# The Role of Inclusive Educational Technologies in Transforming African Cities into Inclusive Smart Cities

*Eric Désiré* KAMENI[1,2,*] and *Stéphane Cédric* TEKOUABOU KOUMETIO[1,2,3,**]

[1] *University of Yaounde 1 - H.T.T.C. – Higher Teacher Training College - Department of Computer and Educational Technology, university of Yaoundé 1, Yaoundé, Cameroon.*
[2] *Laboratory of Computer Science and Educational Technologies (LITE), University of Yaoundé 1, Yaoundé, Cameroon.*
[3] *Center of Urban Systems (CUS), Mohamed VI Polytechnic University (UM6P), Lot 660, Hay Moulay Rachid, 43150, Benguerir, Morocco.*

**Abstract.** Inclusive smart cities aim to create a more equitable and accessible urban environment for all citizens, including people with disabilities, low-income individuals, and marginalized communities. This concept involves using technology and data to improve urban services and infrastructure while ensuring that everyone can benefit from these advances. The observation is that nowadays, in the majority of African countries, the city's transformation into a smart city only concerns a small portion of the population, those in the metropolises who have skills and access to technological tools. Those in rural areas or precarious urban quarters that are not business centres are simply excluded or ignored from the process, perhaps because they do not have the skills or access to emerging technological tools due to their geographical location. Smart education and therefore educational technologies are among the most sensitive in this context. Therefore, Inclusive educational technology can play a significant role in this case by providing access to education and training for all citizens, regardless of their socioeconomic status or physical abilities. It ensures that everyone has access to the skills and knowledge needed to participate in the digital economy and benefit from the opportunities it offers. This work identifies the roles that inclusive educational technologies can play in transforming cities into inclusive smart cities.

keywords: Educational Technologies, smart cities, inclusion, social exclusion

## 1 Introduction

As the world continues to become more interconnected, cities are beginning to adopt a range of technologies to become more connected, efficient and sustainable smart cities. Smart cities are characterized by the use of technologies such as the Internet of Things (IoT) and artificial intelligence (AI) to improve the quality of life for their citizens, enhance sustainability and optimize resource management [1]. Thus, in order to improve the management of urban processes and the needs of inhabitants, various administrations from all over the world have presented a large number of models of future cities in which technology, connectivity, sustainability, comfort, safety and attractiveness are the crucial objectives to be achieved, on the one hand, and raise awareness of the concept of "smart cities" on the other [2]. However, smart cities can also exacerbate existing inequalities if they are not designed with inclusivity in mind. The general observation shows that most of the smart city initiatives that are implemented do not always take into account the socioeconomic disparities that exist in many cities. At the same time, academics and policymakers have increasingly recognized that traditional approaches to urban planning and development are failing to address social inequality and exclusion. This has led to a renewed interest in "inclusive cities" that prioritize social justice, equity, and participation [3]. The concept of inclusive smart cities represents a significant shift in the way urban development had been viewed. By prioritizing social inclusion and equity alongside technological innovation, it creates cities that work for everyone.

The inclusive smart city finds its own meaning in Africa especially since in Africa, the region contains half of the world's extreme poverty. Social inclusion will contribute to improving the conditions for the participation of individuals and groups in the transformation of the city through areas such as markets (labor, land, housing, credit), services (electricity, health, education, water) and spaces (political, cultural, physical, social). In Africa, several cities are implementing smart city initiatives to address the challenges of rapid urbanization, population growth, and limited resources [5]. According to a report by Frost & Sullivan, the African smart city market is expected to reach $158 billion by 2025. The report also highlights that South Africa is leading the way in smart city development in Africa, followed by Kenya and Rwanda. Several

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* e-mail: eric.kameni@univ-yaounde1.cm
** e-mail: ctekouaboukoumetio@gmail.com

works in the literature have addressed the issue of transforming African cities into smart cities [5]. Those of these works interrogate and diagnose the concept of the smart city as it has been applied in Africa in order to decipher the opportunities and challenges that characterize its manifestation in space and in time. While others present the main challenges to having sustainable and smart cities in Africa in the future. Finally, some are interested in how smart cities can contribute to the development and improvement of the living conditions of citizens. However, despite these initiatives, there are still challenges facing the implementation of smart cities in Africa such as limited funding, lack of infrastructure, lack of skills in technology, exclusion, and inadequate policies and regulations among others. As for the technology skills gap, while this is less of a concern for politicians, it stands out as a critical aspect in the transformation of a city into a smart city. For what will a smart city contribute if the majority of its citizens are not sufficiently skilled to exploit the benefits of the technology it offers? Generally speaking, the process of transforming cities into smart cities most often only concerns the actors of the metropolis (in terms of training and use of technology), those of the remote areas being simply forgotten. This last aspect can be a real brake for the transformation of the city, because those who have not been involved may find themselves in a city that is much more ungovernable tomorrow than it was yesterday, characterized by a more complex flow of information and decision-making circuits than ever before, and thus leading to slower decision making. Technological education can be an asset in solving this situation. Inclusive educational technology in Africa is a growing field that aims to provide equal access to education for all, including those with disabilities. In this work, we identify the roles that inclusive educational technologies can play in transforming cities into inclusive smart cities and then propose a model of inclusive educational technologies for transforming cities into smart cities that aim to foster inclusion by focusing on various goals for and set by residents. The academic literature review helped us build an emergent narrative of African smart city exclusion and its relationship with inclusive educational technologies. We then focused on analyzing the conceptual relationships of inclusive cities and inclusive educational technologies.

## 2 Concepts and challenges

Urbanization is a global phenomenon that has led to the growth of cities and towns. The rapid pace of urbanization has resulted in several challenges, including traffic congestion, pollution, and inadequate infrastructure. To address these challenges, there is a need to smartify urbanized cities [16]. Smartification often involves the integration of technology into urban systems to improve efficiency, sustainability, and quality of life [4].

In conclusion, inclusive Smart Cities in Africa face various challenges. Addressing these challenges requires a collaborative effort between governments, private sector actors, civil society organizations, and citizens. By working together towards inclusive Smart City development,

African cities can create sustainable urban environments that benefit all citizens

### 2.1 Design methodologies for inclusive smart cities

The design methodology for inclusive smart cities involves the integration of technology and data-driven solutions to improve the quality of life for all citizens, including those who are traditionally marginalized or excluded. This approach requires a holistic understanding of the needs and perspectives of diverse communities, as well as a commitment to equity and social justice [14, 15].

In addition to the design methodology for transforming cities into smart cities proposed by [15, 16], the design methodology for inclusive smart cities involves several key steps [14, 17, 18, 39]:

1. **Understanding the needs of all citizens**: The first step is to understand the needs of all citizens, including those who may be marginalized or excluded from traditional urban planning processes. This can be done through community engagement, surveys, and other forms of research.

2. **Identifying barriers**: The next step is to identify any barriers that may prevent certain groups from accessing or benefiting from smart city services. These barriers could include physical barriers (such as lack of accessibility), digital barriers (such as lack of internet access), or social barriers (such as language or cultural differences).

3. **Co-creation**: Inclusive smart city design involves co-creation with citizens and stakeholders. This means involving them in the design process and ensuring that their voices are heard throughout.

4. **Prioritizing equity**: Equity should be a priority in all aspects of smart city design, from infrastructure to service delivery. This means ensuring that resources are distributed fairly and that no group is left behind.

5. **Continuous evaluation**: Finally, inclusive smart city design requires continuous evaluation and feedback from citizens to ensure that services are meeting their needs and addressing any issues that arise.

### 2.2 Challenges of the implementation of inclusive smart cities in africa

The concept of Smart Cities has gained significant attention in recent years, with the aim of creating sustainable and efficient urban environments through the integration of technology and innovation. However, the implementation of Smart Cities in Africa has been problematic due to various challenges [7, 8]. One of the main challenges facing the implementation of Smart Cities in Africa is limited resources. Many African countries lack the financial

and technological resources required to develop and implement Smart City projects [6, 8]. According to a report by the World Bank, African cities face a financing gap of $100 billion per year for infrastructure development [12]. This makes it difficult for African cities to invest in innovative technologies and infrastructure required for Smart City development. Another challenge facing inclusive Smart Cities in Africa is inadequate infrastructure [7, 8]. Many African cities lack basic infrastructure such as reliable electricity supply, clean water, and efficient transportation systems. This makes it difficult to implement Smart City projects that require reliable infrastructure such as high-speed internet connectivity and smart grids [13]. We also have Lack of Political Will, the success of smart city initiatives often depends on political will and support from government officials [7, 9, 10]. In some cases, African governments may not prioritize these projects or may not have the necessary expertise to implement them effectively. Privacy and Security Concerns can be also a challenge [9, 11]. Smart city technologies can raise concerns about privacy and security, particularly in countries with weak data protection laws or high levels of corruption. This can make it difficult to gain public trust in these initiatives. Social inequalities also pose a significant challenge to inclusive Smart Cities in Africa. Many African cities are characterized by high levels of poverty and inequality, which can limit access to technology and innovation for marginalized communities [13]. Inclusive Smart City projects must address these social inequalities by ensuring that all citizens have equal access to technology and innovation.

# 3 Social Exclusion in African smart cities and inclusive educational technologies

Smart cities are urban areas that use advanced technologies to improve the quality of life for their citizens. In Africa, smart cities are being developed to address the challenges of rapid urbanization, such as traffic congestion, pollution, and inadequate infrastructure. However, there is a concern that these smart cities may exclude certain groups of people, particularly those who are economically disadvantaged or have limited access to technology.

## 3.1 Social Exclusion in African Smart Cities

The emergence of smart cities in Africa has been accompanied by concerns about exclusion. The development of these cities is often driven by private sector interests and may not take into account the needs and perspectives of all citizens. For example, some smart city projects in Africa have focused on high-end residential areas or business districts, rather than addressing the needs of low-income communities [20, 21]. This can lead to a situation where only certain groups benefit from the technological advancements made in these cities.

One of the main forms of exclusion in African smart cities is digital exclusion, which refers to unequal access to digital technologies and services. This can be due to factors such as poverty, lack of infrastructure, and low levels of digital literacy [22]. Digital exclusion can lead to further marginalization and hinder economic development [23]. Another form of exclusion is social exclusion, which refers to the marginalization of certain groups based on factors such as race, gender, or disability. Smart city technologies can perpetuate existing inequalities by favoring certain groups over others [22]. For example, facial recognition technology may be less accurate for people with darker skin tones [24], leading to discrimination against black individuals. Environmental exclusion is also a concern in African smart cities. The implementation of smart technologies can lead to environmental degradation and displacement of marginalized communities [22]. For example, the construction of new infrastructure for smart city projects may require the destruction of natural habitats or the displacement of indigenous communities.

To address these forms of exclusion in African smart cities, several strategies have been proposed. These include promoting digital literacy and access to technology for marginalized communities [23], involving community members in decision-making processes for smart city projects [22], and ensuring that environmental impact assessments are conducted before implementing new technologies [25].

Exclusion is a significant challenge in African smart cities, and addressing it requires a holistic approach that considers the social, economic, and environmental impacts of smart technologies. By promoting inclusion and equity in smart city projects, African cities can ensure that the benefits of technology are shared by all members of society.

## 3.2 Inclusive Educational Technologies in Africa

Inclusive educational technologies in Africa refer to the use of technology to support and enhance the learning experience of students with disabilities or special needs. These technologies can include assistive devices, software applications, and online resources that provide access to educational content and facilitate communication between students, teachers, and parents. In recent years, there has been a growing interest in the development and implementation of inclusive educational technologies in Africa, as governments and organizations seek to improve access to education for all learners [26].

Inclusive educational technologies have the potential to bridge the digital divide and provide equal access to education for all learners, including those with disabilities for example through the use of open educational resources (OERs). OERs are freely available online resources that can be used for teaching and learning purposes. In African cities, where access to education is often limited, inclusive educational technologies can play a critical role in improving educational outcomes and promoting social inclusion. One example of inclusive educational technology in African cities is the use of mobile devices for learning [23]. Mobile devices are widely available in African cities and can be used to deliver educational content to learners who may not have access to traditional classroom settings.

For example, the Mobile Education for Teachers (MET) program in Kenya uses mobile devices to provide training and support for teachers in remote areas [27]. Another example of inclusive educational technology is assistive technology for learners with disabilities. In many African cities, learners with disabilities face significant barriers to accessing education. Assistive technology can help overcome these barriers by providing tools and resources that support learning and communication. For example, the South African National Council for the Blind has developed a range of assistive technologies, including screen readers and braille displays, that enable blind learners to access digital content [28].

In addition to these examples, there are many other innovative approaches to inclusive educational technology being developed in African cities that can contribute to smart city transformation in Africa [29, 31, 32]. These include virtual reality simulations, gamification techniques, and social media platforms for collaborative learning. However, there are also significant challenges that must be addressed in order to ensure that these technologies are accessible and effective for all learners. These challenges include issues related to infrastructure, funding, teacher training, and policy development.

## 4 Inclusive educational technologies for challenging inclusive smart cities issue in Africa

Inclusive cities and inclusive educational technologies are two concepts that are closely related and have a significant impact on each other. Inclusive cities refer to cities that are designed to be accessible and welcoming to all individuals, regardless of their age, gender, race, religion, or ability. Inclusive educational technologies, on the other hand, refer to the use of technology in education that is designed to be accessible and inclusive for all learners. The relationship between inclusive cities and inclusive educational technologies is multifaceted. On one hand, inclusive cities can provide a supportive environment for the development and implementation of inclusive educational technologies. For example, an inclusive city may have the infrastructure in place that supports the use of technology in education, such as high-speed internet access or community centres with computer labs. Additionally, an inclusive city may have policies in place that support the development of educational technologies that are accessible to all learners. On the other hand, inclusive educational technologies can also contribute to the creation of more inclusive cities. For example, technology can be used to provide access to information and services for individuals who may otherwise face barriers due to physical or cognitive disabilities. Educational technologies can also be used to promote social inclusion by providing opportunities for individuals from diverse backgrounds to connect and collaborate.

There is a growing body of literature on both inclusive cities and inclusive educational technologies. For example, a study by [33] explores the concept of smart cities as a means of promoting inclusion through technology. The authors argue that smart city initiatives should prioritize inclusion by ensuring that technological solutions are accessible and beneficial for all residents. Similarly, a study by [34] examines the use of virtual reality technology in promoting social inclusion among individuals with autism spectrum disorder (ASD). The authors found that virtual reality technology can provide a safe and supportive environment for individuals with ASD to practice social skills and interact with others.

Among the conceptual relationships between these two concepts, we can highlight the following:

1. **Accessibility**: Both inclusive Smart Cities and inclusive educational technology focus on creating accessible environments for all individuals. Inclusive Smart Cities incorporate universal design principles to ensure that public spaces, transportation systems, and digital infrastructure are accessible to people with disabilities [35]. Similarly, inclusive educational technology aims to provide equal access to educational resources and opportunities for students with disabilities through the use of assistive technologies, adaptive learning platforms, and accessible digital content [36].

2. **Digital Inclusion**: Inclusive Smart Cities strive to bridge the digital divide by ensuring that all citizens have access to affordable and reliable internet connectivity. This is crucial for enabling access to online educational resources and platforms. Inclusive educational technology initiatives can work in tandem with Smart City initiatives by providing digital literacy training programs and ensuring that educational content is available in multiple formats and languages [37].

3. **Personalized Learning**: Inclusive educational technology emphasizes personalized learning approaches that cater to the diverse needs of students. By leveraging data analytics and artificial intelligence, personalized learning platforms can adapt instructional content, pace, and assessment methods based on individual student preferences, abilities, and learning styles. In a Smart City context, this concept can be extended beyond the classroom to provide personalized recommendations for various city services based on individual needs [38].

4. **Social Inclusion**: Inclusive Smart Cities and inclusive educational technology contribute to social inclusion by creating environments that foster participation and engagement for all individuals. Inclusive Smart Cities promote social inclusion by designing public spaces that are accessible, safe, and inclusive for people with disabilities, older adults, and other marginalized groups [35]. Inclusive educational technology supports social

inclusion by providing learning opportunities that accommodate diverse learning styles, abilities, and cultural backgrounds [36].

5. **Lifelong Learning Opportunities**: Inclusive Smart Cities recognize the importance of lifelong learning and provide opportunities for individuals of all ages to acquire new skills and knowledge. Inclusive educational technology can support this by offering online courses, vocational training programs, and digital resources that enable continuous learning. By integrating educational technology into Smart City initiatives, lifelong learning opportunities can be easily accessible to all citizens [39].

## 5 Conclusion

Overall, throughout this paper, we have tried to highlight the role of smart education technologies in building inclusive smart cities in Africa. As with any smart city, the inclusive smart city would also use emerging technologies and data to improve citizens' quality of life. However, they have the particularity of adapting strategies with the ultimate aim of creating a more equitable and accessible urban environment for all citizens, including people with disabilities, low-income individuals and marginalized communities, etc. These strategies need to address a number of challenges, including education and the breakthrough of new technologies, particularly in Africa, where the urban population is young and more likely to use these technologies. Thus, the inclusive smart city strategy in Africa is heavily dependent on inclusive educational technologies, whose role is crucial. The role of inclusive educational technologies in the smart city is also reversible, and part of a cyclical process. Indeed, if the inclusive smart city strategy is to foster an environment of infrastructures such as broadband coverage and community telecenters, it must facilitate the implementation of inclusive educational technologies. In future work, we will study models for integrating inclusive educational technologies into smart city strategies in Africa.

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