

Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Hugo Rodrigues · Tomohiro Fukuda ·
Simon Elias Bibri *Editors*

Resilient and Responsible Smart Cities

Second Edition



Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

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Simon Elias Bibri
Editors

Resilient and Responsible Smart Cities

Second Edition

 Springer

Editors

Hugo Rodrigues 
Department of Civil Engineering
University of Aveiro
Aveiro, Portugal

Simon Elias Bibri
Department of Computer Science
and Department of Architecture
and Planning
Norwegian University of Science
and Technology (NTNU)
Trondheim, Norway

Tomohiro Fukuda
Graduate School of Engineering
Division of Sustainable Energy
and Environmental Engineering
Osaka University
Suita, Osaka, Japan

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Preface

Throughout time, cities have always been the center of economic development, technological innovation, social development, and nowadays, cities concentrate more than half of the world population. Nowadays, cities are viewed as complex adaptive systems, consisting of services, resources, and citizens, with strong interactions and changes in both the rapid spatial and temporal domains, but also related to traffic congestion, pollution, environmental degradation without an adequate living environment. These changes create new challenges, and the smart city concept offers opportunities to rise to these challenges, solve urban problems, and provide citizens with a better living environment.

According to the OECD Resilient cities are cities that can absorb, recover and prepare for future shocks (economic, environmental, social, and institutional), and resilient cities promote sustainable development, wellbeing, and inclusive growth. Also, the UN Sustainable Development goals have put several topics in the policymaking debate, namely the 11th SDG, and the imperative of making cities inclusive, safe, resilient, and sustainable.

This book includes several research papers that discuss processes, case studies, and research work that may help the process of building and changing the cities to become more resilient, responsible, and have smart environments, especially in places with a lack of power, resources, and know-how. The book is composed of three parts, the Part I is related to the Computational Advancements in Future Smart Cities, discussing several innovations and developments of technology, IoT, robotization to improve the efficiency of the resource's consumption. The Part II is devoted to The Path to Future Resiliency: Theory and Application, presenting several discussions and solutions for cities facing different hazards, finally the Part III is related to the Challenges and Key Components for Developing Smart Cities, presenting several case studies to improve and turn the cities in a more inclusive, safe, resilient, and sustainable place. The book presents the mix of high technologies, concerns with the efficient use of the resources, and the promotion of a better social environment that can give paths to assure more Resilient and Responsible Smart Cities.

Aveiro, Portugal

Hugo Rodrigues

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Computational Advancements in Future Smart Cities



Building a Smart City from the Periphery to the Centre: Application of Technological Solutions for Intelligent Integration of Peripheral Neighbourhoods

Claudino F. Pereira Mendes, Álvaro Elgueta-Ruiz, Loide Monteiro, and Guevara Cruz

Abstract

The sustainable development challenges for small archipelagic cities are exponentially bigger when compared to the large metropolises on the continent. One of the biggest problems of these small cities face is related to disorderly urban expansion. From night to day, new peripheral neighbourhoods are born, bringing with these all social and urban problems of an unplanned expansion. Hence, it is essential that these cities leverage their progress on sustainable pillars, creating smart solutions tailored to their challenges. In this sense, this article analyses the strategies and solutions implemented in the city of Praia, Cape Verde, with the purpose of classifying it in the context of Smart City. Considering international standards and the specific needs of the city, the impact of digital transformation on the smartization of the city was analysed, as well as the contribution of peripheral neighbourhoods in this process. This study concludes that, in addition to technological solutions, other factors that ensure the sustainable and inclusive growth of peripheral communities must be prioritized for an effective smartization of city. In the specific case of the Safende neighbourhood, the transformation initiated with a view to its smartization, leveraged on fundamental pillars of a Smart City Project. The neighborhood has functioned as a model Living Lab that can be replicated in other similar peripheral neighbourhoods in the city of Praia.

Keywords

Smart City • Sustainable cities • Smart neighbourhood • ICT

C. F. P. Mendes (✉) · Á. Elgueta-Ruiz
University of Cape Verde, Praia, Cape Verde
e-mail: claudino.mendes@docente.unicv.edu.cv

L. Monteiro · G. Cruz
Smart City Cape Verde Foundation, Praia, Cape Verde

1 Introduction

Owing to their size and geographical characteristics, most small island cities face greater challenges than the large cities on the mainland. These challenges are essentially related to transport, economic scalability, climate vulnerability, cost of energy, among others, which are aggravated by the lack of mineral wealth and conventional energy resources such as oil, gas, or coal (World Institute for Development Economics Research, 1995). At the level of land use planning, island cities face another serious problem related to the rapid and disorganized growth of their borders and the emergence of informal peripheral neighbourhoods. In search for better opportunity in social and economic life, entire families leave their homes in the countryside, their island, or their country to venture into large cities on the main island (Mazumdar, 1987; Lall et al., 2006).

In this sense, in the planning of cities, priority must be given to sustainable urbanization, including these new communities and their residents, as a way to meet all the goals of sustainable development (SDG). However, if on the one hand urban areas offer new opportunities and jobs for millions of people worldwide, and contribute to poverty eradication efforts around the world, on the other hand, according to United Nations, a rapid growth in urbanization increases the pressure on the basic resource and increases the demand for energy, water, and sanitation, as well as for public services, education, and health (World Economic & Social Survey, 2013). Today, according to World Economic Forum (2016), a significant part of the population, more than 50%, around the world lives in urban areas and surrounding areas, and expecting to grow to 70% by the year 2050.

The cities of the Cape Verde Islands are no exception. In 2018, according to UN-Habitat data, 65.7% of the population lived in urban areas, with a growth rate of 1.97% in the past 5 years. These urban centres are, in their majority, informal neighbourhoods without urban equipment, with precarious residences, dominated by the unfinished

construction of cement blocks, occupying the unstable slopes and the beds of the streams (UN-Habitat, 2020). The city of Praia, capital of the country, is where this population concentration is most concerned, since the city already had a population of 151,436 inhabitants in 2015, corresponding to more than 27% of the entire archipelago (Instituto Nacional de Estatística de Cabo Verde, 2015). According to the National Statistics Institute, it is estimated that in 2017, the population of Praia was already 159,050 inhabitants, as shown in Fig. 1. This population growth is regional and is due to the increase in internal migration caused by rural outflows and migration from other islands, as well as external migration from West Africa (Dias et al., 2014).

This population growth observed in the city of Praia has caused housing problems in the city, with the rapid growth of spontaneous neighbourhoods in the suburbs of the capital, which do not obey any planning or have any basic infrastructure. Most of these illegal spontaneously occupied neighbourhoods are located in very high-risk areas, especially in the floodplains of the streams and on slopes with a high slope, without a street layout, with lack of basic sanitation infrastructure and deficient public lighting, which makes access to help and emergency means difficult. These neighbourhoods are mainly occupied by precarious buildings inhabited by a population of very low income, which contrast with the city center that followed a planned and structured urban plan (Monteiro et al., 2012). This spontaneous, clandestine, and disorganized phenomenon, which began in the 1960s, persists to this day, revealing the power of population dynamics, but also the weaknesses of the municipal government. In the case of Praia city, taking into account the maritime boundary to the south and the recognition of neighbourhoods to the east and southeast, the dynamics of the emergence of new informal neighbourhoods extends more towards the north, northeast and northwest of the city limits (Nascimento, 2009). Figure 2 shows an example of the urban difference between the city centre and a peripheral neighbourhood in Praia.

The problem of smallness and the periphery is an urgent challenge and, of course, raises the question: what can small towns do for the active participation of peripheral neighbourhoods in regional politics and in the sustainable development of the city? (Hovgaard et al., 2004). To answer this and other questions, the Cape Verde government created the Cape Verde Strategic Sustainable Development Plan (PEDS) whose main goal is to guarantee a better quality of life for the population, reducing inequalities and inequities, so that SDGs have a real impact on people (Governo de Cabo Verde, 2017; Nações Unidas Cabo Verde, 2020). The United Nations advocates the same strategy. According to UN-Habitat's, 2020–2030 strategic plan, only through a clear and transformative strategy, partnerships and a new innovative vision of development, is it possible to effectively respond to new and persistent development problems in the world's cities developing and developed (Estevez et al., 2016; UN-Habitat, 2019). However, cities must be able to overcome some relevant challenges in the smartization process, in order to meet critical requirements such as availability and data processing, security, citizen engagement and better services for citizens. These challenges are linked, not only to technological issues such as: storage and management of a huge volume of data, interoperability, standardization, security and connectivity but also to political issues such as legal obstacles in the treatment of data, social and territorial tensions, political resistance and ideological, among other challenges inherent in the cities themselves (Soupizet, 2017). These must be added the need to create a market for smart technologies, in order to meet the new requirements that smart cities impose on us. Especially for developing countries, who face various constraints related to budget restrictions, lack of technological maturity, lack of technical skills, restriction of integration, limitation in some basic services, privacy and data security, political obligation, it should be to create an appropriate market (Chatterjee & Kar, 2015).

Deficiencies in urban planning, infrastructure, institutional and legal are weaknesses of many African cities,

Fig. 1 Demographic evolution of Praia between 1990 and 2017

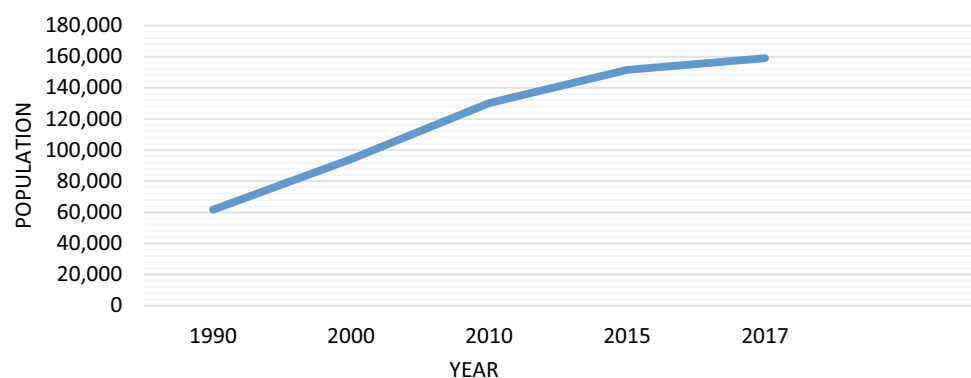




Fig. 2 View of a suburb neighbourhood (left) and the city centre (right)

which have limited their progress. However, a growing urban transformation in these cities is being verified, in this sense, ICT has a fundamental role in terms of improving the system of production and distribution of goods and services, as well as in the connection between communities (Mboup & Oyelaran-Oyeyinka, 2019). In a study on smart city projects in Mediterranean regions, the main challenges for some Mediterranean cities were identified. These challenges were grouped into 6 domains: governance, economy, mobility, environment, people, and experience (Monzon, 2015). Taking into account the characteristics of the city of Praia: island, city capital, low economy, and border with the sea, the challenges would be quite similar, naturally adding some specificity.

This article aims to analyse the impact of digital transformation on the smartization of a small island city, having as reference the city of Praia, in Cape Verde. On the other hand, we intend to evaluate the importance of transforming the Safende peripheral community into a “smart neighbourhood”, taking into account its context as urban living lab and the indicators for smart city projects, in a perspective that the smart peripheral neighbourhoods can help to develop an intelligent and sustainable city.

2 Smart City and Smart Neighbourhood

Smarting cities is an inevitable process. Cities become smart as governments, businesses, and communities increasingly depend on new technologies to meet the challenges of rapid urbanization. In fact, what makes a city smart is the use of innovative and intelligent technologies combining energy, mobility, and infrastructure, to improve and connect the city's seven essential components and services: municipal administration, education, health, public security, real estate, transportation, and public services. A smart city not only raises economic opportunities and social benefits, but it also allows the mitigation of urbanization problems (Washburn & Sindhu, 2010). In this sense, the focus on information and

communication technology (ICT) is fundamental, as they function as the main drivers of smart city initiatives. The integration of ICT with development projects can change the urban landscape of a city and offer a number of potential opportunities, they can help to improve the management and functioning of a city (Vasseur & Dunkels, 2010; Odendaal, 2003).

A smart city is much more than the integration of ICT and the use of digital applications, this concept lacks an important component, which is the people, they are the main protagonists, who through continuous interaction, manage to shape the city. Hence, a smart city should be understood as a creative space that has people, education, learning, and knowledge as priorities (Albino et al., 2015). A smart city is an educational centre that improves the level of education of its inhabitants and that improves competitiveness in the urban context and the global knowledge economy; therefore, it produces more qualified and specialized people. It is this junction between “smart people” and a new creative culture driven by them, which triggers urban development (Nam & Pardo, 2011). However, the smart concept has been adopted by several governments with regard to innovative policies and strategies aimed at the sustainable development of cities, both in terms of urban planning and in terms of economic and social progress. That is, they as a normative claim and an ideological dimension treat smart growth, where “intelligence” is associated with the successful implementation of policies in their jurisdictions (Center on Governance, 2003; Das, 2019). Therefore, when designing a Smart City, we must consider 3 key and interconnected factors: technology (hardware and software infrastructures), people (creativity, diversity and education), and institutions (politics and governance). A city became smart when investments in human capital and IT infrastructure leverage sustainable growth and improve quality of life, through participatory governance (Caragliuet et al., 2009).

World Economic and Social Survey (2013) and Mensah (2019) suggest that an intelligent urban management is

essential in the search for sustainability in cities. Which requires integration, coordination, and multilevel cooperation between local and national communities, and partnerships to mobilize public and private resources to invest in infrastructure, such as roads, water, sewerage, electricity and services, related to schools, public transport and health. In this perspective, a transformation or restructuring betting on Smart City projects must not only consider the new peripheral neighbourhoods, but must also prioritize their integration, through sustainable and intelligent projects—Smart Neighbourhood—where the empowerment of its inhabitants is a strategy for help achieve those goals. The World Bank argues that “building inclusive, resilient, competitive, and sustainable cities and communities is essential to achieving the Sustainable Development Goals by 2030, eliminating extreme poverty and boosting shared prosperity at the local, regional and national level” (The World Bank, 2020).

The way smart cities should be structured creates opportunities for a better inclusion of peripheral communities in the urban perimeter. These communities could eventually serve as laboratories for “intelligent policies” and technological experiments in a perspective of replicable and expansion models, inappropriate for testing in large center (De Falco et al., 2018). If, on the one hand, the peripheral neighbourhoods are a great challenge for urban design, or even spatial planning, on the other, while Urban Living Lab (ULL), they can be an excellent strategy to develop a smart, sustainable and inclusive city, where it is possible to test new technologies and measure public acceptance (Lacroix et al., 2017). But they can also create local development solutions, with new rules and procedures that can be replicated (Huston et al., 2015). Living Labs function as an open-innovation ecosystem in which open-innovation practices are adopted to identify and deal with urban problems (Leminen et al., 2012; Steen & Bueren, 2017), work as a collaborative process that allows the implementation of a systematic governance of stakeholders interconnecting their interactions to address the Smart City (Baccarne et al., 2014; Chesbrough & Bogers, 2014). Kumar (2015), argues that for radical changes to be made and sustainable cohesive communities to be created, the 4P (Private, Public, People, & Partnerships) model should be adopted. Where close collaboration between central and local government is able to exploit the vast potential of human, innovative and creative social capital, as a model for the balanced development of communities, recognizing the power of people to organize and create networks for sharing information, knowledge, resources, and common goals (Vanolo, 2014).

3 Methodology

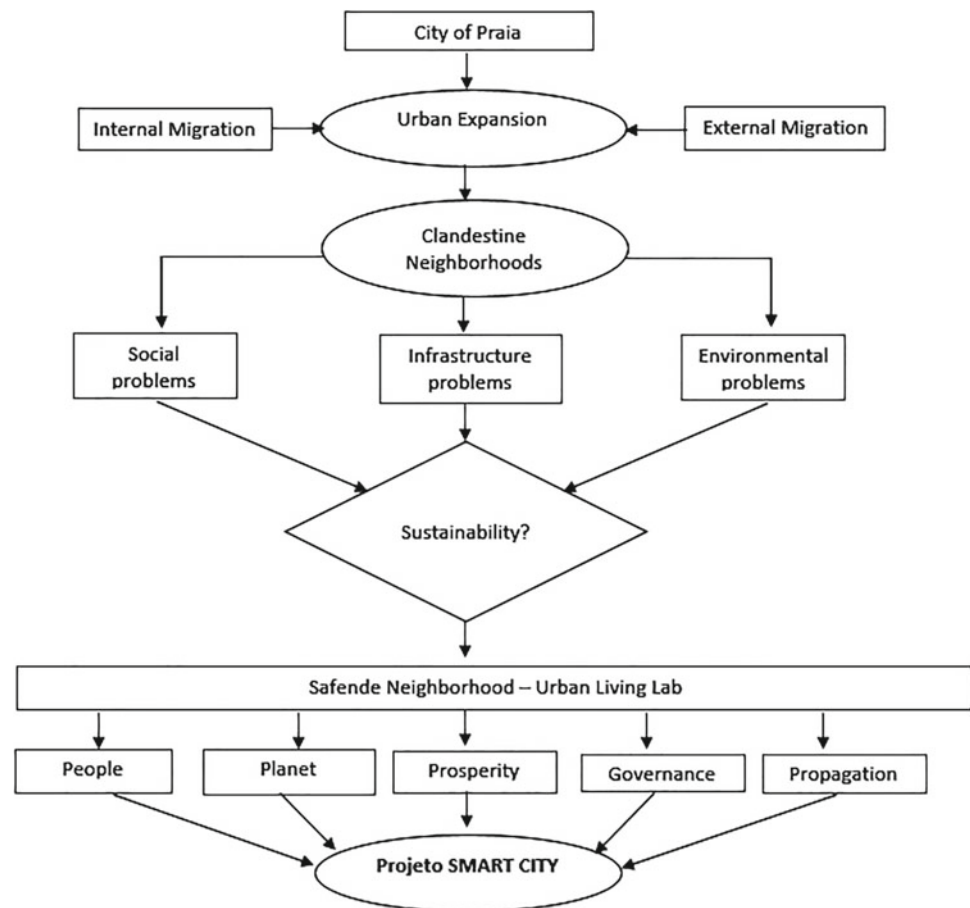
The methodology adopted followed the 5 steps represented in the flowchart of Fig. 3, in order to obtain a qualitative assessment of the smartization of the Safende neighbourhood as a Smart City Project. Thus, in a 1st stage, it resorted to literary analysis, focusing on studies on urban expansion, with an emphasis on small and medium-sized cities, with reduced economic resources and with a maritime border, in which we sought to identify the main factors that influence in the expansion of the city of Praia and its consequences. In the 2nd stage, it focused on the problem that occurred with the informal peripheral neighbourhoods, where more specifically the peripheral neighbourhoods of the city of Praia were analysed. In a 3rd stage, it examined the plans and strategies for the sustainability of the city of Praia, in accordance with the national sustainable development plan (PEDS) and the United Nations Sustainable Development Goals (SDGs). The purpose of this step was to position the city of Praia in relation to the analysed ranking, making a comparative analysis with key indicators. In the penultimate stage, based on the actions and projects implemented and in execution, it was analysed whether the Safende neighbourhood fits within the parameters of an urban living lab (ULL). Finally, in the 5th stage, an evaluation of the smartization process in the Safende neighbourhood was carried out as a Smart City Project, taking as reference the determined indicators, and the data collected in the field.

Data were collected through in-depth semi-structured interviews about the needs of the community and citizens with various partners and decision makers, representing different identified sectors: community leaders, cultural and sports associations, project managers, municipal government, religious leaders and NGOs. Subsequently, based on the analysis of the interviews, data collected locally through SWOT analysis, and considering the specificities of the archipelago, it was possible to configure the indicators to assess the impact of the “smart neighbourhood Safende” project.

4 Smart or Sustainable City?

Taking into account the problems mentioned and the specificity of the city of Praia, a restructuring or upgrading to a more intelligent and inclusive city, seems to be something unquestionable to ensure the sustainability of the city. However, the doubts that may exist are: What should we prioritize in the transformation of the city of Praia, its smartization or its sustainability? Can a city become smart being unsustainable? The only certainty is that, regardless of the path prioritized, ICT would play a major role in

Fig. 3 Conceptualization of the analysis model



improving the management of the city's resources (Elgazzar & El-Gazzar, 2017). In this perspective, some authors argue that the sustainability of cities is intrinsically linked to the adoption of smart technologies that supported the "smart city initiatives" proposed by communities and/or governments of that city. Therefore, the smartization of cities necessarily implies achieving their sustainability and a way to ensure the quality of life of their inhabitants (Albino et al., 2015; Kondepudi & Kondepudi, 2015).

However, in (Yigitcanlar et al., 2019), they argue that although sustainability is often desired as a result of smart city initiatives, there is little evidence of how sustainability results are incorporated or achieved in smart city initiatives, in fact, that the results provide evidence that the current practice of smart cities fails to incorporate a comprehensive sustainability goal that is progressive and genuine. Which lead us to assume that the concept of "Smart and Sustainable City" is the one that best suits the city of Praia. Since it is a broader concept that seeks the quality of life of citizens, through socioeconomic development, but also focuses on the use of technologies in city planning and management, as well as for the optimization of endogenous resources.

In fact, the adoption of information and communication technologies provides an increase in efficiency and productivity through automation and data-based management, especially in relation to the modern configuration of urban and metropolitan areas in the so-called smartization process (Bifulco et al., 2016). Especially in the African panorama, the "smart" concept should have a broader context, focusing on the economy, the environment and the efficiency of transportation, but also on the management of water and energy resources, improving health and safety, as well as on the provision of tools that help in better planning and governance of cities. In this sense, ICT plays a fundamental role as an integrated element to realise the above-mentioned aspects. However, ICT alone does not carry out the smartization of cities (Ahad et al., 2020; Mboup & Oyelaran-Oyeyinka, 2019).

4.1 Smart Cities Features and Indicators

Taking into account the challenges of cities and the benefits of digital technologies in their smartization and sustainability, it was then possible to understand what are the paths to a