Smart City in Cameroon

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Abstract: This paper explored the smart city concept in Cameroon. Its origin, characterization, some examples of smart cities and Africa's situation were highlighted; then, Cameroon's capitals smartness were assessed. A city is smart when it uses ICTs to meet its citizen's needs. The concept appeared in 1990 under the denomination 'virtual city' before becoming what is known today. Several northern cities such as Amsterdam are already labelled smart. In Africa, initiatives are mainly taken under the impetus of Rwanda but there is a willingness of each country to transform its cities according to its understanding. Yaounde's smartness evaluation gave a score of 17.3/100 and the IESE Business School ranks Douala 170th on 174 cities with a score of 17.03/100 which implies they cannot be considered as smart. To transform Cameroonian cities into smart cities, a vision is necessary from the achievement's consolidation to the implementation of a Smart Cities Master Plan.

Keywords: Smart city, Cameroon, Yaounde.

1. Introduction

In 2018, the world urban population was 4.2 billion with 55% living in urban areas (Winkowska et al., 2019). According to forecasts by the Population Division of the United Nations Department of Economic and Social Affairs, this share will increase to 68% in 2050. Urbanization, the gradual migration of people from rural to urban areas, combined with the general increase in world population, therefore implies that by 2050, urban areas will be home to almost 2.5 billion additional people (Winkowska et al., 2019). These urban growths come with unprecedented changes in the demands for energy, water, education, health care, housing, transport, waste and pollution management, which are putting the infrastructure of all the world's cities, and therefore those of Cameroon, under severe strain. The rate of urbanization in Cameroon has increased over the last twenty years and reached a value of 56.37% in 2018; this trend is not expected to decline as low-income countries will face faster urbanization than high-income countries (United Nation [UN],2014). In this context, smart cities appear as a response to the challenges created by this rapid urbanization (Mohanty et al., 2016). While northern countries are using the unprecedented growth of ICTs to implement sustainable and smart solutions in their cities, Africa in general and Cameroon in particular seems to be lagging, hence the interest of this work to investigate the concept of smart city in Cameroon. To provide elements of answers to this concern, this paper will first present the origin of the concept of smart city, its evolution, definitions, characterization and the situation of the smart city in Africa preceded by a presentation of some smart cities in northern countries; then, it will highlight the case of Cameroon by evaluating the performance of its capitals on the topic of smart city and presenting a plan to transform its cities into smart cities.

2. Origin, evolution, definition and characterization of the smart city concept

2.1. Origin and evolution

The concept of the smart city emerged over time with different names and perspectives, as a means of defining urban technological development (Anthopoulous, 2017). Although authors such as (Breux and Diaz, 2017) attribute it various origins, it is clear that its first appearance was in the late 1990s, when academics began to discuss the installation of ICT projects in urban space to address local needs (Anthopoulous, 2017). In a study published in 1997, Graham and Aurigi introduced the term 'virtual city' to denote a city that uses the potential of the Internet to support local democracy, urban marketing, local business-to-business networking and community development within the city. In the same study, they introduced the concept of the 'digital city', a more socially inclusive and dialogue-oriented virtual city, which was lacking in its predecessor. The concept of the 'digital city' then evolved into the 'ubiquitous city' (Anthopoulos and Fitsilis, 2014). The term 'ubiquitous city' was coined by the South Korean government in 2003, and refers to a city that provides services and content to citizens via a network with fixed or mobile infrastructure, built on high-end technologies (Lee et al., 2014). It is only in 2005 that the term smart city will be used for the first time (Pisani, 2015). That year, Bill Clinton challenged John Chambers, president of Cisco, to use his firm's technological tools to make cities sustainable (Pisani, 2015). In response, Cisco launched a research program on the topic smart city. Several other firms such as IBM, Nokia, Schneider Electric and Philips will follow suit later. The result will be an unparalleled effervescence, still visible today, around the issue in academic circles as well as with governments and international organizations.

2.2. Definition and characterization

Since late 90s, where it originated, the concept of Smart City has been the subject of numerous debates between academic, industrial and governmental actors. There is currently no consensus on its definition (Myeong et al., 2018), and Albino et al. (2015) have identified 23 different definitions. This variety can be explained by the fact that the Smart City, due to the diversity of the fields it touches, is subject to multidisciplinary research (Angelidou, 2015). Dameri, (2017) defines a Smart City as a city with great intellectual capital and capable of using its knowledge to choose the best solutions for its quality and future development. Bakıcı et al, (2013) believe that a Smart City is a technologically advanced city that connects people, information and elements of the city using new technologies to create a sustainable, green city with innovative competitive commerce and a good quality of life. Cisco believes that a smart city is one that uses digital technology to connect, protect and improve the lives of citizens. The European Commission's FP7-ICT and CIP ICT-PSP programs see the Smart City as an open innovation environment focused on the user (Schaffers et al., 2011). All these definitions summarize the Smart City as a city that: provides an economic base, builds efficient urban infrastructure, improves the quality of life and the environment, ensures social integration, preserves environmental qualities and guarantees good governance (Yigitcanlar and Lee, 2014). There is no consensus on the different components of a smart city as several researchers suggest different approaches (Dameri, 2017). Nevertheless, all these approaches somehow relate to the six components of the smart city as defined by Giffinger et al. (2007), namely:

- Smart living: Innovation to improve the quality of life in the urban space, social cohesion, health services, citizen's safety, etc.
- Smart governance: Improvement of administrative services, involvement of population in decision-making, dematerialization of services, transparency, etc.
- Smart economy: Technology and innovation to strengthen the development of the city, businesses, employment and urban growth, productivity, entrepreneurship, etc.

- Smart mobility: Intelligent and sustainable transport systems integrated real-time traffic monitoring and control systems, real-time traffic data collection systems, etc.
- Smart environment: Innovation and integration of ICT for the protection and management of natural resources (waste management systems, emission control, recycling, sensors for pollution monitoring, etc.).
- Smart people: Creativity and innovation of the population, level of education, ethnic plurality, participation in public activities, etc.

3. Smart city in Europe, America, Asia and Africa

3.1. In Europe: Case of Amsterdam

Amsterdam is universally recognized as the leading smart city not only in Europe, but also worldwide. However, the development of Amsterdam Smart City has gone through several different phases, from the Digital City Strategy to the Amsterdam Smart City Program (ASC) (Dameri, 2017). The ASC was set up in 2009 with the ultimate goal of meeting CO2 emission targets and supporting the economic development of the Amsterdam Metropolitan Region (Ministry of Industry and Information Technology [MIIT], 2014). Full documentation on the activities and projects carried out under the CSA initiative is available on the CSA website http://amsterdamsmartcity.com/. Here are some examples:

- Smart Work@IJburg: A project to set up an intelligent work center close to the homes of employees who are usually stuck in miles of traffic jams (MIIT, 2014);
- Open data: Apps for Amsterdam 2 is the second open data competition of the municipality of Amsterdam in which developers are challenged to create applications based on the municipality's data in the areas of safety, mobility, employment, energy, tourism, culture and democracy (MIIT, 2014).

3.2. In America: Case of New York

In 2012, Cisco, in partnership with the City of New York through Mayor Michael Bloomberg, launched an interactive platform called City24/7 to provide citizens with information from open government programs, local businesses and on-demand events. In April 2015, Mayor Bill De Blasio announced the release of 'One New York': the plan for a strong and fair City, a comprehensive plan for a sustainable and resilient city for all New Yorkers that addresses the profound social, economic and environmental challenges ahead (New York City Mayor's Office of Tech + Innovation ,2015). This plan, available online at nyc.gov/onenyc, presents projects to prepare New York City for the future. Some examples of projects that fit in with the city vision are listed below:

- New York City's Citi Bike: A bike-sharing system in operation in Manhattan, North Brooklyn and Western Queens. The program deploys hundreds of stations with bikes that are available 24 hours a day, 7 days a week. Citi Bike's connected application helps users find the nearest available bike in real time and tells application users how to get to a station;
- Hunch Lab: A software solution that uses historical data and terrain modelling to predict the occurrence of crimes. This solution identifies crime hot spots, which helps the police to increase public safety in the area.

3.3. In Asia: Case of Singapore

Singapore's Smart City initiatives are part of the 'Smart Nation' vision launched in November 2014 by Prime Minister LEE HSIEN LOONG, which seeks to harness ICT, networks and data in response to the growing urban challenges of an ageing population, urban density and energy sustainability. The Smart Nation vision encompasses a broad spectrum including intelligent transport, security, energy, buildings, education, health and many others. Here are some of the achievements of the Smart Nation vision:

- One motoring: A comprehensive portal serving all drivers and vehicle owners in Singapore. On this web portal, citizens can access traffic information collected by roadside cameras and GPS-enabled taxi vehicles (Inter-American Development Bank [IDB], 2016);
- To engage citizens in improving water use efficiency, the Singapore Water Utility provides a mobile application that allows citizens to view their current bills and payment status, better understand utility usage and submit meter readings (IDB, 2016).

3.4. In Africa

One of the first initiatives bringing together all African countries around smart city issues is the Transform Africa summit, the first edition of which was held in Kigali, Rwanda, from 28 to 31 October 2013 (Mbassi, 2016). This led to the adoption by seven African Heads of State (Rwanda, Kenya, Uganda, Southern Sudan, Mali, Gabon and Burkina Faso) of the Smart Africa Manifesto, in which they committed to take a leadership role in accelerating socio-economic development through ICTs. The Manifesto was later endorsed by all African Heads of State at the 22nd Ordinary Session of the Assembly of the African Union in Addis Ababa on 30-31 January 2014. The five pillars of the Smart Africa Manifesto are policy, access, e-government, private sector/entrepreneurship and sustainable development. Four years later in Kigali, the 3rd edition of the Transform Africa Summit on Smart City Development in Africa was held; the main decision was taken by the 5th Board of Directors Meeting of Smart Africa and it concerned the Strategy of the African Common Network, Smart and Sustainable Cities. Smart Africa was the driving force behind the creation, in partnership with several stakeholders, of Do4africa, an online platform where African start-ups can come and propose their solutions to make Africa Smart. At the practical level, this uniqueness advocated during these summits is hardly palpable, there are rather initiatives at national level and this creates a real heterogeneity in the very understanding of the concept of smart city and in the development of strategies to make African cities smart. The initiatives are spread across the continent, from North Africa to Southern Africa, and from West Africa to East Africa.

3.4.1. Case of Senegal in West Africa

In Senegal, the city of Diamniadio is being built 40 kilometers from Dakar. Due to congestion, the Senegalese capital has become one of the most polluted cities in terms of air quality according to the World Health Organization. By creating a city located 12 kilometers from the capital, the Senegalese authorities wish to offer a competitive urban center and thus redirect part of the urban flows, reduce congestion and CO2 emissions. To achieve this objective, the Senegalese authorities plan to relocate several ministries in the new city and create a dynamic economic ecosystem thanks to companies in the digital sector. The project is not completed but was expected to be close to 80% by 2018; however the relocation of the ministries is already effective.

3.4.2. Case of South Africa in Southern Africa

The Government of Cape Town has launched a four-pillar project with the aim of establishing itself as a smart city. The city is already taking advantage of real-time data efforts to improve emergency response, including fire and rescue, law enforcement and disaster risk management (Thea Sokolowski, n.d.). The Cape Town Emergency Dispatch Centre was established to form an integrated public safety solution that facilitates operations and data sharing. To this end, IBM has launched a fire management portal, which takes fire incident data from the open data platform in Cape Town and overlays it with historical weather maps from IBM's own weather portal (Thea Sokolowski, n.d.). The system can incredibly predict high and extreme risk fires, enabling managers to prepare for emergency response. In addition, the city has implemented the Cape Town open data portal, a website where data on the city can be accessed free of charge to increase transparency and encourage citizen involvement in the creation of solutions.

3.4.3. Case of Rwanda in East Africa

Rwanda is one of the pioneers of intelligent urban engineering in Africa. Considerable efforts have therefore been made to increase and simplify access to public services. For example, the capital city offers its inhabitants free Wi-Fi access in public spaces, transport, restaurants, hotels, etc. The Rwandan administration has also succeeded in anticipating its digital revolution. Mandated by the government, the Rwanda Online company provides citizens with 'Irembo', an internet site that allows them to renew their passports, apply for a new identity card, obtain a copy of their criminal record, etc. At the same time, the public transport payment service has been simplified. Thanks to Tap & Go, users now simply need to obtain a transport card, load it with the number of journeys they wish to make and pass it in front of an electronic box that records the journey. In addition, to support the Smart Kigali initiative, the government has launched the Smart Rwanda master plan which aims to make Rwanda a smarter country with a knowledge economy by using ICT services that improve productivity and efficiency. Rwanda is working with local and international ICT companies including Inmarsat, Nokia, Ericsson and Intel as technology partners to implement Smart City solutions under a public-private partnership (PPP) model.

3.4.4. Case of Morocco in North Africa

Through its economic capital, Casablanca, Morocco aspires to become a reference in terms of smart cities in the continent (Telecom Review Africa, 2019). Currently, this city is home to more than half of the Moroccan population, almost 5 million inhabitants, and this share will increase by almost 70% in 2050 (Telecom Review Africa, 2019). The stakes are therefore high for intelligent and sustainable urban development. The development of Casablanca Smart City should enable a sustainable response to these challenges through an intelligent organization of space, optimization of resources and improved relations with citizens via the collection, management and analysis of data provided by the digital transformation currently underway. Casablanca is, since October 2015, the first African city to be part of the network of twenty-five smart cities selected by the Institute of Electrical and Electronics Engineers (Telecom Review Africa, 2019). In addition, the kingdom has adopted a number of smart city innovations. Maroc Telecom's smart home, offered in partnership with Somfy, allows users to synchronize and record their personal data and to equip their homes with tools that can be operated remotely, enabling them to optimize energy use or improve the security of their homes (Mohamed Jihed, n.d). Lydec has launched a project for smart water and electricity meters that use sensors on the meter to regulate the flow rate according to the customer's energy consumption. The iTaxi, an intelligent mobility service, makes it possible to order a taxi that will be assigned to the customer according to his position in the city.

3.4.5. Case of Cameroon in Central Africa

Yaounde hosted from 11 to 14 July 2017 the ICT Africa Symposium under the theme 'Smart City, Communities 2.0 - SMEs and Online Protection of Vulnerable People in the era of SDGs and Emergency' (OtricNgon, 2017). A meeting that brought together various digital stakeholders, to achieve the establishment of Smart Cities in Africa. The results of this symposium and the actions that resulted from it were nowhere to be found. There is very few information related to smart city in Cameroon. In order to get an idea, an evaluation of its capitals on the theme of Smart City was performed.

4. Methodology

There are multitudes of classifications of cities on topic related to smart city. Table 1 presents a non-exhaustive list of some of these classifications.

Table 1. Some Smart City classification systems (Authors's elaboration).

Indice	Author	Theme addressed	Indicators	Geographical area	Methodology
Smart city performance	Rudolf Giffinger	Smart city	74	European Cities	Z-Standardization
Cities in motion index	Business School of Navarra	Smart city	96	World Cities	DP2 pena distance
Smart city performance	Boyd Cohen, Smart city council	Smart city	62	World Cities	Z-Standardization
Smart Cities Index	Easypark group	Smart city	24	World Cities	-
Smart City Governments	Eden Strategy Institute	Smart city	10	World Cities	-
Arcadis Sustainable cities index	Arcadis	Sustainable city	20	World Cities	-
Global City indicators facility	ISO 37120	Sustainable city	100	World Cities	-
European Smart Cities	Vienna University of Technology	Smart city	90	European Cities	Z-Standardization
Innovation Cities Index	2thinkhow	Smart city	162	World Cities	-
ITU FG-SSC	ITU	Sustainable city	88	World Cities	-
Green city index	Siemens	Sustainable city	30	World Cities	-
United Smart Cities	UNECE	Smart city	71	European Cities	-
SSC INDEX	ITU and Smart Dubai	Sustainable city	91	World Cities	Z-Standardization

The above-mentioned classifications are only suitable for comparing cities among themselves. For this work, it will therefore be necessary to develop a methodology for the individual evaluation of the performance of a city as smart

city, in this case the city of Yaounde. The first step will be to define the indicators, and the second and final step will be to define the method for calculating the city's performance. 115 indicators divided into the six components of a smart city will be used for this assessment as presented in Tables 2, 3, 4, 5, 6 and 7.

Table 2. Smart Environement's indicators (Authors's elaboration).

	Indicators	Sources
1.1	Number of LEED or BREAM sustainability certified buildings in the city	Boyd Cohen
1.2	% Of commercial and industrial buildings with smart meters	Boyd Cohen
1.3	% Of commercial buildings with a building automation system	Boyd Cohen
1.4	% Of homes with smart meters	Boyd Cohen
1.5	% Of homes with smart gas meters	Authors
1.6	% Of total energy derived from renewable sources	Boyd Cohen
1.7	Total residential energy uses per capita (in kWh/yr.)	Boyd Cohen
1.8	Are there municipal grid meeting all of following requirements for smart grid 1.) 2-way communication; 2.) Automated control systems for addressing system outages 3.) real-time information for customers; 4.) Permits distributed generation; 5.) Supports net metering?	Boyd Cohen
1.9	Greenhouse gas emissioned measured in tonnes per capita	Boyd Cohen
1.10	Environmental Performance Index (EPI)	IESE
1.11	Pollution index.	IESE
1.12	CO_2 emission index	IESE
1.13	Methane emissions	IESE
1.14	PM10	IESE
1.15	Fine Particular matter 2.5 concentration (µg/m3)	Boyd Cohen
1.16	% Of city's solid waste that is recycled	Boyd Cohen
1.17	Total collected municipal solid waste city per capita (in kg)	Boyd Cohen
1.18	Access to the water supply	IESE
1.19	% Of commercial buildings with smart water meters	Boyd Cohen
1.20	Total water consumption per capita (liters/day)	Boyd Cohen
1.21	Does your city have a public climate resilience strategy/plan in place?	Boyd Cohen
1.22	Population weighted density	Boyd Cohen
1.23	Green areas per capita	Boyd Cohen

Table 3. Smart Mobility's indicators (Authors's elaboration).

	Indicators	Sources
2.1	Kilometers of bicycle paths and lanes per 100,000	Boyd Cohen
2.2	% Of shared bicycles per capita	Boyd Cohen
2.3	% Of shared vehicles per capita	Boyd Cohen
2.4	% Of Electric Vehicle charging stations within the city	Boyd Cohen
2.5	Number of metro stations per city	IESE
2.6	Number of arrival flights (air routes) in a city	IESE
2.7	High-speed train	IESE
2.8	Inefficiency index	IESE
2.9	Length of the metro system per city	IESE
2.10	Traffic index	IESE
2.11	Annual % of public transport trips per capita	Boyd Cohen
2.12	% non-motorized transport trips of total transport	Boyd Cohen
2.13	Integrated fare system for public transport	Boyd Cohen
2.14	% Of total revenue from public transit obtained via unified smart card systems	Boyd Cohen

2.15	Presence of demand-based pricing (e.g., congestion pricing, variably priced toll lanes, variably priced parking spaces). Y/N	Boyd Cohen
2.16	% Of traffic lights connected to real-time traffic management system	Boyd Cohen
2.17	% Of public transit services that offer real time information to the public	Boyd Cohen
2.18	Availability of multi-modal transit app with at least 3 services integrated (Y/N)	Boyd Cohen

Table 4. Smart Government's indicators (Authors's elaboration).

	Indicators	**Sources**
3.1	% Of government services that can be accessed by citizens via web or mobile phone (E-government development index)	Boyd Cohen
3.2	Existence of electronic benefit payments (e.g., social security) to citizens (Y/N)	Boyd Cohen
3.3	Number of WIFI hotspots per capita	Boyd Cohen
3.4	% Of commercial and residential users with internet download speeds of at least 2 Mbit/s	Boyd Cohen
3.5	% Of commercial and residential users with internet download speeds of at least 1 gigabit/s	Boyd Cohen
3.6	Internet speed in the city	IESE
3.7	% Of infrastructure components with installed sensors	Boyd Cohen
3.8	% Of services integrated in a singular operation center leveraging real-time data. 1 point for each: ambulance, emergency/disaster response, fire, police, weather, transit, air quality	Boyd Cohen
3.9	Open data platform	IESE
3.10	% Of mobile apps available (iPhone) based on open data	Boyd Cohen
3.11	Existence of official citywide privacy policy to protect confidential citizen data	Boyd Cohen
3.12	Number of embassies and consulates per city	IESE
3.13	Certified cities are committed to improving their services and quality of life	IESE
3.14	Strength of legal rights index	IESE
3.15	Corruption perceptions index	IESE
3.16	Democracy ranking	IESE
3.17	Annual number of online visits to the municipal open data portal per 100,000 population	ISO/CD 37122
3.18	Average response time to relevant inquiries made through the city's non-emergency inquiry system (days)	ISO/CD 37122
3.19	Percentage of municipal budget spent on smart city innovations and initiatives per year	ISO/CD 37122

Table 5. Smart Economy's indicators (Authors's elaboration).

	Indicators	**Sources**
4.1	Number of new opportunity-based startups/year	Boyd Cohen
4.2	Ease of starting a business	IESE
4.3	Time required to start a business	IESE
4.4	% GDP invested in R&D in private sector	Boyd Cohen
4.5	% Of city population living in poverty	The World Bank Christa Anderson
4.6	% Of persons in full-time employment	Boyd Cohen
4.7	Innovation cities index	Boyd Cohen
4.8	Cost of living	The World Bank Christa Anderson
4.9	Purchasing power	IESE
4.10	Gross Regional Product per capita	Boyd Cohen

4.11	% Of GRP based on technology exports	Boyd Cohen
4.12	Number of international congresses and fairs attendees.	Boyd Cohen

Table 6. Smart Population's indicators (Authors's elaboration).

	Indicators	Sources
5.1	% Of Internet-connected households	Boyd Cohen
5.2	Broadband subscriptions per 100 inhabitants	IESE
5.3	% Of residents with smartphone access	Boyd Cohen
5.4	Civic engagement activities offered by the municipality last year	Boyd Cohen
5.5	Voter participation in last municipal election	Boyd Cohen
5.6	% Of students completing secondary education	Boyd Cohen
5.7	Number of universities in the city that are in the top 500	IESE
5.8	Number of higher education degrees per capita	Boyd Cohen
5.9	% Of population born in a foreign country	Boyd Cohen
5.10	% Of officially registered ENOLL living labs	Boyd Cohen
5.11	Percentage of labor force engaged in creative industries	Boyd Cohen
5.12	Number of LinkedIn users in the city.	IESE
5.13	Number of landline subscriptions per 100 inhabitants	IESE
5.14	Percentage of households with a personal computer in the city	IESE
5.15	Web Index	IESE
5.16	Registered Twitter users in the city.	IESE

Table 7. Smart Living's indicators (Authors's elaboration).

	Indicators	Source
6.1	Percentage of inhabitants with housing deficiency in any of the following 5 areas (potable water, sanitation, overcrowding, deficient material quality, or lacking electricity)	Boyd Cohen
6.2	Gini coefficient of inequality	Boyd Cohen
6.3	Labor force participation rate of female.	IESE
6.4	Global Peace Index	IESE
6.5	Happiness index	IESE
6.6	Government response to situations of slavery	IESE
6.7	Terrorism	IESE
6.8	Suicide rate by city.	IESE
6.9	Female-friendly	IESE
6.10	Global Slavery Index	IESE
6.11	Percentage of households that exist without registered legal titles	ISO/TR 37150 Survey
6.12	Mercer ranking in most recent quality of life survey	Boyd Cohen
6.13	Cinema attendance per inhabitants	Rudolf
6.14	Museum visit per inhabitants	Rudolf
6.15	Theatre attendance per inhabitants	Rudolf
6.16	% Of municipal budget allocated to culture	Boyd Cohen
6.17	Violent crime rate per 100,000 population	Boyd Cohen
6.18	Number of police officer for 100,000 inhabitants	ISO/TR 37150 Survey
6.19	Technologies in use to assist with crime prevention	Boyd Cohen
6.20	Hospital bed per inhabitants	Rudolf
6.21	Health index.	IESE
6.22	Percentage of the city population with online unified health file accessible to health care providers	ISO/CD 37122

6.23	Annual number of medical appointments conducted through telecommunication or online video services per 100,000 population	ISO/CD 37122
6.24	Ratio of deaths per 100,000 inhabitants.	IESE
6.25	Doctor per inhabitants	Rudolf
6.26	Satisfaction with responsiveness in medical institutions	Rudolf
6.27	Average life expectancy	Boyd Cohen

After defining the indicators, a value is associated to each of them (data which comes from web sources and the experience of the authors); then, the value is criticized logically or according to international standards (value of a reference smart city, recommendations of the WHO, World Bank, etc.). Criticism of the value makes it possible to attribute three possible ratings to it; the low rating which corresponds to a score of 0, the medium rating which corresponds to a score of 1 and the high rating which corresponds to a score of 2. Knowing therefore the score of each indicator, the score of each of the 6 components can be calculated and then brought back to 100 with equation 1.

$$SC = \frac{STI}{SMC} \times 100 \quad (1).$$

SC: score of the component; STI: sum of the score of the indicators of the component; SMC: maximum score of the component (product of 2 times the number of indicator).

With the score of each component the City Performance can therefore be calculated with equation 2.

$$P = \sum_{i=1}^{6} C_i SC_i \quad (2).$$

P: City's performance; Ci: i-th component coefficient; SCi: i-th component score.

As regards the coefficients, there is no consensus on them; in its methodology in developing its smart cities Index, the Group Easypark assigns for example the coefficients 22.5% for the transport and mobility component, 12.5% for the sustainability component, 15% for the governance component, 5% for the innovation and economy component, 17.5% for the digitalization component, 10% for the quality-of-life component, 7.5% for the cyber security component and 10% for the expert opinion; the sum of the coefficients being equal to 100%. Based on this allocation, and including the fact that in the smart city concept, governance, ICT and citizen participation are often considered crucial, the following coefficients will be considered:

- *Smart government: 20 %;*
- *Smart environment: 15 %;*
- *Smart population: 20 %;*
- *Smart living: 15 %;*
- *Smart mobility: 15 %;*
- *Smart economy: 15 %.*

The maximum performance will therefore be 100; if it is between 0 and 49, it is a weak performance, 50 and 79, a medium performance, 80 and 100, a strong performance.

Figure 1 and Table 8 present the overall results obtained.

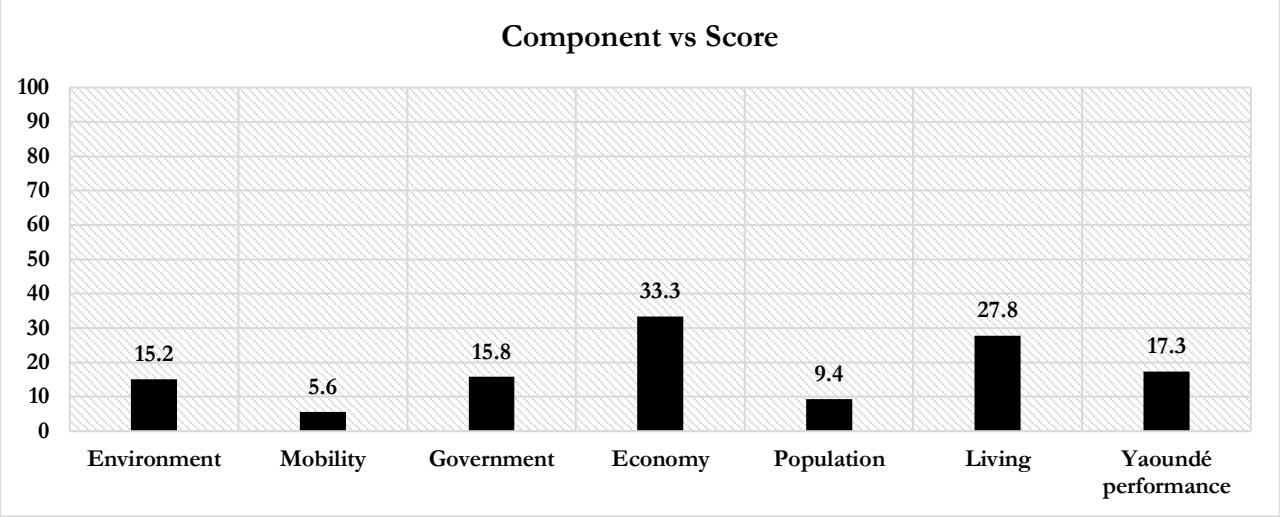

Figure 1. Score of each component and performance of the city of Yaounde (Authors's elaboration).

Table 8. Score and number of low indicators by components (Authors's elaboration).

Component	Indicators	Low indicators	Coef	Score
Environment	23	18	15	15,2
Mobility	18	16	15	5,6
Government	19	13	20	15,8
Economy	12	5	15	33,3
Population	16	13	20	9,4
Living	27	12	15	27,8
Total	115	77	100	
Performance of Yaounde (Equation 2)	17,3/100			

The city of Yaounde scores a very low 17.3 out of 100; this is mainly due to the fact that 77 out of 115 (nearly 67%) indicators scored low. The six components scored less than 50. Tables 9 to 14 present the specific results by component.

Table 9. Smart environment component's results (Authors's elaboration).

Component N°1: Smart environment			
Number of indicators: 23 **MSC: 46** **STI: 7** **SC1 (Equation 1): 15.2 / 100;** **% low indicators: 78 % (18/23)**			
Indicators	**Value**	**Comments**	**Score**
1.1	Not found	Data not found, can be assumed inexistant or very low	Low=0
1.2	0.72 %	Not a known minimal value, but the value is very low of itself	Low=0
1.3	Not found	Data not found, can be assumed inexistant or very low	Low=0
1.4	0.72 %	Not a known minimal value, but the value is very low of itself, it is 29% in Great Bretaign for example (Smart meter statistics of 2019)	Low=0
1.5	Not available	Data not found, can be assume to be inexistant or very low	Low=0
1.6	0.013 %	Not a known minimal value, but the value is very low of itself, it is 29,3% in Great Bretaign for example and 19,7 % in Europe	Low=0
1.7	248 kwh in 2016	Not a known minimal value, but the value is very low of itself, it is 5130 kwh/yr. in Great Bretaign for example	Low=0
1.8	No	Since there are not existent, it can be said that it is low.	Low=0

1.9	0.3 in 2016	The average value was 4,981 according to World Bank	High=2
1.10	3.6 in 2020 for Cameroon	Cameroon is 139th out of 180 countries with a score of 33.6/100, a score below average.	Low=0
1.11	94.3/100	According to Numbeo website, this is a very high level of pollution.	Low=0
1.12	9310 for Cameroon	According to Numbeo website, this is a high value.	Low=0
1.13	18516 in 2012 in Cameroon	No known standard, as it is a greenhouse gas; its very existence can be considered as bad	Low=0
1.14	65 µg/m3	According to the Numbeo website, this is a high rate.	Low=0
1.15	49 for Yaoundé	Not a known norm, the annual average according to the World Bank was 45,5	Low=0
1.16	Not found	Data not found, can be assumed to be inexistant or very low	Low=0
1.17	0.6 kg/day/inhabitant	The world average was 0.74kg/day/inhabitant	Medium=1
1.18	92 % in 2008	A very high percentage	High=2
1.19	0 but its ongoing	Since there are not existent, it can be said that it is low.	Low=0
1.20	30 l/day/inhabitant	The recommended standard is 80 to 120 liters per day per inhabitant for good personal hygiene and hydration.	Low=0
1.21	Yes	To be improved	Medium=1
1.22	13558.1 hab/km2	High density, higher than the density of New Delhi and New York for example	Medium=1
1.23	0.04	The WHO standard is 10m2/inhabitant.	Low=0

Table 10. Smart mobility component's results (Authors's elaboration).

Component N°2 : Smart mobility			
Number of indicators: 18		**MSC: 36**	**STI : 7**
SC2 (Equation 1) : 5.6 / 100 ;		**% low indicators : 88 % (16/18)**	
Indicators	**Value**	**Comments**	**Score**
2.1	Not found	Not a known minimal value, but it is inexistant or very low	Low=0
2.2	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.3	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.4	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.5	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.6	Almost 10 a day	Not a minimum value, but the value is low for itself	Low=0
2.7	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.8	170.65 for Cameroon	Not a known minimal value, but from numbeo the max is 366. So, it can be said that Cameroon has an average value	Medium=1
2.9	0	Not a known minimal value, but it is inexistant or very low	Low=0
2.10	168.17 for Cameroon	Not a known minimal value, but from numbeo website, the max is 297 So Cameroon has an average value	Medium=1
2.11	3.75 %	Not a known minimal value, but the value is very low of itself for a sustainable mobility	Low=0
2.12	46 %	Not a known minimal value, but the lack of sidewalk makes this situation not good	Low=0
2.13	No	Since there are not existent, it can be said that it is weak.	Low=0
2.14	Not available	Can be assumed inexistant	Low=0
2.15	Yes, only	Not a known minimal value, but it exists only for the parking	Low=0

	parking		
2.16	0	Not a known minimal value, but it is inexistant	Low=0
2.17	0	Not a known minimal value, but it is inexistant	Low=0
2.18	No	Inexistant	Low=0

Table 11. Smart governance component's results (Authors's elaboration).

Component N°3 : Smart governance			
Number of indicators: 19 **MSC: 38** **STI: 6** **SC3 (Equation 1): 15.8 / 100;** **% low indicators : 68 % (13/19)**			
Indicators	**Value**	**Comments**	**Score**
3.1	43.27% for Cameroon	An average value according to E-government survey	Medium =1
3.2	Social insurance (CNPS)	Very few	Low=0
3.3	0.00014	Very low, it is 0.03/inhabitant in Italy which is considered to be one of the lowest rates in the world.	Low=0
3.4	4 % in 2016 with the ambition of 10 % in 2020	A value to be improved	Low=0
3.5	< 4 %	Not a known minimal value, but the value is low of itself	Low=0
3.6	2Mbps in average	Very bad according to Normad	Low=0
3.7	Not available	Not a known minimal value, but very important for sustainable and smart city, so can be assumed to be low.	Low=0
3.8	A center of road crashes analysis exists in NASPW	More projects need to be created, a medium sore can be assumed as there is at least one project	Medium =1
3.9	A data portal for the country not for the city	Not a known minimal value, but very important for sustainable and smart city. Others project are ongoing	Low=0
3.10	Not available since the previous is not	Not a known minimal value, but very important for sustainable and smart city. So can be assumed to be low	Low=0
3.11	Very few	To be improved	Medium =1
3.12	40	Not a known minimal number, but to be improved. It is 103 in Abuja. So, a medium score can be assumed	Medium =1
3.13	No	To be improved	Low=0
3.14	6 in Cameroon in 2019	It is an average value above the world average that is 5.696	Medium =1
3.15	25 % for Cameroon in 2019	A low value	Low=0
3.16	2.85/10, 141th out of 167 countries	Very low value	Low=0
3.17	Not available	Can be assumed low as the open data portal is not functioning yet	Low=0
3.18	Not available	There are contacts and an email. But the response time is not known.	Medium =1
3.19	Not available	Information not available, can be assumed to be zero or low.	Low=0

Table 12. Smart economy component's results (Authors's elaboration).

Component N°4 : Smart economy			
Number of indicators: 12	**MSC: 24**	**STI: 8**	
SC4 (Equation 1) : 33.3 / 100 ;	**% low indicators : 42 % (5/12)**		
Indicators	**Value**	**Comments**	**Score**
4.1	Few, 2 found.	Not a known minimal value, more can be done.	Medium=1
4.2	Cameroon is 167th out of 190 countries	A low rank to be improved	Low=0
4.3	14 days in Cameroon in 2019	The world average is 19.597. So, Cameroon is above the average but very far from the 2 days of Singapore.	Medium=1
4.4	Not available	Not a known minimal value; can be assumed to be inexistant or very low	Low=0
4.5	37.5% for Cameroon in 2014	An average value that can be improved	Medium=1
4.6	84.50%	High percentage	High=2
4.7	Not available	Since there are not existent, it can be said that it is weak as for Douala it is only 22	Low=0
4.8	1313 $/month	Affordable according to nomadlist	Medium=1
4.9	Not available	Due to affordable cost of living it can be assumed to be medium	Medium=1
4.10	1527$/ inhabitant	16th in Africa and 99th in the world	Medium=1
4.11	Not available	Not a known minimal value, but the technology transfer is quite small.	Low=0
4.12	Few, 2 found	A low value that can be improved. There are 42 in Cape Town, 26 in Abuja.	Low=0

Table 13. Smart population component's results (Authors's elaboration).

Component N°5 : Smart population			
Number of indicators: 16	**MSC: 32**	**STI: 3**	
SC5 (Equation 1): 9.4 / 100 ;	**% low indicator : 81 % (13/16)**		
Indicators	**Value**	**Comments**	**Score**
5.1	6 % in 2016, 20 % is expected in 2020	A value to be improved	Low=0
5.2	14.03 in Cameroon	Very low, to be improved	Low=0
5.3	16 %	A rate to be improved, it is 89% in Kenya.	Low=0
5.4	Yes	Initiatives to be improved	Medium=1
5.5	43.79 %	Lower than the average, to be improved	Low=0
5.6	60 %	To be improved	Medium=1
5.7	0 %	Very low, to be improved	Low=0
5.8	0.0047	Very low, to be improved	Medium=1
5.9	Not available	Very low, to be improved	Low=0
5.10	0	Very low, to be improved	Low=0
5.11	0	Very low, to be improved	Low=0
5.12	640,000 in	Very low, to be improved	Low=0

	Cameroon		
5.13	0.07 in Cameroon	Very low, to be improved	Low=0
5.14	2.3 %	Very low, to be improved	Low=0
5.15	9.71 % in 2014 in Cameroon	Very low, to be improved	Low=0
5.16	110,000 in Cameroon	Very low, to be improved	Low=0

Table14. Smart living component's results (Authors's elaboration).

Component N°6 : Smart living			
Number of indicators: 27 MSC: 54 STI: 15 **SC6 (Equation 1): 27.8 / 100 ; % low indicators: 44 % (12/27)**			
Indicators	**Value**	**Comments**	**Score**
6.1	96 %	Very high value	Low=0
6.2	0.36	A rate to be reduced	Medium=1
6.3	71 % for Cameroon in 2020	A good rate that is above the world average of 46.914	Medium=1
6.4	2,65/5 for Cameroon in 2020	Low value	Low=0
6.5	5,085/10 for Cameroon in 2020	Average value	Medium=1
6.6	25,4/100 for Cameroon in 2018	Low value	Low=0
6.7	6,62/10	Value to be reduced	Low=0
6.8	In Cameroon, 3076 suicide per year.	Rank to be improved	Low=0
6.9	Bad in Yaoundé	Bad situation to be improved	Low=0
6.10	6.96/1000	Value to be reduced	Low=0
6.11	Not available, it is assumed to be 10% in Douala	A slightly higher rate for Yaoundé is assumed, given that it is the political capital with all the administrations.	Medium=1
6.12	25th in Africa	Rank to be improved	Medium=1
6.13	Not available	Can be assumed to be medium as there are 3 cinemas in the city	Medium=1
6.14	Not available	Can be assumed to be medium as there are 7 museums in the city	Medium=1
6.15	Not available	Can be assumed to be medium as there are 3 theatres in the city	Medium=1
6.16	Very low	A percentage to be improved	Low=0
6.17	53.12 %	A percentage to be reduced	Medium=1
6.18	Less than 50 /100000 inhabitant for Cameroon	A low number	Low=0
6.19	Control centre for surveillance cameras	To be improved	Medium=1
6.20	1.3 for 1000 inhabitant for Cameroon	Value to be improved given that the world average is 2.7	Medium=1
6.21	52.22/100	Average value to be improved	Medium=

			1
6.22	Not available, but there are startup offering these services	This service is not yet popularized in Yaoundé. A situation to be improved	Low=0
6.23	Not available, but there are startup offering these services	This service is not yet popularized in Yaoundé. A situation to be improved	Low=0
6.24	9 for 1000 habitant in Cameroon in 2018	Value to be improved given that the world average is 7.52	Medium= 1
6.25	1.9 for 10000 inhabitants in Cameroon in 2013	Twice the minimum recommended by the WHO, but still needs to be improved.	Medium= 1
6.26	35/100	A very low value to be improved	Low=0
6.27	58.51 years	Below the world average of 72.38 years	Medium= 1

As concerns Douala, the IESE Business School of the University of Navarra has been publishing an annual report since 2013 in which it classifies 174 cities around the world on the theme of 'smart city' through its 'city in motion index', which takes into account 96 indicators as presented in Table 15.

Table 15. Indicators of the IESE ranking (Authors's elaboration).

Component	Number of indicators
Human capital	10
Social cohesion	16
Economy	13
Governance	12
Environment	11
Mobility	10
Urban planning	5
International Awareness	6
Technology	13

In its 2019 ranking, London, New York and Amsterdam occupy the podium with scores of 100, 94.63 and 86.7 out of 100 respectively. Casablanca is ranked as the first African city but 155th out of the 174 cities with a score of 32.31/100. The city of Douala is only ranked 170th with a score of 17/100. Douala's scores are detailed in Table 16.

Table 16. Douala's score for each component (Author's elaboration).

Indicators	Score /100	Rank
Human capital	< 10	163
Governance	< 10	171
International Awareness	< 10	173
International Awareness	< 10	172
Technology	< 10	174
Mobility and transport	< 30	162
Environment	< 50	50

Economy	< 60	172
Social cohesion	< 70	146
Rank		170

Douala scores below 10/100 on five of the nine components assessed by IESE; its best ranking is 50th for the environment component, but it ranks last and second to the last for the technology and urban planning components respectively. Based on these results, Cameroon's economic capital and political capital which are the most developed cities of the country cannot be considered as smart cities. So how can Cameroonian cities evolve into smart cities?

6. Transforming Cameroon's cities to smart cities

The transformation of Cameroonian cities from simple towns to smart cities will have to be based on a vision. The vision of 'transforming Cameroonian cities into smart cities' should be done in several stages in order to ensure its realization; concretely, it is a matter of six stages namely:

- The consolidation of achievements;
- The foundation of the vision;
- The creation of the team in charge of realizing the vision;
- The diagnosis of the existing situation;
- The design of the Smart City Master Plan;
- The implementation of the Master Plan.

6.1. Consolidation of achievements

The aim will be to complete the projects already under way within the deadlines and with the expected results. Among these projects are those defined during the contribution of the State of Cameroon to the Intersessional Panel of the United Nations Commission on Science and Technology for Development
https://unctad.org/meetings/en/Contribution/CSTD_2015_Panel_Cameroon_fr.pdf.
Other projects are defined in:

- The Sustainable Urban Mobility Plan of the city;
- The Updated Road Master Plan;
- The Urban Master Plan;
- The Integrated Strategy for Multimodal Transport Infrastructure in Cameroon;
- The sectoral, sub-sectoral and ministerial strategies.

6.2. Foundation of the vision

It will be about:

- Ensuring commitment to becoming a smart city: This is about ensuring commitment in governance an essential factor for the development of smart city (Lopes, 2017). It is also about ensuring commitment in funding, data collection, sharing and use;
- Identifying the leader: The one who will have the heavy responsibility of carrying out the vision project. He/she must believe in the vision in addition to being qualified and passionate;
- Ensure transparency: Through communication of the vision, objectives and roadmaps, as well as results, even if they are not the ones expected.

6.3. Creation of the team in charge of realizing the vision

This team should be composed of the Vision Leader within local government, accompanied by a team of digital experts (existing staff trained for this task) or a team of external consultants, a selected public (to strengthen citizen participation), civil society and private sector actors (to strengthen public-private partnership).

6.4. Diagnosis of the existing situation

Once the team has been created, the work can then begin in earnest. It will start with the description of the city in physical, infrastructural, social, economic, environmental, demographic, hydrological, and climatological terms; then an assessment of the city as a smart city will be made, using for example the methodology presented in this paper.

6.5. Design of the Smart City Master Plan

The diagnosis of the city will identify the main challenges and opportunities facing by the city. Once these have been identified, they will have to be prioritized in order to define which ones to act on first. Once the priorities have been defined, the Smart City Master Plan for the city will have to be designed. The Plan should contain, among other things, a logical framework and an investment program. The logical framework should specify the general objective, the strategic axes, the strategic objectives, the initiatives/projects, the performance indicators with their reference and target values, the budget allocation and the institutional actors. Table 17 presents a logical framework template. Once the logical framework has been established, the priority investment program can be defined. This will involve defining the projects as in Table 18 and specifying which ones will be financed as a priority. All the information contained in Tables 17 and 18 are strictly illustrative.

Table 17. Logical framework template (Authors's elaboration).

GENERAL OBJECTIVE OF THE MASTER PLAN	**Making the City of Yaounde Smart by 2025**
EXPECTED RESULTS	Improvement of the 6 components of the Smart city
IMPACT INDICATOR	Performance of the city
VERIFICATION SOURCES	Evaluation

STRATEGIC AXES	STRATEGIC OBJECTIVES	PROJECTS	INDICATORS	REFERENCE VALUE		TARGET VALUE		RISK FACTORS	BUDGET ALLOCATION	ACTORS
				Year	Value	Year	Value			
Promoting a smart environment	Reducing the carbon impact through renewable energy, green spaces, water and waste management	To be defined	Percentage of renewable energy	2018	< 1%	To be determined	To be determined	To be determined	To be determined	Ministry of Energy
		To be defined	Green spaces per m2 per inhabitant	2017	0.04 m² / inhabitant	To be determined	To be determined	To be determined		Ministry of Urbanism
Promoting a smart mobility	Encouraging soft mobility and public transport	To be defined	Bicycle lanes	2020	? km	To be determined	To be determined	To be determined	To be determined	Ministry of Transport
		To be defined	Percentages of public transport	2019	3.75 %	To be determined	To be determined	To be determined		Ministry of Transport

Table 18. Project definition template (Authors's elaboration).

Strategic Axes: Promoting and intelligent mobility
Strategic objectives: Encouraging soft mobility and public transport
Project: Bicycle lanes construction
Project goal: increase the number of kilometers of bicycle lanes// Reference value/year: km/2020. // Target value/year: km/2022
Risk factors (Hypothesis) / Measures: Staff not highly qualified / Capacity building workshop for staff
Institutional stakeholders: Ministry of Transport, Ministry of Urbanism, Ministry of Construction of Civil Society
Project cost: 10 billion FCFA

Decomposition of the project in activity and breakdown of the project cost over its duration																										
Activity	Cost	Actors	2020-2021												2021-2022											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Preliminary studies	1 billion FCFA	Consultant, Ministry of Transport, Ministry of Construction, Ministry of Urbanism																								
Construction of the bicycle lanes	9 billion FCFA	Consultant, Ministry of Transport, Ministry of Construction, Ministry of Urbanism																								

6.6. Implementation of the Master Plan

This will be:

- The implementation of projects using tools and new technologies;
- The monitoring-evaluation of projects during their implementation; for this, it will be important to collect information via feedback from citizens and key stakeholders but also via installed sensors for example. Depending on the efficiency obtained, solutions could be proposed to increase it.
- But also:
- The education and training of citizens, government actors, partners, etc... so that everyone can have the skills to understand, use and implement the initiatives effectively while providing feedback and criticism on them.

6.7. Critical factors for success in achieving the vision

The following key factors will need to be considered to ensure the success of the vision:

- Technical factors: The ICT infrastructure and network system will need to be systematically linked to the quality and efficiency required to support the functioning of the smart city (Chourabi et al., 2012);
- Human factors: The government will need to work with the citizens in the development of the city, ensuring that their views are taken into account throughout the decision-making process (Siuryte and Davidaviciene, 2016);
- Taking context into account: The intelligence of building a smart city in the Cameroonian way lies in the ability to adapt it to the socio-economic and cultural realities of cities to meet the most alarming and useful needs and concerns of the populations. These concerns can be oriented towards basic needs such as improving access to healthcare, electricity, water, and setting up adapted and inexpensive transport systems.

7. Conclusion

The objective of this work was to explore the concept of smart cities in Cameroon. Firstly, the origin of concept, its evolution, definitions and characterization were presented; then, the situation of the smart city in Africa preceded by a presentation of some northern countries cities leaders in smart cities were highlighted; finally, the case of Cameroon was studied by evaluating the smartness of its capitals and presenting a plan for the transformation of its cities into smart cities. It emerged that the concept of the smart city first appeared at the end of the 1990s under the name 'virtual city', before becoming what its known today. Although there is no consensus on its definition, the smart city is one that generally uses ICT to better meet the needs of its citizens by providing an economic base, building efficient urban infrastructure, improving the quality of life, ensuring social integration, preserving environmental qualities and ensuring good governance. Furthermore, it emerged that several northern cities such as Amsterdam, New York, and Seoul are already considered as smart cities and are continuing to improve in that way. Africa for its part lacks symbiosis, and even if initiatives are taken mainly under the impetus of Rwanda, there is a strong desire in each country to make its cities smart according to its understanding of the concept; this is the example of Senegal, South Africa, or Morocco. After evaluating the performance of the city of Yaounde, it was found a low score of 17.3/100 and concerning Douala, the 2019 report of the IESE Business School of the University of Navarra ranks it 170th out of 174 smart cities in the world with a poor score of 17.03/100. These scores showed that these two cities, considered as the most developed of the country, could not be considered as smart cities and therefore in order to move Cameroonian cities from ordinary cities to smart cities, a vision will be necessary. A vision that will be realized through six specific phases, from the consolidation of the achievements to the design and implementation of a Smart City Master Plan. A vision whose realization will require institutional actors to take into account the critical success factors of a smart city initiative.

8. Notes

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