assessment of the current conditions in a city with respect to, for instance, the existing engineering infrastructure, the facilities, amenities and housing available to residents, the ability of the municipality to deliver services, the governance structures and the available financial resources. These aspects could be grouped into three interlinked clusters:

- Institutional and organisational arrangements
- Existing infrastructure
- Capacity of government officials and communities

i Institutional and organisational arrangements

Aspects to consider include the robustness of current governance structures, levels of cooperation within the municipality, levels of cooperation between the municipality and role players outside the municipality, policies and by-laws, effectiveness of business processes, and vacancy levels.

ii Existing infrastructure

This step involves an assessment of existing municipal infrastructure, facilities, amenities and housing with respect to, for instance, their quality or condition, quantities or the number per population (where

appropriate), their age, their distribution across the city, backlogs and the planned future developments.

iii Capacity of government officials and communities

In addition to an assessment of physical infrastructure, an assessment also needs to be conducted to establish if the human resources are available to utilise the infrastructure. People are required to provide services and maintain infrastructure. Factors to consider include people's knowledge, skills, competencies, experience, qualifications, attitudes, values and past performance, as well as possible re-skilling and training programmes that may be required when implementing a smart city initiative. Another critical aspect to consider relates to the capacity of communities to participate in and contribute to smart city initiatives.

4.3.2 Enablers for implementing smart city technologies

The assessment of the pre-conditions will assist in reaching an understanding of where a municipality's challenges or 'pain points' are. This will guide the direction of the second component of the decision-making framework, which involves the enablers as discussed next.

i A smart city plan

The drive to become smarter should be a coherent effort across the municipality and it is dependent on partnerships with the business sector, communities and other spheres of government. To enable this, a comprehensive smart city plan or strategy should be developed. All smart city initiatives and technologies should work together to advance the objectives of the municipality and the smart city plan should therefore support the vision as set out in the IDP. Questions that should be answered include the following:

- Do we need a city-wide strategy?
- Do we need sector-specific strategies dealing with specific smart city initiatives, e.g. a strategy focussing on smart water initiatives?
- How do we link our intended interventions with existing plans, e.g. the IDP?
- Do we need to develop a focussed smart city strategy, or do we integrate smart city initiatives into other projects and programmes?
- Do we need to develop a focussed implementation plan for smart city initiatives or do we incorporate these initiatives into other plans?
- How do we ensure that our smart city initiatives contribute to the development of a sustainable and resilient city and also address climate change and natural resource challenges?
- Can the strategic intent and vision be translated into reality by those responsible for implementation? In other words, are the strategic / management decisions synchronised with the realities at an operational level?
- How do we link smart city initiatives to a budget, especially if such initiatives are cross-cutting and involve various departments and role players?

- How does a smart city strategy relate to line functions, and how would progress and impact be monitored and measured across the city?
- How is synergy across the city strengthened to enable the smooth implementation of a smart city initiative?

ii Digital infrastructure

The availability and quality of digital infrastructure are important for smart cities. In this instance, digital infrastructure refers to the physical assets required to operate technologies such as digital communication, computing or data storage. To enable smart city development, digital infrastructure is required to collect data, bring the data to a central point, and then analyse the data to make it useful. The following should be taken into consideration:

- What types of instrumentation do we need (meaning a network of sensors that has the ability to detect, sense, measure and record real-time data)?
- What type of interconnected and integrated systems do we need (i.e. a system that has the ability to communicate and interact with users, operators and managers)?
- What type of systems do we need that has the ability to analyse the situation, enable quick responses and optimise solutions (how do we gain useful intelligence)?

iii Skilled people

To enable smart city implementation, people with the right skills and abilities in the right places are critical. It is the people, not just the technology, which makes a city smart and therefore municipalities will have to extend investments beyond technology and data to investment in human resources. In some instances it may be possible to upskill or retrain existing staff, but in other instances people with specific competencies may have to be employed. The possibility of certain skills becoming redundant as a result of implementing smart technologies should be carefully considered. Decisions need to be made regarding the following:

- Would we need to employ people with specialist skills and experience to implement a particular smart city initiative?
- Would we be able to upskill existing staff to operate and maintain technologies associated with a smart city initiative?
- What skills/competencies would we require in future to support and maintain smart interventions?
- Do our politicians and officials have the willingness and ability to embrace change and accept innovations and smart interventions? Do all involved share the same vision?

iv Partnerships

Collaborating with appropriate partners could play a significant role in the success of smart city initiatives. The key is to establish partnerships that will contribute to the success of the initiative and support the overall aim of creating an inclusive smart city. It is therefore important to identify reliable partners that share the same values and objectives. Partners would have different motivations for participating in a smart city initiative, and it may sometimes be difficult to reconcile, for instance, the

purely commercial intentions of some partners with more benevolent intentions of others. Partners could represent a range of interest groups, including the ICT industry, business (often technology companies), academia and the research fraternity. The following need to be resolved:

- Who should take ultimate responsibility for the coordination of our smart city initiative?
- How do we ensure that all relevant departments participate meaningfully in such initiatives?
- How do we measure performance and impact of cross-cutting smart city initiatives?
- How do we improve synergy between various role players with different mandates and performance indicators to ensure the success of smart city initiatives?

v Community involvement

The active participation of the community in the identification, development and implementation of smart city initiatives could contribute significantly to the success of the initiative. The term community could refer to all role players, stakeholders and affected parties relevant to the proposed initiative. These include residents, the business community (formal and informal), universities, research organisations, government departments and industry. Smart city initiatives allow city citizens to co-create their living environments by becoming active role-players that provide data that feed into the smart city system and contribute to better decision-making. However, it is important to consider the fact that many people may, for instance, not have the financial means to make use of ICT-based initiatives, or may not be IT literate, or may not have access to ICT equipment and services.

Decisions need to be taken regarding the development of a portfolio of smart city initiatives that includes various components that combined will ultimately benefit all communities. This means that some initiatives could be aimed at more affluent communities and others could benefit the poorest people living in the city, as long as none of the initiatives disadvantage a specific segment of the city's inhabitants.

5
CONCLUSION

In view of the growing interest in smart cities worldwide, and particularly in South Africa, there are numerous opportunities for the CSIR to contribute to the development of inclusive smart cities.

Local government and other role players need impartial decision-support to develop smart interventions that are appropriate to their specific context. Cities and towns are increasingly pressured to become smarter. It is not always possible for municipalities to access unbiased, factual information about smart city initiatives and technologies. Some companies offering support are suppliers of technologies, and may therefore not always provide impartial information because of perceived or real vested interests.

The CSIR is an independent, unbiased thought leader on smart cities within the South African context. As an impartial organisation, it can provide comprehensive decision-support and other services. The multi-disciplinary CSIR team includes specialists in the fields of human settlement planning, design and management, technology (including ICT), building design, transport, solid waste, climate change adaptation, water and energy.

Various services could be provided to a range of role players, including local government. The services could include the following:

- Building the capacity of local government officials, councillors and other role players with respect to the smart city basics and the South African interpretation of inclusive smart cities.
- Assessing cities and towns to determine their smart-readiness.
- Developing smart city strategies, policies, implementation plans etc.
- Supporting local governments with the implementation of smart city initiatives.
- Supporting local governments with the preparation of specifications for smart technologies.
- Assisting municipalities with choosing the most appropriate smart technologies.
- Developing smart technologies, processes and initiatives that support the creation of inclusive smart cities.

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