Chapter 1
Unveiling the Smart City: How Smart Is It?

Abstract The emerging concept of Smart Cities brings about promises of increased efficiency and performance of urban areas through the use of specialised digital technology. With an aim to promote innovation, this is prompting a wide adoption in high- and low-income economies as most countries embark on strategies to use the concept to boost foreign investment and financial confidence and to showcase national innovation. However, as the demand for the technology inherent in Smart Cities booms, questions arise as to whether the concept is promoted primarily by ICT corporations driven by profit-making and merely equates supply with demand without any other fundamental values for creating a better future. We suggest that Smart City technology needs to be driven by these deeper values and be integrated into delivery of solutions to multiple local and global needs. This chapter explores this conundrum and showcases the need for tailored solutions rather than "off-the-shelf" technology, as is mostly offered by ICT corporations, and outlines how deeper values as set out through UN processes about sustainability and climate resilience are now essential components of how Smart City is imagined. It also introduces the concept of regenerative design that will be needed to guide how Smart City technology is procured and delivered in the future as an integrated approach to the future city.

1.1 Introduction

The Smart City concept has gained traction and support throughout the world and is now considered as a global phenomenon. The concept only started around 1997, as advanced by Graham and Aurigi (1997). Before this, scientists and engineers from different parts of the world are documented to have only been simulating virtual cities, mirroring most of the concepts known to be associated with today's Smart City concepts. Anthopoulos (2017) supports that this drive to run simulations to further explore alternative solutions was driven by factors like lack of green spaces, violence and insecurity and perceived reduced civil interactions, among others. Such simulation of virtual cities was enabled by the World Wide Web (WWW) and the spread of Internet such that people could make use of devices to interact

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virtually. Those advances, through the virtual city concept, helped to steer transformation toward a digitally oriented city, as advanced by van den Besselaar and Beckers (1998), and unlike the virtual city, it was seen to promote the need for space to enable social and human interaction, and since the idea was actualized via the Internet, it provided the opportunity for an increased interaction beyond the limitations of physical locality. The virtual and digital city concepts were furthered with the integration of urban management centres in the form of digital platforms for local administration and for citizens to interact, especially for information collection and sharing. Anthopoulos (2017) suggests that promoters of these two concepts that are akin to today's Smart Cities perceived urban spaces as interlinked 'islands of communities' that provided those living in them the opportunities to benefit from services and information accessed via the Internet. Ishida (2017) suggests that the concept of digital city was launched in Kyoto in 1998 and provided the opportunity for human interactions to be captured via cameras and simulations that were projected in the form of animations resulting in 2D and 3D virtual spaces.

Other terminologies have been used over the years that can be viewed to have helped create the Smart City concept. Such terminologies like the information city, ubiquitous city and intelligent city have been, in one way or the other, used to describe a city that incorporates the power of information communication technology (ICT) in its core activity. Anttiroiko et al. (2014) believe that the practice of Smart Cities initially started as the virtual city, which has been developed in a more sophisticated manner.

The range of technologies that today are associated with a more sophisticated and complex idea of Smart Cities have emerged from ICT technologies and consist of Internet of Things (IoT), big data, crowdsourcing, machine learning, artificial intelligence, digital twins, mobile connectivity (e.g. 4G and 5G) and blockchain technologies, among others (Allam 2018a, c; Allam and Dhunny 2019; Huiling and Goh 2017). Sepasgozar et al. (2018) claim that these technologies have become the cornerstone of Smart Cities since they offer platforms for installation of 'smart' components and infrastructures and offer systems that allow for real-time collection of big data and analysis of the same. The different varieties and increasing quantity of smart devices and sensors installed in cities, coupled with the advancement in social networks provided by ICT, allow city managers and other stakeholders to gather, analyse and react to emergent data. Thus, real-time action can be analysed to enable better efficiency, speed, scalability and flexibility in almost any kind of urban activity.

It is not surprising then to see that these 'smart' technologies could or even should play a significant role in transforming the design, planning and management of urban life, especially in addressing issues related to healthcare, traffic, communication, environmental sustainability and economic growth. These issues have occupied us for most of the past decade as we tried to define whether Smart City was doing all that it promised or whether it needed to be redefined (Allam 2018b; Allam and Jones 2018a, b; Allam and Newman 2018a; Khan et al. 2017).

Despite the notable benefits and promises of the Smart City concept, there are some reservations demonstrated by both individuals and organisations, like the

United Nations (UN) (Allam 2018a; Allam and Newman 2018b). It is important to see that the response by the UN to this concept has been very guarded. The global debate about future cities has many dimensions and contributors, and there was much written about the importance of the United Nations Sustainable Development Goals for 2015–2030, which now include an urban goal SDG11: 'inclusive, safe, resilient and sustainable cities'. This goal (SDG11) has 10 targets and 14 indicators, but it is of interest that in all these words about what cities need to do, none are saying that we should have Smart Cities, despite the increasing use of the term. The reason apparently is that Smart Cities are seen to be essentially a branding war between different multinational corporations in the ICT space. In a 2016 report by the Economic and Social Council (ECOSOC) of the UN (United Nations 2016), these reservations are pronounced. The report acknowledges that the Smart City concept has the potential to address issues related to urbanization trends and to help in achieving the Sustainable Development Goals (SDGs), but it raises some concerns. The challenges are seen to be tied to the implementation of the concept and include (1) localisation of smart infrastructures, (2) lack of skilled labour, (3) financing challenges, (4) application of a suitable governance model and (5) the challenge of inclusion. The report is particularly critical of the lack of inclusive models in the delivery of the Smart City.

Most critics of Smart City strategies that are being proposed are seen as being borrowed from other geographical locations and areas where the programs have apparently been successful; hence, they fail to address the local development challenges. By failing to integrate local solutions to Smart City programs, issues like security and privacy concerns become prominent, and social inequality is deemed to increase. For instance, despite the increased adoption of Smart City concepts in different geographies, cases of homelessness have been on the rise (Bezgrebelna et al. 2021). Such are attributed to factors like gentrification, prompted by impacts of application of 'smart' technologies in cities, making cost of living untenable for most of the residents (Wilhelmsson et al. 2021).

Though the concerns by the UN and others like Yigitcanlar et al. (2018), Mosenia and Jha (2017) and Alomair and Poovendran (2014) are valid and demand attention, the concept of Smart City is still very popular, and we too believe it has considerable potential (Allam and Newman 2018b; Braun et al. 2018). However, there is a particular need to redefine Smart City to enable it to reach its full potential.

The solution, as set out in this book, is for cities to take the goal, targets and indicators and see how they fit the kind of technological opportunities that are emerging as the Smart City. Perhaps in this way, the Smart City can be revised into being more than an economic tool in the tradition of modernist systems of change and rather stand as an accelerator for 'inclusive, safe, resilient and sustainable cities'.

1.2 The Adoption of Smart Cities

Even though Smart Cities are well used in popular and academic literature, a proper definition is still debatable (Albino et al. 2015; Chourabi et al. 2012). Table 1.1 sets out six definitions based mostly on the reviews done by Chourabi et al. (2012) and Cocchia (2014). Often the definitions are just what a 'good' city should be while others emphasise technology.

What is universally agreed is the potential use of the concept to solve numerous urban challenges where data analysis could help. However, numerous stakeholders have capitalised on the concept as a branding tool to encourage an increased adoption by numerous cities, especially for surveillance and security purposes. The perceived popularity of 'Smart Cities' in contrast to its less favourable counterparts like 'sustainable cities' and 'resilient cities' is probably because the proponents of smart technologies are not seriously addressing the issues of resilience and sustainability. This book seeks to address that issue.

The term sustainable cities emerged with the need for cities to address sustainable development (Satterthwaite 1997), while 'resilient cities' emerged with the question of planners and designers of how to quickly and efficiently recover from urban perturbations, often linked with climate change (Vale 2014). A comparative analysis (Fig. 1.1) of the terms 'Smart Cities', 'sustainable cities' and 'resilient cities' (Google 2018a, b) shows that the term sustainable cities was more popular until late 2010. Following this, the term Smart Cities emerged as most popular. In August 2015, the terms 'resilient cities' was factored at 3% and 'sustainable cities' at 5% in comparison with the popularity of 'Smart Cities', which was at its peak. This trend underlines questions as to how Smart Cities gained popularity as opposed to its counterparts.

Cocchia (2014) suggests that the keywords smart, intelligent, knowledgeable, sustainable, digital and ubiquitous have often been associated with cities that have embraced the use of ICT to address various urban issues. Those are in turn made to appear and have evoked a sense of 'modernity' which most cities, particularly low-income and emerging economy cities, aim to achieve. Beside the catchy keywords, the associated technologies that render improved urban fabrics provide an aura of modernity through order and synchronicity. Issues like traffic, housing, water and energy provision, security and the environment are thus possible to be addressed in this kind of branding. Those can even be made to positively impact on branding through cultural and artistic dimensions of cities and improve on its infrastructure, all with an aim of improving a societal sense of belonging (Allam 2018b). To et al. (2018) show this very clearly by asserting that smart infrastructures as included in high rise buildings, transportation routes, recreation centres and street lighting projects are not only proposed to make cities 'smarter' but are designed in such a way that they embrace 'modernity', which in turn helps to improve urban economic status. For instance, it has been noted that cities such as Singapore, Tokyo, Barcelona, Amsterdam and Copenhagen, among many others, have improved on their attraction by adopting the Smart City concepts (Gascó-Hernandez 2018; Joss et al. 2019;

Table 1.1 Proposed definitions of Smart City adapted from Chourabi et al. (2012) and Cocchia (2014)

Author/s	Definition
Giffinger et al. (2007)	A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens
Hollands (2008)	A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens
Harrison et al. (2010)	A city 'connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city'
Natural Resources Defense Council (2018)	A city striving to make itself 'smarter' (more efficient, sustainable, equitable, and livable)
Toppeta (2010)	A city 'combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, in order to improve sustainability and liveability'
Washburn et al. (2009)	'The use of smart computing technologies to make the critical infrastructure components and services of a city—Which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—More intelligent, interconnected, and efficient'
Setis-Eu (Cited in Cocchia 2014)	'Smart City is a city in which it can combine technologies as diverse as water recycling, advanced energy grids and mobile communications in order to reduce environmental impact and to offer its citizens better lives'
Dameri (2012)	'A Smart City is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development'
Northstream (2010)	'Concept of a Smart City where citizens, objects, utilities, etc., connect in a seamless manner using ubiquitous technologies, so as to significantly enhance the living experience in twenty-first century urban environments'
Hall et al. (2000)	'A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens'
Su et al. (2011)	'Smart City is the product of Digital City combined with the internet of things'
IBM (2010)	'Smart City is defined by IBM as the use of information and communication technology to sense, analyze and integrate the key information of core systems in running cities'
California Institute (2001 cited in Cocchia (2014 #287))	'A smart community is a community that has made a conscious effort to use information technology to transform life and work within its region in significant and fundamental rather than incremental ways'

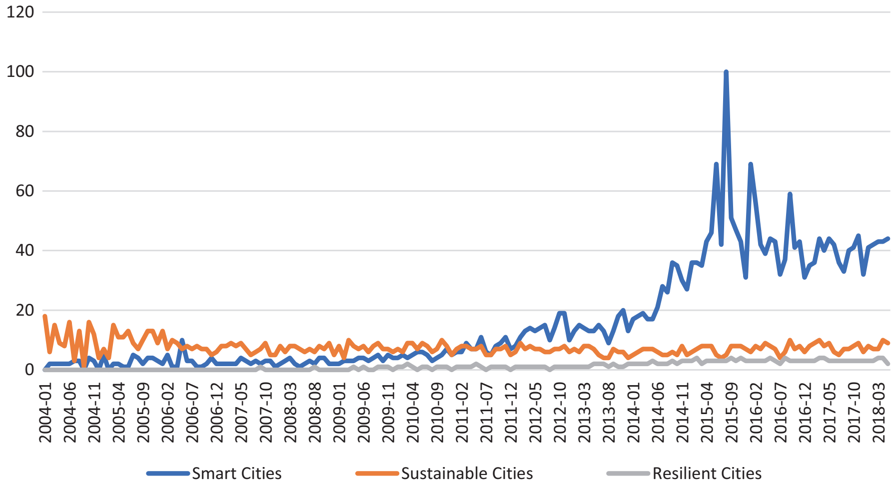

Fig. 1.1 Number of searches for three types of cities worldwide. (Google 2018a, b)

Rohaidi 2018; McKinsey & Company 2018a, b). Interestingly, a majority of these cities have managed to include sustainable development agendas which also helps in improving economic growth, as advanced by Trindada et al. (2017). But they are an afterthought, not the mainstream purpose which is to assert that digital data capacity can solve most problems.

The concept of Smart Cities has been gaining momentum around the world as set out in Figs. 1.2 and 1.3 though, as Fig. 1.2 suggests that it may have peaked in 2015.

The popularity of Smart Cities projects and programs has been mushrooming across the globe, such as in India, China, UAE, South Korea and even in small island developing states like Mauritius (Datta 2015; Glasmeier and Nebiolo 2016; Nam and Pardo 2011; Allam 2017; Kitchin 2014). Data from 2004 to 2018 was sourced from Google Trends (Trends 2018), and the y-axis on both Figs. 1.1 and 1.2 highlights the popularity (ranging from 0 to 100). A study of the term 'Smart Cities' surprisingly highlights that Smart Cities are most popular in Mauritius (Fig. 1.3), and a case study on these Smart Cities is presented below.

Kolotouchkina and Seisdedos (2017) explain that cities such as Songdo in South Korea and Masdar in Abu Dhabi, among others, have managed to tap into the perceived status of Smart Cities to rebrand their cities as attractive destinations based on place-branding strategies. However, over time, those have been unable to fulfil their original branding as eco-cities or Smart Cities. Smart city branding has been sought by many cities from low-income and emerging economies. Mancebo (2020) further suggests that the Smart City concept has become a successful branding tool that has allowed cities to maintain a competitive edge while highlighting their potential technological throughputs. Sofeska (2017) contends that this branding is advanced by the adoption of seemingly high-tech strategies aimed at the improvement of resilience and liveability status of cities, for the aim to rank higher in liveability

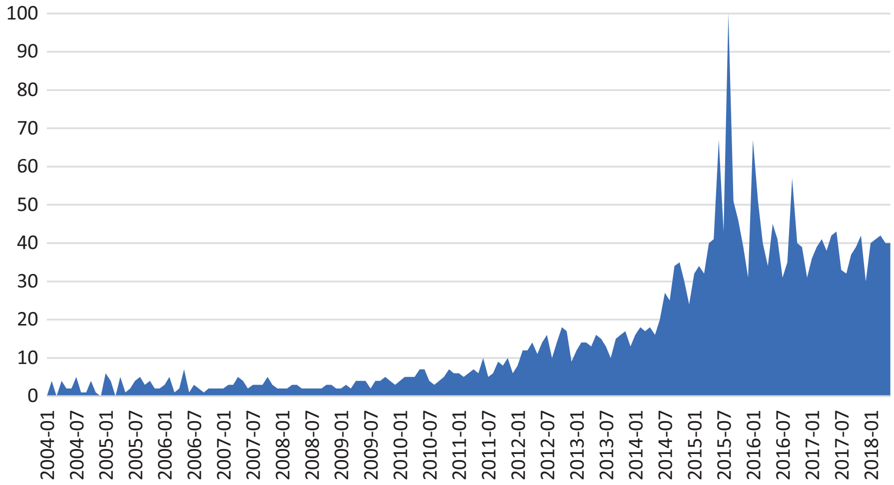

Fig. 1.2 Relative number of hits for Smart Cities searches in Google between 2004 and 2018. (Google 2018a, b)

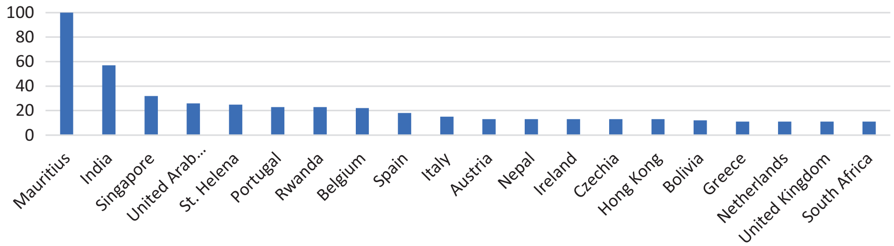

Fig. 1.3 Countries with most searches for Smart Cities between 2004 and 2018. (Source: Google Trends Explore)

status indexes. But there is little obvious direction as to how digital data capacity can actually do that in any of their strategies.

At the centre of this branding is the use of big data, automation and other technological advancements that are now synonymous with Smart Cities (Allam and Dhunny 2019). The data generated by the numerous and diverse number of installed 'smart' components across a range of networks are generally hoped to interact between each other. Indeed, technologies such as IoT (Bruneo et al. 2019; Bibri 2018), machine learning, cloud computing and even blockchain technologies (Barkham et al. 2018; Souza et al. 2016) can allow Smart Cities to automate different aspects of urban life in a coherent way, but these technological options must be given policy and strategic direction. The associated employment opportunities that have come from each of those smart technologies is used to further support its branding strategies but the ability to show each of these technologies can enable outcomes addressing the big UN agendas of sustainability, climate change economic development and inclusion, are rarely provided.

Huertas et al. (2021) dwell on the role of technologies and their applications to Smart City models in reinventing the character of different cities. They acknowledge that most cities, faced with the devastating impacts of climate change, have adopted strategies to optimize the use of resources and to better engage with dimensions of environmental sustainability, but they suggest no clear link to how these Smart City models can actually achieve this.

By using such technologies like big data analytics to improve areas that can positively impact on local economies and security, cities have managed to rebrand and reposition themselves to attract a wider global audience, which translates into increased visitors. This is captured in a report by Mastercard (2017) that found out that the most advanced Smart Cities are those with a diverse and multitude of smart components and smart systems in place, aimed to attract a large number of visitors and in aiding the management of urban areas. This is seen as increasingly important for urban policy makers as visitors contribute to a sizeable revenue from the consuming of different services and products on offer. The technologies work at enabling specific local areas to be branded as 'modern' and 'safe'. But is this enough?

The place-branding strategy that a majority of Smart Cities have embarked on to position themselves for economic development has allowed many cities, even those with low incomes, to make use of technology to create employment and enhance urban management, performance and efficiency. They hint that this may help with all their other problems, but in reality, they don't know how to do it. So, the world has witnessed the proliferation of Smart Cities, even in remote areas where the concept looks disparate and unnecessary. An annual report by Berrone and Ricart (2018) released in 2018 captures 165 Smart Cities worldwide, but a good score of them, as admitted in the report, has not been included in their analysis.

McKinsey and Company (2018a, b) suggested that the number of Smart Cities is set to continue to rise as technological advancements take shape. This book will show that unless the Smart City technology is made part of the bigger UN agendas, there will not be much further expansion. We believe that Smart City as a branding exercise for digital data capacity needs to diminish and the big agendas need to drive the future of cities. But we will also show that Smart City will be an essential part of that bigger agenda.

1.3 Smart Cities as a Profitable Venture

The discourse about the Smart City concept being used as a branding tool aimed at promoting economic growth through the technologies associated with it suggests that this demand is an incredibly profitable venture. McKinsey and Company (2018a, b) do show that most Smart City programs are powered by components, systems, organisations, businesses and individuals who aim to benefit financially from these undertakings. This is affirmed by Richter et al. (2015) who argue that even though small local entrepreneurs have failed to capitalize on the concept of Smart Cities, large corporations are investing massively in both development and branding of Smart City. The same argument is advanced by Taylor (2014), from CISCO, who shares how service providers can tap into the concept of Smart Cities to increase economic throughput from the provision of a wide and diverse array of 'smart' products and services.

This profit-seeking drive however can be made to the detriment of the end users. They can be delivered as unfair economic models that marginalize the big issues from the UN about sustainability and climate change. An example is from the transportation sector where companies such as Uber and Google capitalize on the improvement of public infrastructure (aided by public taxpayers) to improve their private profit targets. Large corporations such as IBM and Cisco have been in the forefront of such technologies and have made substantial profit and built their reputation from the sale of hardware, software and digital services, platforms and solutions. Their positioning have earned them the opportunities to services cities such as Rio, Barcelona, Kansas and others in countries that have national Smart City agendas like China and India (McKinsey & Company 2018a, b). However, at no stage have these projects linked in with strategies to increase electrification of transport or to provide solar energy as the fuel.

Other large companies like Google, ABB, General Electric, Ingersoll Rand, Siemens AG, Hitachi Ltd., Huawei Technologies Co. Ltd., Koninklijke Philips and Microsoft (Mordor Intelligence 2018) are also among the tech innovators and providers of Smart City technologies particularly on artificial intelligence (AI). None of these stand out as leaders in sustainability and climate mitigation, but they could have used this technology to help drive those options.

The Smart City approach to solving urbanisation issues is not a stand-alone concept and is backed and supported by corporates with substantial financial resources (Allam 2018b, c). There is thus a highly competitive market where companies compete to tap into this profitable market without needing to drive the technologies further into these broader issues. Perhaps the drop in the branding of Smart Cities could be an opportunity to do what they always should have been doing – helping the world's cities become more inclusive, sustainable and climate resilient.

In an analysis carried out by Navigant (2018), the two main leaders in Smart City work are Cisco and Siemens which are closely followed by a set of contenders including IBM, Hitachi, Microsoft, GE, Schneider Electric and Bosch, among others (Fig. 1.4) (Navigant 2018). Sadowski (2016) also warns about the potential agenda of Smart City corporations in supporting a stand-alone profit-making agenda through the implementation of Smart City solutions. These commentators suggest that if cities invest in these corporations as part of their branding exercise rather than investing based on the values and visions derived from participatory approaches to governance as outlined by Nam and Pardo (2011), then smart technology may simply be wasted investment.

The attractiveness of the Smart City concept that seems to make large corporations seek to be associated with it is its market capitalization which has been rising as more cities were adopting the concept and its technologies. This has been

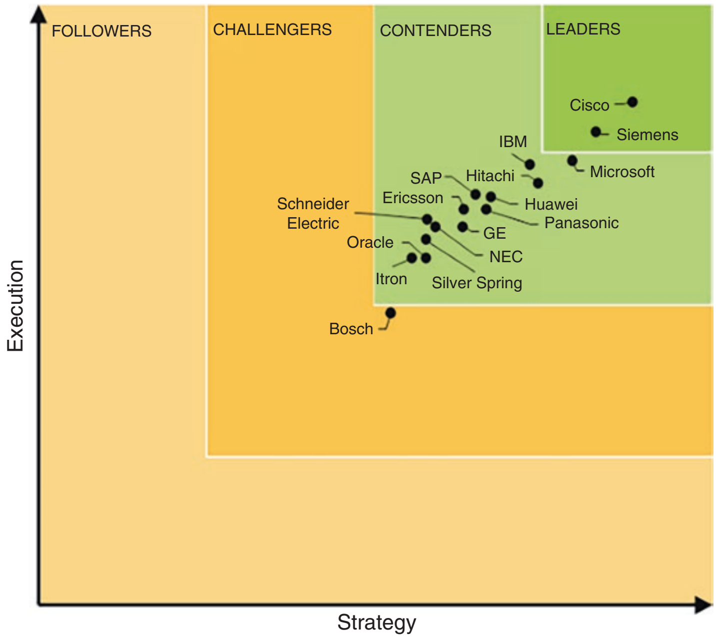

Fig. 1.4 Leader board of Smart City suppliers. (Navigant 2018; IMARC 2021)

expected to continue increasing, and it has been explained that, by 2025, the Smart City global market value will exceed its current value of $882.3 billion to above $2.5 trillion by 2027. In Europe alone, the report records that this concept will have the capacity to generate an annual revenue of over $120 billion from the current $50 billion. The Asian region will be the most active region in terms of implementation of the Smart City concept and is expected to drive substantial revenue generation.

The impressive revenue flow from Smart City projects is however seen, in the short term, to profit mainly corporations rather than cities. The reason is that the amount of investment required is deemed substantial and on the other side the return of investment is lengthy if linear business reporting is exercised. For instance, a report by Fishman and Flynn (2018) highlights that only approximately 16% of Smart City projects are self-funded, highlighting that a majority of the remaining percentage are funded via public-private partnerships (PPPs). Though this is among the potent alternatives to the financing of Smart City infrastructures and other bigger projects with wider value, numerous tax incentives are often further sought to encourage investment (Allam et al. 2018; Allam and Newman 2018a). A majority of Smart City initiatives are not meant for direct revenue generation but are meant to boost systems and operations that would in turn promote bigger goals of economic growth, security, resilience and sustainability. It is these bigger goals that draw funding and support from the public sector in cities and other levels of government to create these PPPs. The broader goals provide a conducive environment for associated revenue generating programs to be initiated. But do they actually deliver on those broader goals?

1.4 The Market Monopoly of Smart City Technology

A substantial number of large corporations have been positioning themselves for economic gains in the Smart City implementation arena. The race to gain competitive advantage in the provision of services, products, solutions and partnerships is apparent as depicted in Fig. 1.2. The competition is driven by the fact that numerous Smart City products like software, hardware, systems and expertise are required, but a majority of cities are not in a position to develop, install and maintain such products. Therefore, they contract and procure the services of corporations with capacity, both in terms of finances, skilled manpower and resources to install them on their behalf. As noted above, most Smart City projects are delivered by the adoption of PPP financing models; therefore, the winning corporation, or consortium, may have to incur almost all the cost, but in the long run, the endeavour becomes lucrative since they remain as the provider for the services, provision and maintenance of products and networks. This is even after the duration of contracts as most cities do not have the capacity for data gathering and analytics, installation and repair of smart components and/or running and maintaining systems (Calzada 2018).

This explains why large corporations invest heavily in research and development (R&D), developing patents and branding propriety technologies. This competition can be however detrimental to progress on broader goals for cities. As Yigitcanlar et al. (2018) decry, the core reason that prevents the actualization of a city's broader goals through the Smart City concept is the lack of standardisation of protocols and standards such that different Smart City components can interact with each other seamlessly. This confusion of technologies is not unusual in the history of cities as particular firms try to emphasise their specific capabilities rather than emphasise their value in integrated problem-solving. By adopting an isolated networking architecture, protocol and system, it means that small and local companies are shut out of the Smart City process. The change to a more inclusive and integrated set of technologies could easily open the Smart City system at any point to small and local firms. However, this would disrupt the market share and control of the large corporations. Jawhar et al. (2018) affirm this argument by showing how difficult it is to integrate services in Smart Cities for easy coordination and control. They argue that currently, most Smart Cities consist of such technologies like cyber physical systems (CPS), IoT, wireless sensors networks (WSNs) and cloud computing which are controlled by different corporations from a long distance away.

Zhang et al. (2016) delved into finding solutions for how the standardisation could be done and even proposed a framework that could be adopted to achieve collaboration, but the adoption of such options remains extremely untenable. Espada et al. (2019) also expressed the need for collaboration to these ends, but it is evident that this has not been achieved with competition being the reason behind the slow pace in finding a uniform protocol for similar services. Another argument is that with the heavy investment in R&D, large corporations are able to provide services and products at competing prices since their production and maintenance cost are greatly reduced. For smaller companies, offering such services or products at competitive prices would be difficult since in most cases, their operational costs are relatively higher.

Besides the above difficulties of harmonizing networking architecture and protocols, large corporations are also engaged in aggressive marketing campaigns aimed at promoting the concept of Smart City. Hollands (2015) outlines the motive behind this is profit-making, especially noting that ICT and digital connectivity are the main drivers of Smart Cities. He explains that by doing this, a sizeable number of cities fall prey to such corporations rather than utilising small and local companies, as large companies align themselves with the demands for development and implementation of the concept with quick turnaround times, even though the solutions are not contextualised. Similarly, Smart City campaigns are designed to evoke the sense of being left behind among cities that are not yet 'smart', and since the implementation of these projects is expensive, cities end up partnering with the large companies so controlling the entire project from design, development and implementation, operations and maintenance. By so doing, local companies and start-ups cannot match the technical and financial muscle of their larger competitors. This also can lead to issues of intellectual property of data and privacy concerns (Zoonen 2016).

Van Winden and van den Buuse (2017) acknowledge that large organisations are able to engage in larger projects since they usually have pilot programs which can be replicated in other localities when required. How the gap in market monopoly can be bridged is an interesting and complex issue that is explored later on in this book. An obvious intervention is the provision of incentives and support especially in pilot Smart City projects. This will provide small companies with financial capacity and exposure to train their staff and gain confidence to participate in larger projects. The incentives could be in the form of financial support, especially providing opportunities for the companies to secure loans and other support at reasonable rates, offering tax holidays, exemptions and the provision of domestic company protection mechanisms (Allam 2018a; Allam and Newman 2018a). Since most small projects and pilot projects are run by local municipalities and local players, Söderström et al. (2014) explain that small companies could gain experience by tapping into implementation opportunities, hence gaining confidence to transfer knowledge to larger projects when called upon.

1.5 Contextualising Smart City Technology

Van Winden and van den Buuse (2017) have demonstrated that the success of large corporations in implementing Smart City projects can be credited to their ability to perform numerous pilot projects and engage in intensive R&D on the best practices. They are able to offer technological solutions in the form of 'off-the-shelf' products that are easy and quick to implement. Nevertheless, evidence have shown such approaches of sourcing for ‘off-the-shelf’ solutions are not always the best, especially in providing optimal performance in complex and unique environments. The solutions are packaged in such a way that they seem to be able to address an array of issues that are common in most cities but often they miss the subtle differences of culture and place. Caird and Hallett (2018) explain that though there has been an increase in activities by the International Organization for Standardization (ISO), aimed at ensuring availability of standardised Smart City measurements, Smart City solutions are being promoted without showing that in fact they are not always compatible, scalable and replicable in a way that local areas can manage. For instance, Allam (2020) highlight that, in the case of privacy and security of Smart Cities, though there is a standardisation of techniques such as encryption, authentication and anonymity standards, among others, hackers from different regions find ways to navigate past these measures and compromise the security of systems and networks.

Bosch et al. (2017) suggest that there are many salient and unique issues synonymous with each city that render the cloning of such technological solutions as impractical. Chamoso et al. (2018) add that the customisation of technologies is not always easy since a majority of them do not provide high-level services that would allow developers to encapsulate the local needs coupled with cultural requirements. McKinsey and Company (2018a, b) further believe that off-the-shelf technological solutions are in most cases developed with the exclusion of stakeholders like sociologists, urbanists and other experts that have a key understanding of issues that confront cities and city fabrics. In addition, Bosch et al. (2017) argue that urban dwellers, who are the ultimate consumers of the Smart City technologies, are also not factored in, and this results in a bigger challenge once the project is implemented using such technologies. The result is a growing lack of acceptance of the concept from urban dwellers other than elites though these also can be bypassed as the Toronto example suggests, as set out in the Preface. Hamilton and Zhu (2018) argue that as issues of privacy and security emerge, citizens become reluctant to contribute to data sharing or in decision-making that relates to the city and how it ought to be managed. Berntzen et al. (2016) suggest that this trend results in difficult collaboration between policy makers, urban dwellers and other stakeholders in issues like smart waste management, optimal use of resources and adoption of other sustainability practices aimed at making the Smart City concept a reality in ways that benefit everyone (Newman 2020).

Costs associated with addressing localised issues related to privacy and security are noted to be expensive but necessary. The rise in cost is associated with the fact that it is not easy to customise ‘smart’ technologies to fit local needs, hence ensuring the role of technology developers long after a project’s life cycle. Where customisation is possible, it has been argued that it becomes even more expensive as tailoring an off-the-shelf solution represents a considerable cost (Chêne 2009). On the other side, if the technological software is customisable with harmonised protocols in place, the operation and maintenance services could be left in the hands of small and local companies that would use local talent and resources, resulting in more competitive fees than large corporations. With an off-the-shelf solution, it may sometimes become hard to find a financier (Julian et al. 2015), especially in the case of PPP financial models as most financiers and developers would prefer to support a project that addresses the societal and cultural challenges in particular places, especially in cities, so as to ensure a direct influence and control.

To remain true to the purpose of adopting the Smart City technologies, Smart City solutions must be tailored and contextualised. This entails the engagement of various stakeholders when formulating policies, guidelines, designs and implementation strategies of the Smart City concept (Tomson 2017). Pereira et al. (2017) support that this is bound to allow for the seamless sharing of information enabled by increased collaboration between the municipalities, higher levels of government and engagement of community and other stakeholders. Through collaboration, the Smart City model and resulting technology can be adopted to provide customised local solutions. This can boost stakeholders' participation and confidence which is an essential ingredient in the success of a Smart City project. With tailored and contextualised solutions, local and small companies that understand the local challenges have the potential to participate in the implementation of projects, by being directly involved or in offering technical support. Similarly, urban dwellers would get the opportunity to secure employment opportunities as local businesses grow and new ones focusing on regeneration of all elements of the city emerge.

1.6 Redefining Smart Cities

The Smart City concept has demonstrated that it is a useful driver of urban change but that it lacks local contextualisation. Indeed, the concept of Smart City has largely created a fog about the issues of sustainability and climate resilience because it has suggested that these will somehow be addressed through the acquisition of digital data capacity. As will be shown in later chapters, it has probably been the most significant paradigm for much urban activity that has emerged out of the knowledge economy and its associated digital technology. But it is not a paradigm that can truly stand by itself as it is lacking inherent values for environmental, social and economic gain. 'Smart for what?' is constantly being raised now.

The illustration of the Toronto, a waterfront project quayside in the Preface, is highly symbolic on why Smart City is declining as a driving idea for cities. This is especially now that the post-COVID-19 economic agenda for cities needs financing and the Climate 100+ agenda is net zero with associated support of SDGs.

The key ideas in this next agenda of sustainability, climate resilience and inclusive economic development need all the help they can get, and this must include Smart City systems. The core of these net zero technologies are solar, batteries and electric vehicles, as well as the associated technologies of circular economy, resource efficiency and biophilic urbanism. These are best delivered at small-scale, local levels (Newman 2020; Green and Newman 2022). Thus, rebuilding the new economy will need a different economic model that makes the best of these technologies through much more local and contextualised development. This is much more able to then integrate the broader UN SDGs along with the net zero targets.

1.6.1 So Where Does Smart Cities Sit in This Emerging Economy?

In order to achieve these goals, there will need to be a growing and very significant utilisation of Smart City technology. The difference is that these technologies must be integrated into the broader environmental, social and climate values that must now be driving the development process. This must occur from the inception of projects whether they be from the Smart City private companies or the increasingly active public and private projects set up for net zero outcomes. Both of these systems can no longer be left in a silo that promises much but cannot deliver by itself. They need each other especially in the present dispensation where the impacts of COVID-19 coupled with the ongoing conflicts between Russia and Ukraine might prompt an increase in unsustainable practices. As such, it would be critical to redefine the Smart City programs to ensure they are not anchored, or dependent, on nonrenewable practices such as use of nonrenewable energies, as countries seek to stabilise their economies as well as shift their attention from traditional supply chains.

1.7 Conclusion

The Smart City is seen as being driven by ICT corporations looking to engage in a profit-making industry. The lack of harmonisation between the Smart City proponents has not only been making it harder for smaller, local companies to tap into established networks, but the competitive nature of the process has led to market monopolies that are now seen as driving the Smart City agenda, rather than any need to solve local and global problems. This can lead to economic disparities that can impact negatively on the urban social fabric. The need for contextualised technologies that feed into and drive the Smart City models is thus seen as paramount to ensure increased sustainability, resilience, economic development and inclusive dimensions. The reaction may be setting in as demonstrated in Toronto that we must 'kill' the Smart City. Or perhaps we can redesign the Smart City to enable it to find the deeper values of regenerative development that are emerging as the guiding next generation of urban planning. The other chapters will help explain this further.

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Chapter 2
Smart Cities and Sustainability: How Smart City Helps with Sustainability

Abstract The challenges and impacts from rapid urbanisation coupled with the impacts of climate change and other global planetary boundary issues are prompting cities to take urgent action toward safeguarding the sustainability of the urban fabric – reducing environmental and social impacts while improving liveability. The advent of sustainability-oriented technology is being recognised as having a predominant role in this process. However, these solutions are often claimed as part of the Smart City technology arsenal when often they have little to do with digital data systems. Thus, the agenda of Smart Cities in the past has claimed digital technology upgrades will automatically help solve sustainability problems; however, the simple provision of more digital capacity does not necessarily mean this will happen. New approaches to sustainability where smart systems are made an integrated part of the metabolism of cities can provide solutions that also can lead to increased liveability levels.

2.1 Introduction

There are nine planetary boundaries identified that nations and cities need to address (Steffen et al. 2015). Cities are able to address most of these through their energy, water, transport, industry and waste systems with various scales of action (Meyer and Newman 2020). Perhaps the biggest of the boundaries and certainly the one attracting the most attention in the 2020s is climate change.

The impacts of climate change are now urgent as highlighted by the recent report of the IPCC (IPCC 2018), and the role of cities in this process is apparent (International Energy Agency 2017a, b). The IPCC reports highlight that a global warming of 1.5 °C above preindustrial levels would have devastating consequences on the entire global ecosystem and human activities are responsible for an increase in temperatures by between 0.8 and 1.2 °C. If mitigation measures are not hastily implemented, by 2030 and beyond, the rise would increase from 1.5 to 2 °C and beyond (almost 3.5 °C) (IPCC 2022), and the consequences will be dire. With the rise of 0.8 °C, it is reported that the global sea level has risen by approximately 1.7 cm, and this would continue to increase in tandem to increase in temperatures.

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The World Bank (2010) projected that such increases in temperature would lead to a permanent GDP reduction of between 4% and 5% in South Asian and African countries.

The need to address climate change is addressed in more detail in the next chapter. Here we want to show how cities need to be understood as systems that not only create wealth and liveability, but they are like natural system metabolism, converting resources like energy, water and materials into urban fabric but at the same time inevitably creating waste that must be dealt with; otherwise, it has global and local impacts. Sustainability in cities can be framed as 'reducing the resources, reducing the wastes and increasing the liveability at the same time' (Newman and Kenworthy 1999b). In this chapter, we will examine the growing lists of issues on the agenda of sustainability in the local and global arena, how this can be applied to cities using the metabolism approach and how smart systems can be used to assist in delivering more sustainable cities.

2.2 Sustainability Issues in Cities

Cities, as is any given economy, are the engines of economic growth (Collier et al. 2018). Mitra and Mehta (2011) and the World Bank (2010) show that large percentages of national GDPs are attributable to cities. To achieve this, cities consume a large amount of resources – water, minerals, energy, food, land and forests, among many others. Bergesen et al. (2017) contend that in the process of availing these resources, large amounts of pollutants and greenhouse gases are emitted which have potential to affect global and local environments such as the increase in global temperatures (IEA and UNEP (2018) report). Among the leading contributors of these pollutants include traditional power plants relying on fossil fuels (Narayanan et al. 2019), automobiles (Newman and Kenworthy 1999a), factories emitting poisonous gases and liquid effluents that find their ways in the soils and water aquifers (Tripathi 2017). In addition, the increase in global population allied with an equal increase in consumerism directly contributes to environmental impacts. Kalmykova et al. (2016) explain that twentieth-century housing, electronics and automobiles are products that are resource intensive and are mostly sourced from nonrenewable sources. Similarly, when most of these products complete their life cycle, they are disposed, rather than recycled, leading to increased levels of pollution and subsequent environmental degradation.

The unprecedented rates of urbanisation and the rapid increase in urban population which Kaneda et al. (2020) predict will reach over 68% by 2050 are among the factors which contribute to the overexploitation of natural resources and pose threats to human survival. With such trends, it became urgent from the 1970s on that many changes needed to be made and hence the notion of sustainable development was created through the UN's process called the *World Commission on Environment and Development* (WCED 1988).

Cities were soon made part of this sustainability agenda, and a series of approaches were created for how urban planning could become part of the solution, not the problem: sustainable city (Newman and Kenworthy 1999b), eco-city (Cugurullo 2017), resilient city (Stumpp 2013) and low carbon city (Shen et al. 2018) were adopted at different periods. They are all geared toward the application of knowledge to urban planning with a shared goal of increasing sustainability in various ways.

Slowly the experimentation using these different models has yielded tangible results which include using environmentally friendly construction materials, promoting the importance of mixed land use like in the case of Singapore (Ong 2017) and emphasising the need for reduction in use of automobiles in favour of cycling and using transit initiatives like is advanced in the 15-Minute City concept (Allam et al. 2018a, b). The application of digital technology could have been immediately applied to accelerating the sustainability solutions using these models. But they were not.

2.3 The Smart City Takeover

According to Van Winden and van den Buuse (2017), all the ideas brought forward in the above models have converged to a new urban planning concept known as Smart City. The Smart City agenda was born out of the global financial crash when the digital economy was created using digital technology. This concept was hailed for its unique economic benefits that could be brought about by its ability to spur efficiency and increase performance in the social, economic, environmental and political spheres. For instance, the adoption of the Smart City concept was suggested to help in boosting the attractiveness of cities, thus boosting tourism activities, attracting foreign direct investments (FDIs) and, on the local front, promoting employment opportunities, among many other things (Anand and Navío-Marco 2018). It should be noted that the list did not refer to any sustainability outcomes but instead assumed that if the above outcomes were obtained, then the other sustainability goals would follow. They did not. In fact, the focus on Smart City projects had the unintended consequence of marginalizing important sustainability and climate change agendas, despite their success in attracting investment and promoting economic growth.

This fogging of the sustainability agenda by Smart City proponents can be seen by many other commentators who made the same error of assuming that the simple increase in digital capability would automatically solve environmental problems. Anthopoulos (2017) explains that the concept of Smart City, via a range of diverse technologies, has brought numerous smart innovations in urban centres that are proving positive in addressing the impacts of climate change – though these are rarely quantified by the author. Macháč et al. (2016) point at such trends like the adoption of green and blue infrastructure that help in reducing the intensity of extreme weather conditions as well as improving the quality of air that in most cases is polluted from different pollutants in the city. None of these technologies were digital smart systems; they were just simply direct sustainability-oriented technologies branded as smart.

In the same way, Blanco et al. (2018) argue that the technologies utilized in Smart City projects have allowed for smarter urban planning strategies allowing for pockets of green spaces in cities that serve as recreation parks and help the city dwellers to maintain a healthy lifestyle. These are quite simply normal urban planning that has been known and delivered for hundreds if not thousands of years. They do not need to be called smart. Blanco's suggestions are simply good planning with a series of sustainability benefits such as (a) protecting some urban biodiversity as well as reducing the amount of hard surface runoff, thus easing flooding in cities, and (b) allowing for the densification of urban areas and thus allowing for the optimisation of space, as well as resettlement of numerous households. There is no need to suggest these will automatically happen if digital data capacity is increased but perhaps it would have happened if the smart systems had been integrated into real projects delivering these broader goals of city management.

Smart cities were also claimed to be implicitly resource efficient by Kylili and Paris (2015) who hail the zero energy buildings that are deemed crucial in helping in the reduction of emissions by their ability to allow for 100% consumption of alternative, renewable energy. None of these approaches are explained in terms of the digital systems needed, but instead they are simply branded good sustainability practice as 'Smart City'. This is dangerous as the concepts led to many cities prioritizing and procuring digital capacity with a rationale that this would automatically create sustainability outcomes. They are not going to do that unless they are designed for that purpose.

Liveability outcomes were also claimed to be automatically linked to the Smart City. For example, Appio et al. (2019) suggest that Smart City concepts have the promise of increasing the liveability of cities while enabling the vision of cleaner environment to be achieved. Calvillo et al. (2016) highlight that this is possible through its emphasis on the use of cleaner energy in households and in other areas like street lightings, in industries and in transport and communication sectors, among others. However, this may well have simply been greenwashed as the majority of Smart City technology that was actually procured through this period was about surveillance, often rationalised as improved liveability. This could be affirmed by considering the case of China, which currently has the highest number of cities branded as 'smart', yet it is among the leading countries in terms of emission.

The liveability index of Smart Cities was suggested to help in improving the security in all aspects of the city. With technologies such as big data, artificial neural networks (ANNs) (Allam 2019), Internet of Things (IoT) and others, the numerous technological components installed in cities can allow for real-time gathering and analysis of data that is essential for immediate and contextualised solutions and responses to urban challenges. These could have been attached to sustainability outcomes but invariably were only about how to control human behaviours. Such technologies and components allow for the prediction and analysis of human behavioural trends (Mahdavinejad et al. 2018) and thus were rapidly picked up by companies wanting to manipulate consumption of anyone whose data they could obtain and even been used to manipulate election outcomes by shaping individualised messaging.

These same Smart City technologies could have been used for citizen participation in the planning and management of cities through data sharing via social media platforms and bridging the gap of social inequality (McKinsey and Company 2018; Martinez-Balleste et al. 2013). The same Smart City technology could have been used to achieve increased sustainable outcomes in every aspect of city life in both low-income and high-income cities. They could have been and should have been focused on sustainability, but were not.

2.4 Sustainability and The Metabolism of Cities

Cities can be viewed as living organisms and as entities that sustain life in an organic way, as portrayed by Jane Jacobs (1961), Christopher Alexander (2002) and Nikos Salingaros (2014). The analogy of a city as a living organism is particularly useful in helping to understand sustainability in an urban planning context. Urban metabolism is the study of input and output processes of cities to understand how the structural issues about sustainability depend on understanding the resources which are the core inputs, the wastes that are the related core outputs and the desired liveability which results from this metabolism. The goal of sustainability is to reduce the resources and reduce the wastes while simultaneously increasing the liveability (Newman 1999). See Fig. 2.1.

Proper understanding of the urban metabolism concept is an important step toward the pursuit of sustainability outcomes, as this will mean an optimal utilisation of available resources and better use of planning designs more responsive to modern sustainable agendas, as captured in the SDG11, the New Urban Agenda and

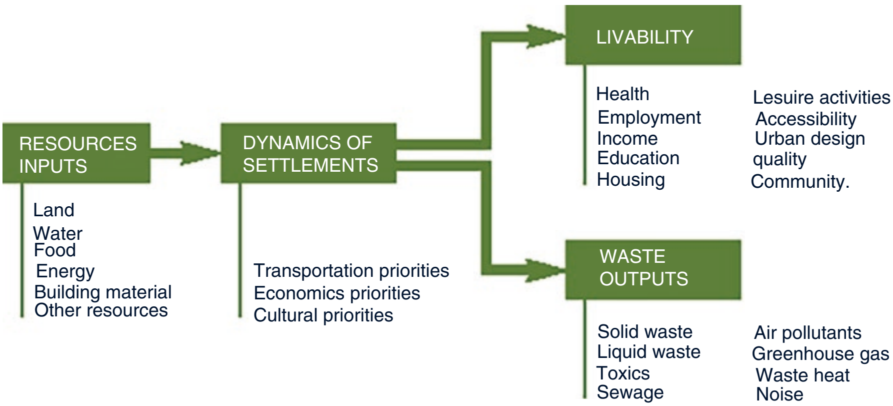

Fig. 2.1 Extended metabolism model of human settlements

other initiatives. The mechanisms for doing these changes are suggested in Fig. 2.1 to be cultural, economic and transportation priorities.

(a) Cultural changes are brought through the community. As Salingaros (2005) suggests, such an understanding would ensure that humans and their interactions with each other and with the urban fabric will be determining factors in urban planning. Salingaros (2006) believes that technologies especially those with the potential to allow for compact cities are the solution to addressing sprawl but this requires good community facilities to be part of the compact city. He argues that such technologies have the potential to impart life to more compact apartments and office towers that have for long been erected without considering their value in advancing sustainability. Similarly, Newman, Beatley and Boyer (2017) also advocate for inclusion of biophilic urbanism systems that would promote cyclical and regenerative metabolism and work best in compact cities.
(b) Economic priorities are about how best to provide infrastructure for all the cities' needs and to do this using economic incentives that reduce the need for resources and enable wastes to be recycled. Newman (2020a, b) argues that cities need to invest in renewable and distributed energy, create sustainable mobility systems and focus on ensuring inclusivity and healthy cities as part of the next economy.
(c) Transportation priorities create the different kinds of urban fabric including the transport infrastructure suggested above. The different parts of the city require different transport infrastructure solutions and highlight the value of local, contextual solutions.

Smart city technologies are not listed in these mechanisms, but in reality, the delivery of each of them outlined above is much easier and more productive if Smart City systems are integrated into each of them. For example, it is possible to apply real-time data generation and analytics and real-time monitoring of different aspects of automation to each of the cultural, economic and transportation systems outlined. If integrated in from the start, the Smart City can help make sustainability happen. It is possible to achieve wholeness, resiliency and sustainability in cities while also improving the liveability status, thus actualising the benefits of shaping cities using the concept of urban metabolism (Newman 1999), but the two big ideas of the last 30 years in cities – sustainability and Smart Cities – must be integrated.

2.5 Integrated Smart Urban Metabolism

Faced with increasing challenges tied to urbanisation and rapid population increase, cities are in dire need to achieve more sustainable levels of urban metabolism, and the role of technology is paramount in this process. Chávez et al. (2018) acknowledge this proposition and argue that technology is important in helping stakeholders understand, plan, implement and track urban metabolism especially if the future of the urban fabrics and components is to be secured. The need for technology is propagated by the fact that urban centres have been known to consume approximately 75% of the global natural resources (UN Habitats 2018) and, in return, generate over 50% of global solid wastes and between 60% and 80% of greenhouse gas emissions and other pollutants (UNEP 2016). IRENA (2018) records that over 85% of energy consumed in majority of cities is from nonrenewable energy sources like fossil fuels and only a meagre 15% is derived from renewable energy sources.

Such figures are expected to keep increasing, as it is projected that over 68% of the global population will be living in urban centres and these are all growing bigger, especially large cities. For instance, according to the United Nations (2018) in 2016, there were approximately 512 cities globally that hosted at least one million people. By 2030, these cities are projected to increase to approximately 662 cities. In addition, megacities that have more than ten million people are expected to increase from 31 cities, recorded in 2016, to about 41 cities by 2030 (United Nations 2016; UN Population Division 2019). Such numbers will mean an increase in consumption of different resources and, at the same time, an increase in waste generation. Nevertheless, with technologies such as Smart City technologies and systems integrated with sustainability-based technologies and systems, it is possible that smart and sustainable urban metabolism can be achieved.

Integrated approaches to smart and sustainable cities are being trialled (Allam and Jones 2021). For instance, in the energy sector, alternatives like photovoltaic-solar energy, hydro energy, wind energy and others are being rapidly introduced in all countries (Motyka et al. 2018; REN21 2018) but will only be able to truly take over from fossil fuels when smart systems are used to integrate them into grids both large and small, especially into the rapidly emerging distributed grids which require local integration (Green and Newman 2022).

Fan et al. (2019) express how the use of technology in managing urban fabric has had significant impacts on the energy-food and energy-water nexus, where the emphasis is on optimising sustainability approaches that integrate these different elements. Restrepo and Morales-Pinzón (2018) explain that by using modern technological advancement such as the use of big data, AI, IoT and machine learning, cities are now able to track, and project in real time, the inflow and outflow of materials; hence, informed and decisive actions are taken both in optimising resource use and also in management of wastes. Gaigné et al. (2012) highlight that by doing this, city managers are able to formulate the best approaches that promote growth and, at the same time, emphasise the sustainable agenda. But the initiative to integrate these elements is rarely part of the contracts with the responsible government agencies; instead, they are left with the branded package of smart systems and need to work out the next steps themselves.

Besides being focal in providing efficient resource management and increased performance, with reduced wastage of resources, technology can foster changes of behaviour in urban dwellers, who are frequently much concerned about their consumption behaviour (Samad et al. 2019; McKinsey and Company 2018). In particular, technologically inclined concepts such as the Smart City are said to accommodate and promote the participation of citizens in the governance of the cities, especially through information sharing. By so doing, Stewart et al. (2017) report that most urban dwellers where such technologies are fully integrated are said to embrace the need for resource optimisation, and a majority are actively participating in 'smart' initiatives like the use of bicycles and public transport systems instead of owning automobiles that contribute to harmful emissions. A case in point is the city of Copenhagen that is said to benefit from cycling culture of the locals where over 90,000 tonnes of CO2 that could have reached the environment are saved, thus improving the sustainability of the city (International Organization for Standardization 2015). However most of these initiatives for cycling and walking in Copenhagen were done well before any smart systems came along (Matan and Newman 2016).

Cities are also active in adopting what Newman and Thomson (2018) called 'cyclical use of resources' (recycling), thus reducing the amount of waste. For instance, Shahrokni et al. (2015) explain how the city of Stockholm has managed to optimise waste management and recycling. However, it is not possible to claim that this has been done by adopting a data centred approach. The data are now gathered from smart components installed in cities as well as from urban dwellers, but this builds on decades of non-smart initiatives (Newman and Kenworthy 1999b).

Smart technology can be integrated into urban metabolism to accelerate how most urban areas can achieve increased liveability dimensions by adopting better and more efficient management of resources. The emphasis on the adoption of mixed land use, smart waste management and adoption of cleaner renewable energies is possible but must be integrated into mainstream sustainability practice.

2.6 Infusing Smart Technology into Sustainability in Cities

Cities and urban centres are in a constant process of change. The industrial revolution prompted the transformation of most western cities from medieval to industrial cities (International Federation for Housing and Planning 2016). When automobiles came into existence in the twentieth century, there was a demand for further transmissions, and the resulting urban models led to an increase in central business districts characterised by high-rise buildings, improved transportation systems and also increased urban sprawl, as people could afford to travel to areas far from cities. In the recent past, the advent of ICT and its ability to seamlessly integrate into the urban fabric has seen a rise in new high-tech urban developments which have been actualised in various forms (Allam 2017). Information and communication systems based on digital data are the newest kind of technology in cities and these as cities seek to improve economic, social and environmental outcomes. Now cities are planning technoparks, technopoles, science parks and eco-cities which all feature these new smart technologies (Oh and Phillips 2014). The newest planning model that is particularly gaining substantial attention after the realities of the COVID-19 pandemic is the 15-Minute City model. The model proposes a redefinition of urban areas such that besides them being 'smart', they also incorporate aspects of proximity, accessibility, diversity and ubiquitousness (Allam et al. 2020). This way, some of the existing challenges in cities such as traffic, prompted by increased number of private cars, would be addressed. Further, this model proposes prioritisation of the human dimensions well defined in SDG11; hence, its successful adoption would not only allow cities to be only smart, but they would be vibrant with human oriented outcomes.

2.6.1 How Then Do We Infuse Smart City Technology into Urban Sustainability Programs?

The emphasis on the use of technologies in those concepts demands a restructuring of how we manage cities. The rest of the book will show this can be done starting with climate change and then with the regenerative design approach and finally how to build it into economic development as an inclusive process.

In all these chapters, it will be important to see how the theory of urban fabrics can be used to find local and community-based approaches, to regenerate each part of the city differently using integrated infrastructure. The theory of urban fabrics is outlined briefly using examples of how it can be applied to integrate the smart and sustainable/net zero technologies:

1. Old central cities have a fabric based on walking as that was how they were formed around the potential to walk to everything in half an hour, and hence all the core infrastructure needs to support walkability in these areas. Smart and sustainable infrastructures need to fit together to make walkability more attractive for everyone and not just safer. This means better lighting and shared transport systems as well as shared solar energy managed by shared data that enables a highly intensive knowledge economy to thrive.
2. Nineteenth- and early twentieth-century transit fabric is spread along corridors, and the medium density fabric was built around reaching all the key parts of the city in half an hour by train or tram. These areas need to regenerate the transit systems with electric vehicles of all kinds, especially new twenty-first-century e-rideables and trackless trams, buildings with mixed use and shared solar for all power and recharging of vehicles with special economic uses for health, education and shopping services.
3. Twentieth-century car-based suburbs that are designed around reaching everything by car in half an hour. The low-density suburbs are important for large warehousing and industry as well as housing but are increasingly creating small urban centres that enable transit and walkability for these outer areas. The opportunities for solar are more extended as well as other aspects of the circular economy such as waste recycling. Large precincts can integrate smart and sustainable infrastructure.
4. Peri-urban and rural villages are increasingly seeking ways to use smart and sustainable infrastructure that can enable a large degree of self-sufficiency with

access to the adjacent city when specialised services are needed. The need for community-based smart systems to enable complete net zero outcomes is feasible here.

The alternative approach taken by many nations is to establish new cities. There is not a great history in any of these new cities, so they are becoming rarer. Although new cities would be a breath of fresh air to the planner and some urban dwellers, building a city from scratch is not always a sustainable endeavour as it creates demand for more resources (Slavova and Okwechime 2016) and generally increases dependency on unsustainable practices like the use of automobiles. This is true since available lands for such projects in most countries are relatively far from existing cities; hence, people are forced to travel using fossil fuel powered vehicles, since public encouragement in the form of fiscal incentives for energy saving and new kinds of transit services is generally left out of these new cities. Shepard (2017) suggests that these challenges relate to the expensive nature and the amount of time required to consider them to make new cities ready and self-reliant. Tosics (2015) showed how residential units expected to accommodate over 20,000 people in a new town of Aspern Seestadt, Vienna, are projected to take over 20 years to complete, and it was started in 2015. He acknowledges, like Salingaros (2006), that such new projects are unsustainable and proposes the adoption of compact residential neighbourhoods in existing cities. We would suggest regenerating all parts of the city with new twenty-first-century infrastructure using the theory of urban fabrics is likely to be much more successful.

Economically, a brand-new city will pose an unfair advantage as businesses and most lucrative economic activities may be bound to flock to the new cities leaving existing ones in a slow state of urban decay. Inclusion is more likely if regeneration happens inside the present urban fabrics. However, they need to also be inclusive in the sense of retaining the qualities of place in each urban fabric. Jacobs (1961) outlined in her famous book *The Death and Life of Great American Cities* that existing cities were built around some indelible heritage that identify and relate with the identity of the place and a unique sense of belonging to locals. She was reacting to the freeways and high-rise public housing used to clear out older urban fabric in New York with a complete loss of places with significant heritage. These places lost all their economic activities as well because local people had fashioned their businesses to accommodate to the unique local urban fabric. The theory of urban fabrics starts by recognising the value of each place, respecting its functionality and then seeking to regenerate this by new, integrated twenty-first-century infrastructure.

2.7 Conclusion

While smart technology is a strong component of urban futures and its role in achieving urban regeneration is significant, the most important quality to be sought in any urban process is to ensure the deeper values of place are respected. There is a strong tradition in architecture and urban planning that outlines this approach through authors like Salingaros (2006, 2014), Alexander (1965, 1979, 2002) and Jacobs (1961). The contribution of this book is that such place values now need to include values about climate resilience, net zero and broader reductions in urban metabolism and liveability. These are defining the next economy and need to be attended to rapidly within our cities.

But these deeper values cannot be simply put aside by smart technology branding exercises that assert that all the big issues will be dealt with by some kind of magic. The reality is that some cities have been getting increased digital data capacity, but no other sustainability goals are achieved. Cities must be geared toward increasing the 'wholeness' of the city, and as we suggest, cities need to bring in smart technology as part of an integrated package that will simultaneously improve the urban metabolism as well as the liveability status.

Allam and Newman (2018) argue that the integration of technology in existing cities allows citizens to be participants in their management by sharing vital data that help improve areas like security but could also allow other resource and waste management objectives. Kraus et al. (2015) suggested that smart technologies can also allow locals to be more innovative and provide them with opportunities to exploit entrepreneurial opportunities that in turn lead to improved economic status and job creation and, in extension, help in reducing economic and social inequalities. This book suggests that it is no longer acceptable to simply say Smart City technologies 'allow' such fine objectives, but they must be simultaneously applied to create these outcomes, or else they are simply a branding exercise.

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