SMART CITY RWANDA
MASTERPLAN

SMART CITY RWANDA MASTERPLAN

VERSION 2.0

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CONTENTS

FOREWORD

Hon Jean Philbert Nsengimana
Minister of Youth and ICT

Information and Communication Technology (ICT) is changing the way cities evolve, helping to respond to the challenges of rapid urbanization and the pressure that is exercised on infrastructure while citizens' expectations for better quality services keep rising.

The rapid growth in mobile and broadband penetration in Rwanda presents new opportunities for innovation that leverages the tremendous capacity of our youth to innovate and transform our cities into smart cities.

This Smart City Masterplan provides a framework to guide Rwandan cities and towns in their efforts to harness ICTs to provide a higher quality of life to their citizens, businesses and visitors. The document lays out a vision for cities of the future that embed technology and data across city functions to make them more efficient, competitive and innovative.

Financing smart city initiatives can be challenging. However, by creating an enabling environment, a variety of financing models and innovative financing instruments can be explored. They range from public investments to public-private partnerships but most importantly investment from the private sector.

It is important that regardless of the financing mechanism, the governance of smart cities is designed in such a way that the central and local governments remain in control to fully ensure a balance between required resources, effectiveness of technology solutions and quality of service delivery.

EXECUTIVE SUMMARY

The transformation of Rwanda from an agrarian economy into a knowledge-based society is taking place in the context of two of the biggest drivers of change in the 21st century — rapid urbanisation and the increased application of digital technologies in all sectors of society. To meet these challenges, and take advantage of the opportunities of the digital world, Rwandan society is being transformed. Citizens are increasingly moving to towns and cities, acquiring new skills and demanding better services. Cities are growing and require better planning, governance and new financing.

Smart cities, in which leaders and citizens use data, information and knowledge to ensure a co-created resilient and sustainable future, can play a large role in the transformation of Rwanda. By ensuring inclusive data-led management and planning, efficient community-based infrastructure and services and localized and shared innovation, cities can be drivers for economic development and sustainable development.

This Smart City Masterplan is intended as a guide to help Mayors and urban managers go through the process of developing their own smart city strategies and masterplans, as well as providing a strategy for the government to promote the development of smart cities in Rwanda on a national level.

It is divided into five chapters. **Chapter 1** provides the context of the state of Rwandan towns and cities today and outlines existing urban and ICT-related challenges. It also describes existing smart initiatives in Rwanda and sets out the policy context of the Masterplan.

Chapter 2 provides a definition of smart cities and sets out what is meant by 'smart city' in the Rwandan context. The Rwandan smart city model is a combination of three often followed smart city models - the technological model, the strategic model and the collaborative model. This ensures that smart cities in Rwanda make use of scalable technology solutions and financing models; new data and monitoring processes that enable more flexible strategic planning and management; and improved and more accessible local services through collaboration, co-ownership and co-creation.

Chapter 3 describes how the national government and local authorities can go about building smart cities. Before embarking on the smart city journey, Rwandan urban leaders first need to make four early decisions, including committing to becoming a smart city, identifying smart city champions, setting the vision and choosing to be open and transparent. Once these four decisions have been made, local authorities should follow 10 steps to realize the vision, including creating a smart city stakeholder partnership team, creating a strategic action plan and testing smart city technology through pilot projects. Change management, including decisions related to privacy and cyber security, monitoring and evaluation and coordination at the national level, as well as financing, are also outlined.

Chapter 4 sets out the smart city action plan itself. This is based on three smart city pillars, smart governance and planning, smart and efficient services and utilities and localized innovation for social and economic development, followed by nine smart city building blocks and 27 action initiatives. The 27 initiatives provide a comprehensive plan that towns and cities can follow to implement smart city projects and solutions at the local level, as well as guidance for the national government. Each initiative is associated with a relevant urban scale - national level, capital city, secondary cities, towns and rural settlements.

Finally, **chapter 5** sets out how the Rwanda Smart City Masterplan links with the wider smart city vision for Africa. The recommendations found in this document, along with the Smart Africa Alliance Smart and Sustainable Blueprint for Africa, can be used to provide guidance for future national and local smart city masterplans throughout the continent.

01

INTRODUCTION

The Government of Rwanda has set an ambitious vision: to transform the country from an agrarian economy into a knowledge-based economy by 2020. This transformation is taking place in the context of two of the most important trends of the 21st century — rapid urbanisation and the increased application of digital technologies in all sectors of society.

To meet the ambitious goal, and deal with the challenges and opportunities presented by urbanisation and digital technologies, major changes will take place in the Rwandan society. According to Vision 2020, 35% of the population is projected to live in urban areas by 2020, meaning that large numbers of people will move to towns and cities, putting pressure on local governments to ensure that urban growth is managed sustainably. Reaching 95% internet penetration by the end of 2017, presents new opportunities to develop the digital economy but also requires new digital skills among the population.

Large-scale education programmes to build basic and digital literacy will be necessary. Citizens will need new skills — in engineering, urban planning, architecture and technology. New legislation around data privacy, security and access must be adopted. Changes to urban planning and management processes will be required and new ways will be found to deliver services to citizens.

This Smart City Masterplan provides a framework to help Rwandan towns and cities manage the transition of the 21st century and help ensure the future prosperity of all Rwandans. It is intended as a guide to help Mayors and urban managers go through the process to develop their own smart city strategies and masterplans.

The Masterplan was developed in 2017, based on extensive discussions, meetings and workshops with a variety of urban and ICT stakeholders in Rwanda, including ministries, regulatory bodies, local authorities, academia, civil society and the private sector. The development was aligned with the Smart Africa Alliance *Smart Sustainable Cities Blueprint for Africa..*

Kigali City © RDB Rwanda

1.1. THE CONTEXT OF CITIES IN RWANDA TODAY

POPULATION GROWTH

According to the Rwanda National Institute of Statistics, the Rwandan population is expected to grow from 10.5 million in 2012 to 16.3 million in 2032. The urban population is expected to increase from 1.7 million in 2012 to 4.9 million in 2032, a near doubling in percentage terms from 16.5% in 2012 to 30% in 2032. The Rwanda Vision 2020 which aims to transform Rwanda into a middle-income country, estimates that the urban population will reach 35% by 2020.

As a direct consequence of this growth, the country will experience an unprecedented increase in population density, which will reach 645 inhabitants per square kilometre by 2032, from the current 440 inhabitants per square kilometre. Rwanda has started to prepare for these developments. The Kigali City Masterplan of 2013, for example, accounts for a growth from 1.3[1] million inhabitants to 3.7 million inhabitants in 2032

1. Source: http://www.kigalicity.gov.rw/new_web/64/?L=0

UGANDA

BIRUNGA
NAT'L PARK

Musanze

Nyagatare

DEMOCRATIC
REPUBLIC OF THE
CONGO

Rubavu

GISHWATI
NATURAL
RESERVE

Ile
Bugarura

Ile Wahu

Lac
Kivu

Ile
Idjwi

WESTERN
PROVINCE

NORTHERN
PROVINCE

AKAGERA
NATIONAL
PARK

EASTERN
PROVINCE

Muhanga

Kigali

UNITED
REPUBLIC OF
TANZANIA

SOUTHERN
PROVINCE

Ile
Gom

Rusizi

NYUNGWE
NAT'L PARK

Huye

BURUNDI

● National capital
◉ Secondary cities
✦ ✚ Airport, airstrip
–··–··– International boundary
▬ ▬ ▬ Provincial boundary
─── Road

0   10   20   30   40   50 km
0   10   20   30 mi

Fig.1: Rwanda map and provinces

1.2. URBAN AND ICT CHALLENGES IN RWANDA

A ACCOMMODATING A GROWING HOUSING DEMAND

With an average yearly urban growth rate of over 3.5%, the urban population in Rwanda is expected to double in less than 20 years' time according the Rwanda National Institute of Statistics. By 2032, Rwanda needs to build the equivalent of eight new Kigali's based on its current density to accommodate new urban residents. This presents a great challenge; by 2032, more than 800,000 homes will have to be built.

According to the Ministry of Infrastructure, the demand for affordable housing is estimated at 560,000 units by 2020, which translates to the construction of 93,400 units annually. With an average of 800 to 1,000 homes built in Kigali each year, the city alone could face a housing deficit of 344,000 homes by 2020. Through three policy pillars, the National Housing Policy covers the aspects of access to housing, resource efficiency, land, infrastructure, skills development, strengthening of the local construction industry, construction materials and technology.

From 1.7 to 4.9 million urban residents in 20 years

2012

Kigali 0.75 M

Urban Population
1.7 Million

2032

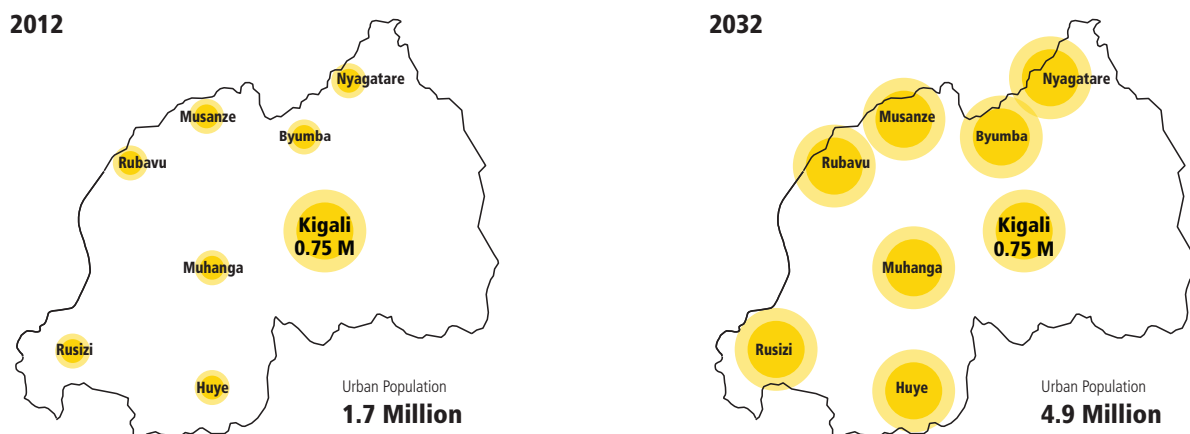Kigali 0.75 M

Urban Population
4.9 Million

Fig.2: Urban population growth from 1.7 to 4.9 million urban residents in 20 years

The percentage of the population living in informal settlements in Rwanda has progressively decreased, with 53% of the Rwandese population living in informal settlements in 2014, compared to 96% in 1990. Despite this crucial achievement, unplanned areas are expected to increase again at a rate of 4% per year until 2022. This is caused by a limited availability of suitable building land, which leads to the development of informal areas on steep slopes causing environmental threats and increasing infrastructure provision costs. Additional factors, such as overcrowded rental market and high demand in construction materials, further add to this problem.

B MOBILITY AND ACCESSIBILITY TO URBAN SERVICES

The demand for transport in Rwanda is expected to increase due to rapid urbanisation, amplified by the growing number of middle income households. The rough topography of Rwanda limits the possibility of expanding current mobility services and basic infrastructure without driving up service provision costs. Multiple areas and neighbourhoods in Rwandan cities are already experiencing limited connectivity that hampers mobility and accessibility. Due to the hilly terrain, some cities are sprawling, with multiple cores requiring large infrastructure investments to facilitate connectivity. The 2015 National Urbanization Policy recommends densification as a way of optimizing public investment in infrastructure.

The costs involved in developing this additional infrastructure make it difficult to financially sustain a multimodal public transport network. As a landlocked country, and with no link to regional railway and inland water transport, most of the trade and transport in Rwanda is done by road. High transportation costs due to the lack of alternative infrastructure and dependency on imported fuel hampers economic competitiveness and development. A challenge for Rwanda lies therefore in identifying opportunities that enable a sustainable increase in the capacity of the current infrastructure to accommodate multimodal transport solutions with a focused on non-motorized transport.

C RESILIENCE, CLIMATE CHANGE AND ENVIRONMENTAL RISKS

Rwanda is an exemplary country in terms of functional initiatives for environmental protection, such as promotion of reforestation practices, district forest management plans, the low-carbon energy policy and the plastics ban. Nevertheless, the rapid population growth is increasing pressure on natural resources. The main impacts include agricultural land degradation, soil erosion and reduced soil fertility, loss of biodiversity, deforestation and wetland degradation. ICT and technological innovations can support the challenge of sustainable maintenance of Rwanda's natural resources by developing an infrastructure for environmental monitoring, developing online tools for education on sustainable resource use and using social media to engage the public in environmental monitoring.

Another priority is climate change, which has resulted in an increased frequency and intensity of extreme natural events. Urban growth and a change in urban patterns may increase the risk of these threats; an increase in energy and car use and congestion lead to an increase in carbon production, which in turn has a negative impact on the country's overall CO_2 production. Flooding and extreme heat can cause increasing pressure on existing infrastructure causing further problems with traffic congestion. Rwanda is therefore investing in multiple adaptation and mitigation projects, such as the implementation of biogas and rainwater harvesting facilities and reforestation initiatives.

D INFRASTRUCTURE GAP

With the backing of substantial government and donor investment, Rwanda has solid infrastructure compared to countries on a similar stage of economic development. However, rapid urban growth is likely to increase demands on basic infrastructure. Further investment is necessary to ensure universal access to basic infrastructure, particularly energy and transport, but also water supply, sanitation, watershed management and broadband connectivity.

Citizens are either provided with a direct connection to energy and water services or a utility collection point within 500 metres of their home. Still, access to affordable energy has been identified as the number one challenge that businesses face when considering expansion plans. To meet energy sector policy goals by 2018[2], Rwanda requires a $4 billion total investment, representing almost 20% of GDP per year.

Significant effort has been put into internet access. Through a public-private partnership with Korea Telecom, 4G LTE coverage is expected to reach 95% of the country by the end of 2017. Mobile phone penetration is around 70-80% and around 31% of Rwandans are making use of digital services. ICT is increasingly being used to provide utility services. An online billing system has been put in place for energy and water services, while a prepaid card system is provided to collection point users. A monitoring system can further help to realise large savings by enabling more precise pinpointing of leakages and prevent losses. Maintenance, operation and depreciation of infrastructures will continue to require considerable investment.

2. Energy Sector Strategic Plan 2014

E POVERTY AND INEQUALITY

The levels of poverty reduction in Rwanda vary between districts and provinces, generating an imbalance in social and economic development. Although poverty reduced more in rural areas than in urban areas from 2008 to 2011, poverty in rural areas still stands at 49% compared to 22% in urban areas. Poverty also affects women more than men in Rwanda. Although inequality peaked at 0.52 of the Gini coefficient in 2005 and then decreased progressively to 0.49, it is still high compared to other Sub-Saharan Africa countries.

The World Bank's World Development Report 2016, shows that while digital technologies have spread across the world, the benefits have not been evenly shared. Those better educated and connected have received most of the benefits of the digital revolution. In Rwanda, nearly 70% of the population is still not online, meaning they are unlikely to benefit from the positive effects of smart city technology. To ensure that increased application of digital technology does not increase inequality, large investments in education, digital literacy and internet access for the poor, particularly youth, women and minority groups are required.

Done right, ICT and technological innovation can support vulnerable groups, for example by providing low-income families with access to education or provide people with disabilities tools to live independently. The key is the realization of an inclusive smart city by providing wide ICT access and promoting digital inclusion. Rwanda's digital land regularization programme, for example, was found to double the rate of investment and maintenance of soil conservation structures, an effect which was particularly marked for female-headed households.[3]

3. Ali, Daniel Ayalew, Klaus Deininger, and Markus Goldstein. 2014. "Environmental and Gender Impacts of Land Tenure Regularization in Africa: Pilot Evidence from Rwanda." Journal of Development Economics 110: 262–75

F FINANCIAL STABILITY, JOB CREATION AND COMPETITIVE BUSINESS ECOSYSTEM

Poor economic global performance remains a large challenge to Rwanda's economy and financial sector. A weakened demand of Rwanda´s commodity exports could lead to a reduction of the purchasing power of both government and companies regarding imported goods and services on which the country strongly relies.

To cope with the current population growth dynamics in Rwanda, the country will require 200,000 new jobs each year. In comparison; the number of waged formal jobs in Rwanda in 2013 was 396,000. This means that both jobs in the formal and informal sectors need to increase significantly. Rwanda is setting up initiatives to promote local businesses and products, such as the 'Made in Rwanda' campaign.

The private sector needs to play a key role in the economic transformation of the country, but remains small and with limited competitiveness. More than 99% of companies are micro or small enterprises focused on traditional export products. A lack in skills and low labour productivity can pose further barriers to the private sector's competitiveness. Education and skills are an essential component to the transition from an agrarian to a knowledge-based economy. High electricity costs and an insufficient logistic system further hinder the profitability and scalability of Rwandan companies. The increase in demand of services because of a growing number of middle income households can provide companies with new business opportunities in which ICT and technology can play an important facilitating role.

G LACK OF ADEQUATE CAPACITY
(EDUCATION SYSTEM, INNOVATION, DIGITAL LITERACY, AND CAREER SKILLS)

The Government of Rwanda has taken large strides in extending access to basic education. However, education in rural areas, among the urban and rural poor, and among children with disabilities and special learning needs, remains a challenge. ICT and technology plays a key role in providing more people with access to education through campaigns as 'One laptop per child'. The current net enrollment ratio for secondary school in Rwanda is 28% and only 8% of young adults go to college, which anticipates that heavy investment will be needed to expand existing infrastructure and increase the number of teachers and teaching materials.

The establishment of the University of Rwanda in 2013 represents a milestone in the consolidation of quality education. Still, the improvement of the relevance of education and the ability to address labour market demands present key challenges. The education sector will need to provide students with the competences and skills that are required to access the labour market, create (high-skilled) jobs and seize new business opportunities.

Formal sector companies in Rwanda reporting inadequate skills in the workforce have more than doubled in Rwanda since 2006, with larger companies particularly affected. The 2009 National Skills Audit reported severe skills gaps in the private sector with a skills deficit of over 60% in priority sectors such as agriculture, tourism, construction, finance and mining.

ICT and technology can provide new business opportunities but its use is still low in the private sector in Rwanda. More awareness needs to be raised among companies on the competitive advantages that ICT, including software, hardware and internet, can provide. The education system needs to focus on improving the capacity for research and development to promote a culture of innovation inside both the public and private sector.

H NEED FOR USABLE REAL-TIME INFORMATION AND DIGITALIZATION OF CITIZEN SERVICES

The urban environment of the 21st century is characterized by high complexity and uncertainty. Cities constantly need to weigh available budgets against actions necessary to meet urban challenges, such as climate change mitigation and adaptation, population growth, infrastructure development and the availability of housing. To meet these challenges, it is essential for cities to obtain real-time information, which can be provided by data generated through ICT and technology.

Data and information is needed for future planning and strategic management, collecting and analysing data regarding urban trends, indicators and urban hotspots. This information is essential to understand how actions succeed, what the citizens see as more important and which areas need more attention. Data is crucial to enable municipalities and ministries to decide where to use budgets most efficiently, or where to orient private resources.

Such real time and strategic data and information should be updated regularly, while caring for privacy and data safety. This will require additional resources, knowledge and budgets.

1.3. CURRENT SMART INITIATIVES IN RWANDA

IREMBO E-GOVERNMENT PORTAL
Online platform where citizens can access more than 30 different government services in one place.
https://irembo.gov.rw

KIGALI LAND AND CONSTRUCTION ONE STOP SHOP
Online 'one stop shop' platform where developers can apply and pay for construction permits and receive an answer within 20 days. The databases also contain information for landowners.
http://www.kcps.gov.rw

KIGALI SMART BUS PROJECT
Public buses in Kigali are being fitted with free wifi and contactless payment terminals from a Rwandan company called Tap'n'Go.

KIGALI POLLUTION MAPPING
The Rwanda Climate Observatory partnered with Safe Motos to use low-cost sensors to measure air quality in Kigali. Each day, a Safe Moto driver would pick up an air quality sensor and drive it around the city. The data from the sensors was then mapped to asses air quality across Kigali.

DATA REVOLUTION POLICY
An open data policy, currently in draft form, is being developed. The policy is based on the 2013 Rwanda Open Data Readiness Assessment report and proposes the implementation of several initiatives, including the establishment of an open data steering committee, an open data desk at NISR, institutional data release guidelines, data hosting incentives for investors, a personal information protection law, a national open data portal and a data innovation centre.

4G LTE ROLLOUT
Through a public-private partnership between the Government of Rwanda and KT Corporation, 95% of Rwandan citizens are expected to have access to 4G LTE by the end of 2017.

MICROGRIDS
There are a number of ongoing electricity microgrid initiatives ("off-grid" systems) in Rwanda, including a collaboration between Rwanda's Energy Development Corporation and Ignite Power which aims to connect 250,000 people to solar energy by 2018 and Smart Village Microgrids, a research project by the Energy Institute at Colorado State University.

NDI HANO!
The Ndi Hano! program enables daily SMS reporting from public primary schools to create data on teacher and pupil attendance. The data is shared with education managers, schools, teachers, and parents in order to improve accountability

Minister of Youth and ICT Visits Africa Code Week
© MYICT

SMART ELECTRICITY METERS

Rwanda Energy Group is in the process of providing smart meters, communications networks, and data management services to a number of large and medium customers representing 50% of total sales. This will provide a platform for further distribution grid modernization as Rwanda Energy Group develops and deploys more functions related to smart grid functionality.

KIGALI INNOVATION CITY

Plans are underway to establish an innovation park on the outskirts of Kigali. The Kigali Innovation City will be linked to academia, government and industry and will provide an innovation growth platform for Rwanda including human capital development, technology innovation and financial capital.

DRONE DELIVERY SYSTEMS

In 2016, the government of Rwanda, in partnership with California-based startup Zipline, started the world's first national drone delivery programme. The programme will deliver medical supplies across the country.

HUZA ENERGY RESOURCE PLANNING SYSTEM

Rwanda Energy Group is in the process of implementing a new integrated business management system to make the energy utility more responsive to customer needs, minimise revenue leakages across the network and standardize workflows.

RWANDA INFRASTRUCTURE GEOPORTAL

Online platform maintained by the Ministry of Infrastructure with data about infrastructure, planning, urban and rural development, transportation, water and sanitation. *http://mininfra-geoinfo.maps.arcgis.com*

WATER AND ELECTRICITY ONLINE PAYMENTS SYSTEMS

Online water and electricity billing system for customers with a direct connection to their property. Customers without a direct connection will soon be provided with the option to pay for water or energy with an online prepaid card. Connectivity will be provided through central points that are located a maximum of 500 meters from customers.

President Kagame launches the medical drone for delivery © Paul Kagame, Flickr

E-HEALTH SERVICES

A range of e-health services, including the Rwanda Health Management Information System, Community Health Worker Information System, the CBHI monthly indicator reporting system, and RapidSMS, an SMS-based platform enabling effective and real-time two-way communication and alert system for community health workers.

E-POLICING SERVICES

A range of e-policing services, including CCTV services connected to a central command centre in Kigali, an e-policing strategy which includes registration of drivers licenses through Irembo, the use of social media for first responders and online tracking of vehicles and speed governors.

ONE LAPTOP PER CHILD PROGRAMME

Programme to provide all children with laptops. So far it has helped distribute 100,000 laptops and is set to distribute another 500,000 in the next 5 years.
http://one.laptop.org/map/rwanda

DIGITAL REVENUE COLLECTION

Rwanda has a comprehensive e-payment and certification system which includes some local authority payments and taxes.

OLPC Rwanda Workshop Day © One Laptop per Child

1.4. POLICY FRAMEWORK

TOWARDS A KNOWLEDGE-BASED SOCIETY

In recent years, Rwanda has adopted a series of important policy frameworks that lay the foundations for this Smart City Masterplan.

Vision 2020

Established in 2000 and revised in 2012, the aim of Vision 2020 is to transform Rwanda from an agrarian economy to a knowledge-based society by 2020. To achieve this, the Vision 2020 identifies six interwoven pillars: good governance and an efficient state, skilled human capital, a vibrant private sector, world class physical infrastructure and modern agriculture and livestock, all geared towards prospering in national, regional and global markets. Within the infrastructure pillar, communication, ICT and urban development are highlighted as important drivers. The Vision 2020 document is currently being updated and extended to Vision 2050.

The Smart Africa Manifesto

The Smart Africa Manifesto, adopted by African heads of state in 2013, provides a vision for achieving socio-economic development through ICT. The Manifesto outlines five key principles: to put ICT at the centre of the national socio-economic development agenda, to improve access to ICT, especially broadband, to improve accountability, efficiency and openness through ICT, to put the private sector first and to leverage ICT to promote sustainable development. The Smart Africa Manifesto is being implemented through the Smart Africa Alliance, established in 2016. Within Smart Africa, Rwanda is leading the smart cities theme.

The Smart Rwanda 2020 Masterplan

Following the adoption of Vision 2020, national information and communications infrastructure plans were initiated to provide strategic frameworks for using ICT to achieve development. The first of these, the National ICT Strategy and Plan (NICI) 1 (2000-2005), focused on putting in place the foundational legal and regulatory framework to allow the liberalization of the telecommunication sector and attract private sector investments. The second, NICI II (2006-2010), focused on infrastructure and connecting people and on launching several flagship ICT initiatives such as the One Laptop Per Child projects. The third, NICI III (2011 – 2015), focused on transforming services, for example e-government services.

The fourth and most recent NICI Plan, the Smart Rwanda 2020 Masterplan, which builds on the previous NICI Plans, has three goals: economic transformation, job creation and accountable governance. These in turn are supported by seven pillars ranging from education to finance and women and youth empowerment in technology. The Masterplan identifies 67 priority projects, with an estimated investment need of around $500 million, to implement between 2016-2020. However, to reach the ambitious goal of reaching a knowledge based society, the Masterplan recognizes, will require Rwanda to make serious investments in education, ICT awareness and digital literacy and ensure that cooperation between academic institutions and the ICT industry is strengthened.

RWANDA VISION 2020

Kigali, July 2000

SMART RWANDA 2020
MASTER PLAN

Towards a Knowledge Based Society
Kigali, October 2015

1.5. ALIGNMENT TO NATIONAL URBANIZATION POLICY

In 2015, Rwanda adopted a National Urbanization Policy to show how urban development can be a driver for economic development. The purpose of the Policy is to enhance institutional capacity to manage urbanization in a coordinated manner and integrate urban planning and management to ensure sustainable growth, improve urban quality of life, provide job opportunities and increase urban productivity. This will be achieved through a series of guiding principles: sustainability and resilience, integrated planning, decentralized urban governance, participatory planning, market-responsiveness, sustainable land use, appropriate urban management and social inclusion.

The National Urbanization Policy addresses four policy pillars: coordination, densification, conviviality and economic growth. Policy documents developed under the framework of the urbanization policy aim to concretize the principles of sustainable urban development in Rwanda. The 27 smart city initiatives (see Chapter 4) are related to the four policy pillars of the National Urbanization Policy in the following ways:

COORDINATION:

This pillar ensures multi-level institutional coordination, good governance and effective planning. The Smart City Rwanda Masterplan ensures data-based institutional coordination through a **cross-ministry financial and project management platform** (Initiative 2), promotion of planning tools and participatory planning processes through **GIS-based urban management platforms** (Initiative 1), **dynamic data-supported master planning** (Initiative 3), **digital citizen engagement tools** (Initiative 7) and the creation of i**nnovation teams in ministries and local authorities** (Initiative 22).

DENSIFICATION:

This pillar ensures land use efficiency for sustainable urban development. The Smart City Rwanda Masterplan proposes concrete initiatives related to strategic investment phasing, such as the **cross-ministry financial and project management** platform (Initiative 2) and informed decision-making to support the development of efficiently serviced urban neighbourhoods with initiatives such as **digitally monitored and managed utility networks** (Initiative 13) and **data-led 'door-to door' mobility solutions** (Initiative 10).

CONVIVIALITY:

This pillar promotes quality of life, mitigation of disaster risks, social inclusion and cultural preservation. The Smart City Rwanda Masterplan pinpoints concrete initiatives for conviviality such as **digital service points for rural settlements** (Initiative 14), s**mart urban agriculture projects** (Initiative 15), **sensor-based environmental data** (Initiative 16), **smart and green building labs** In to promote sustainable living and working (Initiative 17) and the development of **smart, sustainable and shared neighbourhood pilot projects** (Initiative 18).

ECONOMIC GROWTH:

This pillar links urban development to green growth and market- responsiveness to unleash the potential of innovation, public-private partnerships, local revenue development and efficient financial management. The Smart City Rwanda Masterplan promotes concrete initiatives such as **a national fund to encourage challenge-based innovation** (Initiative 21), **local digital business platforms** (Initiative 23), **collaborative urban innovation acceleration labs** (Initiative 25) and **personalized e-finance platforms for all life-time services** (Initiative 26).

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

NATIONAL URBANIZATIONPOLICY

December 2015
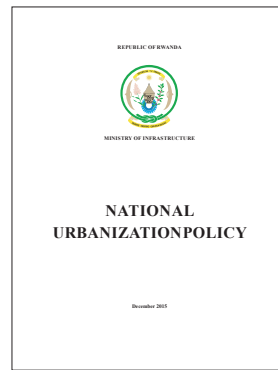
Rwanda Smart city pillars	Rwanda Smart City Masterplan building blocks	Smart Rwanda 2020 enablers	Smart Rwanda Masterplan pillars
1. SMART GOVERNANCE AND PLANNING	A. Data led management and planning	GOVERNMENT AND MANAGEMENT	GOVERNMENT
	B. Smart policies and regulations		
	C. Public engagement and open data		CITIES
2. SMART AND EFFICIENT SERVICES AND UTILITIES	D. Shared local infrastructure	SECURED AND SHARED INFRASTRUCTURE	EDUCATION
	E. Efficient, demand based services		SMART AGRICULTURE
	F. Sustainable and resilient resource manage-ment		HEALTH
3. LOCALIZED INNOVATION FOR SOCIAL AND ECONOMIC DEVELOPMENT	G. Education, innovation and digital literacy	ICT CAPABILITY AND CA-PACITY	BUSINESS and INDUSTRY
	H. Localized and challenge based financial opportunities		
	I. Digital transformation of financial and municipal services		FINANCE

Smart Rwanda 2020 Masterplan	Smart Africa Manifesto 2013	National Urbanization Policy	UN-Habitat urban planning principles
Enhance the national ICT Governance and regulatory structure	To improve accountability, efficiency and openness through ICT	Decentralized urban governance	More compact cities
		Appropriate tools for urban management	Better integrated cities
		Sustainable land use	
		Participatory planning	Socially inclusive cities
Utilize ICT for education as a tool to enhance teaching and learning	To leverage ICT to promote sustainable development	Integrated planning	Resilient to climate change
Expand medical and health services to enhance citizens quality			
Boost agricultural productivity, industrialization and commercialization		Sustainability and resilience	
Build shared, robust resilient infrastructure to underpin service delivery and national ICT initiatives			
Improve and expand access to ICT skills and innovation capacity	To improve access to ICT, especially broadband	Social inclusion and cultural preservation	Better connected cities
Advance women and youth social economic empowerment through ICT			
Improve financial infrastructure to expand access to financial services	To put ICT at the center of the national socio-economic development agenda	Flexibility and market responsivenes	
Promote trade and industry development by enhancing value of products and services			

Table 1. The relations between the new Rwanda smart city strategies and current urban, smart city and ICT guidelines

02 SMART CITIES

2.1. WHAT IS A SMART CITY?

A smart city is a compact, connected, socially inclusive and resilient city that leverages the power of technology, data and innovation to improve the quality of life of residents and to coordinate and integrate urban management sectors.

A smart city uses digitalization and technology to provide a high quality of life for its citizens, businesses and visitors. A smart city embeds technology and data across city functions to make them more efficient, competitive and innovative. Cities become smarter through a series of steps that enable them to become increasingly resilient and able to respond quicker to new challenges.

Digital technology can support the functioning of urban fundamentals such as planning, basic services, governance and housing in the smart city. Urban density and proximity of buildings, connected and efficient street networks, mixed urban uses, adequately located housing, public spaces and connected green infrastructure are prerequisites for a sustainable city. Technology can be is used to help cities trigger the full potential of economic and social development. Through innovation, openness and connectivity, smart cities ensure that they meet the environmental, social and economic needs of present and future generations.

2.2. THE RWANDA SMART CITY VISION

In Rwanda's smart cities, leaders and citizens use data, information and knowledge to ensure a co-created resilient and sustainable future.

This will be achieved by inclusive data-led management and planning, efficient community-based infrastructure and services and localized and shared innovation and economic development.

Rwanda, has the potential to champion the development of smart cities in Africa, due to its stable and innovative leadership, the fast digital transformation and the innovation capacity of its youth.

Kigali convention centre © Rwanda Government

2.3. THE RWANDA SMART CITY MODEL

Building smart cities requires focusing on both the physical and technological layers of urban development. The physical layer is anchored in the principles of sustainable urban development presented in the National Urbanization Policy of the Republic of Rwanda, which promotes more compact, better connected, socially inclusive, resilient and integrated cities.

For the technology layer of urban development, the research on smart cities highlights three main models that smart cities follow.

The **technological model** is based on formulating a framework for new economic opportunities, enhancing the startup ecosystem, testing new technology in 'urban beta-sites', and seeing the city as a hub of knowledge and experience. In this model, global technology companies are invited to apply and test their technology and finance implementation within the city borders.

This model has been the smart city driver for:
Barcelona, Singapore and Chicago.

The **strategic model** is based on a culture of long term strategic planning and constant monitoring. This model sees technology as a tool to assist in achieving long term urban goals, through data-led monitoring and ICT.

This model has been the smart city driver for:
Vienna, Birmingham and Copenhagen.

The **collaborative model** is based on the understanding that municipal services and community wellbeing are challenged by size, complexities and the dynamic character of cities in the 21st century. This model is based on small scale solutions that reach out and engage communities and neighbourhoods, innovative municipal workers and motivated and engaged citizens that work towards mutual ownership. This model sees collaboration and engagement as one of the main tools and goals.

This model has been the smart city driver for:
Boston, Tel Aviv and Medellin.

The best approach to follow for Rwanda, and other African countries, is a combination of the **three technological models.** This allows for new or improved scalable technology solutions and financing models; new data and monitoring processes that enable more flexible strategic planning and management; and improved and more accessible local services through collaboration, co-ownership and co-creation.

The Rwanda smart city model is centred around **3 main pillars, 9 strategic building blocks and 27 action initiatives.** (See Chapter 4)

3 main pillars	Smart governance and planning			Smart and efficient services and utilities			Localized innovation for social and eco-nomic development		
	1			**2**			**3**		
9 building blocks	A	B	C	D	E	F	G	H	I
27 initiatives	1	4	6	10	12	16	19	23	26
	2	5	7	11	13	17	20	24	27
	3		8		14	18	21	25	
			9		15		22		

WHEN RWANDAN CITIES...

Kigali City © RDB Rwanda

Use technology to engage citizens and other urban stakeholders,

…they reach wider audiences and enable more voices to be heard in order to create joint ownership that better prepare citizens and stakeholders for needed changes.

Localize infrastructure, utilities and services and utilize co-ownership and co-creation,

…they narrow service delivery and infrastructure gaps while minimizing costs and raising efficiency of urban systems.

Use accurate and relevant data to manage and plan,

...they are better equipped to manage urban challenges, climate change and the dynamic needs of their citizens

Promote digital transformation of financial and municipal services,

…they improve service delivery while reducing costs and promoting a more reliable and attractive local business environment

Include innovation training and mindset in formal education,

…they create a future generation of scientists, businessmen, teachers and leaders, better equipped for dealing with the complexities of the 21st century.

Create smart and performance-based policies and regulations,

…they allow city leaders to "feel the pulse" and react to urban, financial and social changes, while improving governance and the regulatory objectives and visions.

Use localized and challenge-based financial opportunities,

…they create partnerships between the innovation and business sectors, work towards common goals and needs, while reducing costs for local authorities and improve the competitiveness of the local business sector.

Utilize sustainability and resilience strategies in their resource management,

…they make better decisions, balancing between social, economic and environmental aspects and are better equipped for sudden changes and events within the built environment and its surroundings.

Use technology to engage citizens and other urban stakeholders,

…they reach wider audiences and enable more voices to be heard in order to create joint ownership that better prepare citizens and stakeholders for needed changes.

03 BUILDING SMART CITIES IN RWANDA

A smart city masterplan should not be a unique "stand alone" document. The plan must be synergetic and strongly linked to day-to-day management routines and processes of the local authorities and to strategic and long-term policy making.

At the national policy level, the plan proposes initiatives for the concretization of the National Urbanization Policy of the Republic of Rwanda. At the regional and municipal scales, the Masterplan elaborates on the initiatives presented at the National Strategy for Climate Change and Low Carbon Development, the Spatial Development Framework and the Masterplans developed or under development in the different municipalities.

In order to help leaders and managers of Rwandan towns and cities start the process of becoming smarter, four early decisions need to be taken. These four decisions are followed by 10 steps to implement the smart city vision.

3.1. FOUR EARLY DECISIONS

1. COMMIT TO BECOMING A SMART CITY

Many cities around the world have chosen to brand their cities as "smart" without thinking about what it really means for them. These brand-led "smart cities" tend to phase off very fast, losing the inspiration and creating suspicion among those who initially acted fast to embrace the change. Leaders, who decide that their city needs to become smart have to understand the responsibility that comes with collecting data, sharing it, and acting on it. This is particularly important when taking actions or making changes based on data collected in the smart city. Becoming smarter has great advantages, but it is a journey that no one should start without understanding what is required from the city.

Any Rwandan smart city should start by following the '10 steps' (see 3.2) and implement at least one smart city initiative from each strategic building block (see Chapter 4).

2. IDENTIFY THE CHAMPIONS

A really smart city does not only implement projects, but follows a process with connected action plans which are managed constantly. A city which focuses too much on discrete projects may miss opportunities for change or lose focus on the areas and topics most relevant for the city. To manage this, the smart city process has to have a dedicated leader. In some cities it may be a senior elected leader, in others a senior c-level director. Appointing such a leader is essential. Without one, the necessary changes — for example removing barriers, distrust and managerial problems — will be difficult, particularly in a context of managing issues affecting several departments, administrative levels and different types of organizations. Navigating this unknown territory will need a high-level leader confident to make changes, for example to regulations and processes, based on new information or data. The leader is, in many cities, followed by a dedicated team of digital champions (existing staff trained for the task) or a team of external consultants and essential stakeholders — all defined by size typology, local challenges and availability of funds.

Kigali Cityscape 2016 © Alex Niragira

3. CREATE A SHARED VISION

A smart city must have a unique vision. Although the main objectives and components might be based on a document such as this Masterplan, each municipal leadership has to create its own vision, practical objectives, indicators and targets. It is essential that the vision relates to any existing urban master plan or municipal vision. This vision then needs to be communicated well in order for it to be accepted and understood by fellow leaders and civil servants. It also has to be complemented by individual targets, frameworks and a comprehensive action plan. The vision is not static and may be altered, if new data and public acceptance allow for change

4. CHOOSE TO BE TRANSPARENT

One of the most important components of becoming "smart" is accepting openness and transparency and sharing the process with all urban stakeholders. Communicating the vision, targets and roadmaps, as well as the results — even if the outcomes are not what was expected — will result in higher acceptance. This will also get better results in the long term as the city can change what has proven wrong and build on successes.

3.2. TEN STEPS FOR REALIZING THE VISION

IDENTIFY CHALLENGES AND OPPORTUNITIES

Based on the prepared city profile and through stakeholder engagement, identify the main challenges and opportunities facing the city. Once identified, prioritize them. What can be solved easily and locally? What needs to be fixed first?

CREATE A STRATEGIC ACTION PLAN

In collaboration with citizens, and based on the smart city vision and other existing municipal visions and strategies, create a strategic action plan. The action plan should contain goals, indicators, initiatives, priorities and clearly identify the internal and external stakeholders that will be affected or need to be included in the planning. The action plan should identify communities and sites for pilot projects.

STUDY THE CITY

Create an initial profile of the city, including the unique physical attributes, existing infrastructure, financial, social and environmental advantages, demographic character and existing challenges. Do surveys, run citizen participation processes, analyze data and establish key performance indicators.

1 **2** **3** **4** **5**

CREATE A STAKEHOLDER PARTNERSHIP TEAM

This team should consist of the smart city leaders in the local government, chosen public and private champions and other stakeholders from civil society and the private sector — relevant to the challenges identified. This is crucial to create trust and co-ownership of the process and the results.

COLLECT ESSENTIAL INFORMATION

Once you have identified the main challenges, collect the most relevant and needed information to develop better understanding of how to tackle them. Investigate their impact on the financial, social and environmental aspects of the city. Figure out where in the city the challenges are the greatest. Assess who in the city are being most affected.

ELABORATION OF A PLANNED CITY EXTENSION PLAN

Use the information gathered from the primary study and the challenge process to elaborate a dynamic, GIS-based map of the city extension. The map shall provide an urban structure that minimizes transport and service delivery costs and optimizes the use of land. The map will include 'hotspots' where the challenges are the greatest and goals and targets related to each challenge. The map should include tools that enable digital analysis and be accessible to a wide variety of stakeholders

MONITOR AND EVALUATE THE PILOT PROJECTS, THEN SCALE

Evaluate the success of the pilot projects and proposed technological solutions in meeting the challenges. Collect feedback from citizens and local stakeholders, as well as through sensors and using data when and where needed. Evaluate and analyse the preliminary success, and based on this data, consider direct and indirect effects of the solutions and decide to continue, adjust or abandon the initiative, while examining the relevance for use in other locations within the city, and elsewhere based on local culture, costs or other effects. Based on the evaluation the projects can be scaled and replicated. Provide feedback to citizens and other stakeholders.

APPLY DYNAMIC MANAGEMENT AND COORDINATION PROCESSES

Evaluate success or failure through continuous monitoring and stakeholder feedback. Make regular changes. Alter, replace or prioritise initiatives through regular evaluations and validations of the action plan. Promote PPP initiatives based on realtime opportunities and update the vision based on political changes or shifts in needs or budgetary situations.

6   **7**   **8**   **9**   **10**

TEST LOCALIZED PILOT PROJECTS

Based on the strategic action plan, test tools, processes and new technologies through a series of pilot projects. The pilot projects should be in real-life relevant locations and may include comparative trials of similar solutions and evaluations made based on the key performance indicators. Evaluate necessary spatial and financial enabling frameworks.

BUILD LOCAL CAPACITY

Provide education and training to government officials, citizens and partner organisations. Ensure everyone has the skills to understand, use and implement the initiatives effectively, while being able to provide useful feedback regarding the quality and relevance of the solutions or some components.

3.3. MANAGING THE CHANGE

The process of creating smart cities requires change — partly related to technology, but also with regards to government processes and approaches to technology and innovation among government officials, citizens and other stakeholders. In order to manage this change, the following issues should be considered.

A. NATIONAL COORDINATION

Create a Smart City National Coordination Committee, consisting of senior national ministry officials, high-level local authority managers and other stakeholders, including a youth representative, a women's representative and a disabled people's representative. The Committee will work to overcome barriers and obstacles and ensure that successes can be learned from and replicated.

While such a Committee would not have statutory power, its significance will be derived from the seniority of its members. To ensure this, it should be represented by Director-Generals or Deputy Director-Generals of all relevant ministries, including the Office of the President, a mayor from each of the urban scales (capital city, secondary city, town) and the Chairs of the National Women's Council, the National Youth Council and the National Council for Persons with Disabilities.

The Committee should have authority to develop internal policies and guidelines to enable efficient and coordinated actions - including coordination between different ministries, governmental bodies and local authorities - while also monitoring potential duplication of responsibilities, budgets and resources. The Committee should meet regularly (monthly or bi-monthly) during planning and implementation of the first two smart city initiatives and once a quarter or twice a year, following the successful implementation of these projects.

B. COMMON STANDARDS, DIFFERENT SOLUTIONS

Create relevant planning and building codes, technological standards and common procurement and evaluation methods. Ensure that successes of different solutions, products and processes can be compared across localities.

C. MONITORING SUCCESS

Create a common monitoring system. Ensure that this includes information on what should be evaluated, the evaluation and iteration methods and who does the evaluation. Finally, decide on how to present results to the public.

D. LOCALLY APPROPRIATE TECHNOLOGY

Many urban technology solutions have been created for northern cities, not for the dynamic and emerging cities of Africa. To ensure that technology is appropriate for the Rwandan context, develop a system of technology assessment which includes examining specifications, design, usability, deployment models, synergetic potentials, adoption rates, business models and maintenance models. Once relevant technology has been selected, divide them into three groups: mature and directly implementable solutions, solutions that need further development and essential new development needs. New solutions and those that need further development should be tested in beta-sites and evaluated properly.

E. PRIVACY AND CYBER SECURITY

A technologically integrated smart city exposes potential vulnerabilities. Insecure hardware is prone to hacking, leading to system shutdowns, unencrypted links open up possibilities for security lapses, while a simple bug can have a huge effect on an integrated system like a smart city.[4] These risks can affect economic stability and national security, leave companies vulnerable to the theft of their intellectual property, and lead to the misuse of vast amounts of personal data. Mechanisms need to be implemented that protect the handling of sensitive data. Responsible smart city master-planning means giving citizens the opportunity to provide consent to the processing of their personal data, monitoring the extent to which private organizations collect data from the public sphere as well as ensuring that the data collected is only used for defined purposes.

F. YOUTH AND WOMEN

Rwanda's smart cities need to be socially inclusive so that everyone benefits from the transition from an agrarian to a knowledge-based economy. Women, youth and marginalized communities especially need to be included in decision-making and planning processes. Introducing a smart city partnership team (section 3.2.), consisting of a diverse group of representatives, provides a platform for different perspectives and opinions to be heard.

Social inclusion within the smart city relies on awareness raising and ensuring access to ICTs. Investment in the development of digital tools and ICTs need to be accompanied by policies enhancing people's digital education and incentivizing the use of these technologies. Making WiFi freely available in public places, community outreach programmes to spread digital literacy, and community initiatives to increase and encourage internet access and availability all open up possibilities for everyone to reap the benefits of smart cities.

G. POLITICAL CHANGE AT LOCAL LEVEL

During the smart city implementation process, local political leaders or senior civil servants might change. To ensure the sustainability of the process, a strict documentation and evaluation process is essential. Strategies and policies need to be approved and followed.

H. NEWLY INVESTOR-BASED BUILT CITIES AND DEVELOPMENTS

Many medium to large new developments are led from beginning to end by private sector developers and investors. These kinds of development should be seen as an opportunity to realize the smart city vision. In order to do this, a policy should be created which requires all large developments to be smart, sustainable and connected to the community. This may be an opportunity to work with private sector partners by specifying ICT and smart infrastructure networks in the planning stages and including them in tenders for construction and development - to be paid by the developer or as a PPP initiative.

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4. Ernst and Young (2016) Cyber Security: A necessary pillar of Smart cities

University of Rwanda's 3rd Graduation Ceremony | Kigali, 29 July 2016 © Rwanda Government

3.4. FINANCING SMART CITIES

Financing smart city initiatives can present major challenges. Up to now, many smart city initiatives in the world have been presented as pilot projects with initial funding by public research bodies (such as the EU Horizon 2020 programme), grants by innovation funds (such as those created by donors such as USAID and Sida) or by private vendors interested in learning and experimenting in real-life locations.

However, to make these projects sustainable in the long-term, they have to be based on local financial models and resources (even when they might be financed by external resources or public-private partnerships), ensuring that national government and local authorities are in control and fully evaluate the financial processes, understand methodologies and find a balance between needed resources, effectiveness of technology solutions and ensuring quality of service delivery.

Although smart city initiatives have clear financial and social value and many of them do present a clear return of investment, there are still barriers related to financing. Often these barriers are due to the following reasons:

- **Uncertain project costs** - mainly due to the novelty of solutions

- **Regulatory risks** - as regulation may not yet exist or be fit for purpose for some new technologies

- **Lack of existing impact assessments** - providing clear data on cost and revenue

- **High upfront costs** - compared to using existing solutions

- **Small scale and small markets** - which may deter investors due to high investment costs and longer periods for returns

Considering these barriers, focus on the following potential financial strategies:

1. Create enabling regulation

Such regulations and standards should enable the testing and evaluation of previously untested technology and may include the following:

- **Special testing areas**, for example urban labs or innovation neighbourhoods allowing unregulated or untested technologies to be tested. (See Initiative 5)

- **New and flexible regulatory frameworks** for initiatives such as micro-grids and peer-to peer solutions. (See Initiative 12)

- **Innovative tendering processes**, including reducing requirements for innovation-based tenders, use of challenge-based tender processes and shifting to performance-based tenders instead of descriptive processes.

View of Kigali City Tower © Rwanda Government

2. Reduce information gaps

A common barrier to private investment is uncertain project costs and lack of information related to return of investment. National and local authorities can reduce this information gap by making relevant data available, including:

• **Magnitude and locations of challenges** - to allow for better understanding of the size of the market and financial constraints that may exist. (See Initiatives 1 and 4)

• **Potential starting points** - defined by urgency, opportunities or urban strategies. (See Initiatives 1, 2 and 17)

• **Data regarding previous/current projects and case studies** - in different locations, including success factors and financial results, in order to reduce financial and operational risk and uncertainty.

3. Improve business conditions for private investors

In addition to the strategies above, in order to ensure private sector investment, it is crucial to reduce bureaucratic burdens by improving relevant e-services. This may include e-property registration and e-open trading systems, including common or open databases providing information to investors

4. Create new financial models

Smart city initiatives differ largely in scale and costs, and may be divided into three main groups:

A. Small or medium-sized projects in the startup space

Many small projects lack initial start-up funds. This can be solved by making available grants, loans (including convertible debt), and equity investments. However, often these funding models can be inaccessible to startups and SMEs due to:

- High interest rates
- Low rate of return
- Long repayment periods
- Perceived or real risk to investors
- Small scale of projects reducing revenue and initial profit

To deal with these issues the following financial strategies can be used:

- National guarantees to reduce risks for investors and banks
- National loans to companies working on specific strategic smart city initiatives
- Compulsory grace periods to projects approved in municipal innovation tenders
- A national fund for startups and entrepreneurs (see initiative 21)
- Create specific financing solutions for smart city initiatives (see initiative 27)

B. Medium-sized projects that may be implemented internally or outsourced

Projects related to existing municipal structures and challenges could be funded locally but may face difficulty in implementation due to the novelty of the solutions. This can be solved by the following financial strategies:

- Multi-stage procurement processes, starting with small-scale pilot projects that require less investment
- Implementation trials led by innovation teams in local authorities prior to procurement (see Initiative 22)
- National guarantees to investors and companies after A or B trial stages
- National innovation fund with national and global partners giving low rate and high risk loans to local authorities or to selected companies
- Exploring the use of blockchain instruments to finance projects and reduce bureaucratic burdens in the financing process

C. Large scale projects that may be financed by national or international budgets, or by PPPs

Projects that need substantial funds are usually infra-structure projects such as microgrids, or large pilot projects. These can be made with different PPP solutions[5] such as concessions, build-operate-transfer (BOT) and design-build-operate (DBO) options. However many of these solutions are used for large scale infrastructure projects when working directly with national govern-ments and not local entities. Therefore we propose methods and initiatives to ease the barriers and enhance the will of private investors to compete in such projects (see Initiative 2).

Concessions - gives a concessionaire the long term right to use all utility assets conferred on the concessionaire, including responsibility for operations and some invest-ment. Asset ownership remains with the authority and the authority is typically responsible for replacement of larger assets. Assets revert to the authority at the end of the concession period, including assets purchased by the concessionaire.

Build Operate Transfer (BOT) Project - is typically used to develop a discrete asset rather than a whole network and is generally entirely new or greenfield in nature (although refurbishment may be involved). The project company or operator generally obtains its revenues through a fee charged to the utility or government rath-er than tariffs charged to consumers.

Design-Build-Operate (DBO) Project - the public sector owns and finances the construction of new assets. The private sector designs, builds and operates the assets to meet certain agreed outputs. The operator is taking no or minimal financing risk on the capital and will typically be paid a sum for the design-build of the plant, payable in installments on completion of construction milestones, and then an operating fee for the operating period.

5. http://ppp.worldbank.org/public-private-partnership/agree-ments/concessions-bots-dbos

04 THE SMART CITY ACTION PLAN

4.1. OVERVIEW OF THE ACTION PLAN

The following Rwanda Smart City Action Plan builds on three pillars, nine building blocks and 27 action initiatives and apply to five scales - national level, capital city, secondary cities, other towns and rural settlements. It is crucial that innovation in Kigali is complemented by initiatives in secondary cities to prevent draining ideas and human capital from other cities.

The 27 initiatives have been developed in consultation with a wide variety of Rwandan stakeholders, including government ministries, local governments, academia, civil society and the private sector. They constitute a comprehensive multi stakeholder action plan to help make Rwandan cities smarter. Town and city leaders can use these initiatives to develop their own smart city masterplans, strategies and processes.
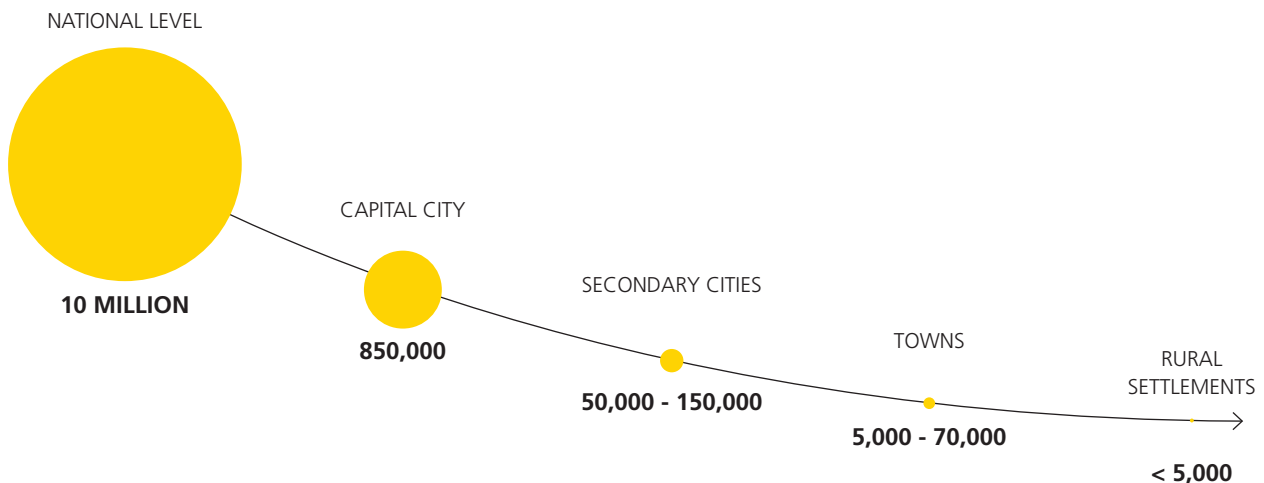
Five city profiles

NATIONAL LEVEL

10 MILLION

CAPITAL CITY

850,000

SECONDARY CITIES

50,000 - 150,000

TOWNS

5,000 - 70,000

RURAL SETTLEMENTS

< 5,000

Fig.5: Scales of the five city profiles

PILLARS	BUILDING BLOCKS		INITIATIVES	
1 Smart governance and planning	A	Data-led urban planning and management	1	Integrated, GIS-based urban management platforms
			2	Cross-ministry financial and project management platform
			3	Multi-stakeholder safer cities programme
	B	Smart policies and regulations	4	Dynamic data-supported urban master planning
			5	Enabling environments for urban technology testing
	C	Public engagement and open data	6	Data strategies including open data, privacy and cybersecurity
			7	Accessible internet zones in strategic and residential areas
			8	Digital citizen engagement tools accessible to all
			9	Urban Data accessible to all
2 Smart and efficient services and utilities	D	Shared local infrastructure	10	Digitally monitor and manage utility networks
			11	Explore smart micro grids based on the prosumer model
	E	Efficient, demand based services	12	Regulatory frameworks for virtual power plants and other demand-based management solutions
			13	Smart data-led 'door-to door' mobility solutions
			14	Digital service points for rural settlements
			15	Smart urban agriculture projects
	F	Sustainable and resilient resource management	16	Sensor-based environmental data
			17	Green and smart building labs
			18	Smart, sustainable and shared neighbourhood pilot projects
3 Localized innovation for social and economic development	G	Education, innovation and digital literacy	19	Innovation in education, from primary school to higher education
			20	ICT skills training in education, for local authorities and the general public
			21	National fund to encourage challenge-based innovation
			22	Innovation teams in ministries and local authorities
	H	Localized and challenge-based financial opportunities	23	Promote local digital business platforms
			24	Create collaborative community co-working and digital excellence centers
			25	Establish collaborative urban innovation acceleration labs with academy, community and industry
	I	Digital transformation of financial services	26	Introduce personalized e-finance platforms for all life-time services
			27	Electronic due-diligence and business loan systems for SMEs

Table 2. Action Plan

4.2. THE 27 INITIATIVES FOR SMART CITIES IN RWANDA

The initiatives were developed through a stakeholder process, including meetings with a wide range of stakeholders from national and local government, private sector, academia and civil society. The process considered challenges, opportunities and existing smart initiatives as well as existing urban and ICT-related gaps that may be informed by this Smart City Masterplan.

Based on this process, 27 smart city initiatives have been identified. They vary in scale, cost and focus, and may not all be relevant for every local authority or urban scale. The initiatives are intended as a starting point for towns and cities to become smarter, and local authorities may decide to build on them or develop their own initiatives under each strategic building block. Each initiative is related to a smart city pillar, a strategic building block and an urban scale. Some have been proposed as strategic initiatives. Each initiative has also been linked to the city flows, city services, smart citizen services and smart city domains found in the Smart and Sustainable Cities Blueprint for Africa.

Each initiative has an associated short case study. The case studies are intended as inspiration for the development of Rwanda-specific projects, not as prescriptive processes to follow or recommendations for technologies to implement.

Kigali City © RDB Rwanda

INITIATIVE 1

Integrated, GIS-based urban management platforms

Strategic initiative

PILLAR	**1**
BUILDING BLOCK	**A**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Governance

Cross agency collaboration

Cities experience a variety of challenges as described in Chapter 1. In order to tackle them, urban managers need reliable, up to date and actionable information to take good planning decisions, enable collaboration and direct investment. Some cities have the capacity to collect data, but lack common platforms to record and analyse location-based performance information and use it to develop well-informed plans and strategies.

Geographical Information Systems (GIS) can be used to build an urban management platform, accessible across departments and municipalities and enabling staff to track historical and current datasets, geotagging incidents as well as pinpointing areas for high potential for private investment and projects. This system should be accompanied by data sharing strategies and collaborative management processes. As GIS is a common spatial database format, national government departments, municipalities and the private sector can produce, analyse and share data to promote trust and improve service delivery.

The Ministry of Infrastructure has established a national geo-database with substantial data on infrastructure , planning and environmental aspects, with the objective of integrating all spatial data available in the Ministry on one data platform. However, although a national platform is a great starting point, and is essential for national strategies and projects, there is further need to integrate data held by other organisations such as municipalities, the private sector and civil society. The platform also needs to be developed into an accessible dynamic management tool, building on existing GIS data held by a variety of stakeholders. To ensure success it is crucial to have ongoing data and GIS capacity, provided by dedicated internal staff.

The platform should include layered municipal and regional maps, time and geo-tagged, as well as tables, dashboards and other analysis and presentation tools. These are all available though most vendor provided solutions. The geodata may be presented in 2D or 3D (such as in Singapore) and may include real time data (in safety and service issues) and static data - collected and presented in predefined intervals.

Case study

The London Infrastructure Mapping Application, UK

A geodatabase allowing the public, investors and local government to understand the phasing of projects, synergies and tensions that arise from the cumulative impact of development, the potential for greater coordination of works and the ability of systems to respond to London's growth in the short, medium and long term. The application incorporates information from utility companies, local authorities, developers and the Greater London Authority. Projects can be viewed by location, value, financing status as well as by sector.

https://maps.london.gov.uk/ima/

INITIATIVE 2

Cross-ministry financial and project management platform

PILLAR	**1**
BUILDING BLOCK	**A**
CITY PROFILE	NATIONAL

Governance

Cross agency collaboration

Across Rwanda, a wide variety of projects are initiated by national and local government, private companies and local and international non-profit organisations. In many instances, these projects are coordinated through Rwanda's existing Development Assistance Database, which coordinates aid projects through the Ministry of Finance and Economic Planning. However, the Database doesn't fully cover the needs for coordination between all stakeholders - sometimes resulting in poorly planned efforts. Coordination challenges such as this exist all over the world but particularly affect countries with very high growth rates such as Rwanda.

To meet this challenge, a national digital project coordination platform should be created. The platform can be connected to existing budget coordination platforms, but should include non-government projects and should be fully accessible to ministry and local authority staff as well as to stakeholders outside government.

A key feature would be the requirement of all stakeholders to register projects, including adding geo-data, alerting local authorities and other parties, timetables, targets, outcomes, possible barriers and issues affecting local communities. This can be easily linked to existing urban planning, land registration and construction permit systems. By providing forward-looking information on ongoing and planned projects, all stakeholders, including national and local government bodies, utilities, service provides, donors and private companies can better coordinate efforts, eliminate gaps and identify over-

laps and make better planning decisions. Coordination in this way can significantly improve emergency response as well as help initiate and monitor public private partnership projects. The initiative should include a distinction between government-to-government projects (focusing on those to be led by local authorities and districts) and business-to-government projects, matching local authorities with the private sector and donors.

Case study

The Rwanda Development Assistance Database

Used by the Ministry of Finance and Economic Planning to track and manage aid funds and development results across all major donors and NGOs. The system is integrated with Rwanda's SmartFMIS budgeting platform.

https://dad.minecofin.gov.rw

INITIATIVE 3

Multi-stakeholder safer cities programme

PILLAR	**1**
BUILDING BLOCK	**A**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Governance

Safety and emergency response

Cross agency collaboration

Although Rwanda is considered one of the safest countries in Africa, security and emergency management remains an issue. There are some safe-city projects initiated by the national police, including CCTV services connected to a central command centre, geolocated incident data, driver license registry through Irembo, social media for first responders and online tracking of vehicles. There is also a plan to connect individual police units directly to the command centre using GPS and audio and video feeds. However, due to resource constraints most of these initiatives are focused on Kigali and are not available in other towns and cities. In addition, while there is a community policing network and a call-center with theme-based incident reporting lines, none of the existing data collected is used for spatial development or day-to-day urban management.

In order to create synergy between data, policies and connectivity, local governments should establish smart and safe data-led policies and mobile-based safe city connectivity systems. By consolidating geo-located and time-based emergency call data, emergency service reports and municipal complaints, incident maps can be built to show crime hotspots and incident times. This data can be integrated into a GIS management system (see Initiative 1), linking safety with other urban management concerns such as building permits, transportation and basic services or indicators such as income. In addition, the data can be used to develop spatial planning frameworks and safety strategies built on UN-Habitat's Safer Cities Programme, focusing on management of

streets and public spaces as a key to neighbourhood safety.

Building on existing social media and text-message reporting systems, a mobile-based safe city connectivity system could provide a direct link between affected citizens and first responders through a community crowdsourced incident scene map. Citizen's reports can show dark areas, crime hotspots, hazardous routes and damaged infrastructure, in some cases replacing the need for classic safe-city camera-based solutions. This mobile system may be part of a wider engagement tool (see Initiative 8).

Case study

The Medellin Integrated Metropolitan Emergency and Security System (SIES-M), Colombia

The platform brings together more than 10 government agencies from the security, transportation, health, disaster management and environment sectors on a single operations platform. With a single emergency call from citizens, different services can respond in a coordinated manner. The platform also integrates data from 823 video surveillance cameras distributed throughout the city.

INITIATIVE 4

Dynamic data-supported urban master planning

PILLAR **1**

BUILDING BLOCK **B**

CITY PROFILE   NATIONAL, KIGALI, SECONDARY CITIES

Governance

Cross agency collaboration

Spatial planning is historically a static process, based on one-time data collection and planning. However, considering developments in digital technology and real-time data and the fast changing-nature of African cities, new tools are needed to improve interaction between city planning and urban challenges. This can be done by integrating data and digital public engagement into the planning and management of the built environment.

In recent years, Rwanda has produced masterplans and spatial development frameworks for Kigali and secondary cities such as Rubavu and Nyagatare. However, although the plans are of good quality, future plans - anticipating large urban population growth rates - will require a new and smart planning system. This initiative may require some revision of national planning frameworks to take into consideration time and data as part of the planning process, creating "open plans" which can be adapted based on real-time or recently collected data. For example, instead of defining exactly the land use, it could provide indicators that allow for a land use change (for example change in population size). Instead of stating the exact space needed for public spaces and roads, it will ask for proof of access to infrastructure and services.This should be done by creating an agreed process for defining indicators and targets, how data is collected and who can make changes.

Dynamic planning is not a "low hanging fruit" and needs resources such as a regulatory framework, a GIS and data analysis system (see Initiative 1), good data collection processes (for example through sensors), regular community engagement and capacity building. This kind of planning system also requires an ongoing planning process with teams of urban planners. However, overall there is no doubt that dynamic planning is cost-effective and more suitable to public engagement and new financial opportunities. This is a radical change and it is essential to start with suitable pilot projects at neighbourhood level to provide better understanding of what is required to implement it at a larger scale.

INITIATIVE 5

Enabling environments for urban technology testing

PILLAR	**1**
BUILDING BLOCK	**B**
CITY PROFILE	KIGALI, SECONDARY CITIES

Citizen services   Business services   Governance

Due to insufficient knowledge about impact, business models and adoption rates, implementation of new technologies often require early stage testing prior to wider deployment. International experience shows that cities that cater for experimenting and testing often attract investment and startups, raising revenue as well as providing opportunities to ensure new solutions are fit-for-purpose, meet local regulations and are financially viable.

There are different models for urban testing environments. Cities can define areas with limited planning regulation for experimentation, create a regulatory environment for innovation or a friendly financial environment catering for risky investments. "Simplified planning zones" (SPZ) or "special purpose districts" (different terms are used in different countries) can be good platforms. These areas can be defined for a specific use, for example innovation, with flexible planning regulation, land use rules and financing requirements where companies can test innovative solutions. Innovation districts (newly built or existing neighbourhoods) also have a management structure supporting startups, research and beta-siting, making available urban data, hosting challenge-based innovation contests and hackathons to help small and large companies develop solutions to challenges at low cost and in a controlled environment

Kigali Innovation City has all the chances to become such an district. However, while it has an impressive management plan, plans for R&D centers and academic bodies

alongside young and mature companies, it currently lacks the regulatory and policy framework to cater for the highest possible experimentation. Also, innovation in the capital city need to be complemented by secondary cities to prevent draining ideas and human capital from other cities. Similar zones (with the right scale and structure) should be established in the secondary cities, ideally with a focus on local context and potential (for example tourist areas can focus on innovation in tourism services).

Case study

@22 Barcelona, Spain

An innovation district promoting social and economic urban renewal. The district, located in an old industrial part of the city, developed a strategy for 'a new model of a compact city', based on innovation activities, green spaces, advanced industries, a strong industrial heritage, subsidized housing, a new mobility model and revitalized public spaces.

http://www.22barcelona.com

INITIATIVE 6

Data strategies including open data, privacy and cybersecurity

PILLAR	**1**
BUILDING BLOCK	**C**
CITY PROFILE	NATIONAL, KIGALI, SECONDARY CITIES

Governance

Information and Open Data

Tools for citizen engagement

Building on the existing draft Data Revolution Policy and the 2013 Rwanda Open Data Readiness Assessment, a data strategy, license and personal data protection law, as well as the Data Revolution Policy itself, should be approved. These should outline the following:

a. Which data can be shared across ministries, districts, local authorities and with citizens and the private sector.
b. How to collect and distribute data.
c. How data can be saved, for how long, and by whom.
d. Which personal data can be collected and shared and how privacy of citizens can be ensured.
e. The regulations and systems necessary to ensure good use of data (procurement rules, supervising bodies, cybersecurity systems).
f. The necessary staff, training and systems required to ensure cybersecurity

An Open Data Licence should explain the conditions under which the data may be used, with every government agency following the conditions of the licence. Open licences are inappropriate in certain circumstances, such as where consent has not been granted (i.e. personal data), is subject to licences or is third-party generated data. Similarly, classifying data as 'open' potentially removes a revenue stream for local municipalities. Local municipalities could consider charging a licence fee in the event that a private company uses public data for profit-making purposes.

As recommended by the draft Data Revolution Policy, open data portals should be created for Kigali and secondary cities. Considering that Rwanda has the most available government data in Africa (moving from 74th place in 2015 to 44th in 2015 according to the Global Open Data Index), it will be an easy task to consolidate data and make it easily accessible to citizens, government bodies, researchers and the private sector to use for research and innovation. Open data portals need resources for management and maintenance, either public or private, or a combination.

Case Studies

The Hitachi City Data Exchange Copenhagen, Denmark
This system, funded by Hitachi and collaboratively owned by the municipality, gives public bodies full access to datasets for free, basic access to civilians and academia and pay-per-use access to private companies and research organizations.
https://www.citydataexchange.com

London Datastore, UK
Free and open data-sharing portal where anyone can access data relating to London. The site provides over 600 datasets to help citizens, business owners and developers understand the city and develop solutions to London's problems.
http://data.london.gov.uk

INITIATIVE 7

Accessible internet zones in strategic and residential areas

PILLAR	**1**
BUILDING BLOCK	**C**
CITY PROFILE	SECONDARY CITIES, TOWNS

Connectivity

Despite major developments in internet access, digital technology use and digital literacy, a lot remains to be done in Rwanda, as elsewhere, to bridge the digital divides across gender, geography, age, and income. Although Rwanda is digitising fast, with 4G LTE expected to cover 95% of the country by the end of 2017, nearly 70% of citizens are not online and nearly 30% don't have a mobile phone. This digital divide is particularly apparent in secondary cities and towns.

By reducing information costs, digital technologies can lower economic and social transactions for firms, individuals and the public sector. They promote innovation when transaction costs fall to essentially zero. They boost efficiency as existing activities and services become cheaper, quicker, or more convenient. And they increase inclusion as people get access to services that previously were out of reach. Lack of access to the internet means higher transaction costs, no access to government services such as Irembo and increased inequality between those with access and those without.

At the secondary city and town level (and in a more basic extent in rural settlements, (see Initiative 15), it is crucial to ensure that people have access to the internet and digital services. Internet zones, providing free and accessible wifi to citizens, should be established all over the country.

The internet zones should be located in strategic locations, but more importantly, in residential areas with

large numbers of people without the financial capacity or in areas that lack internet connectivity. This can be implemented using public funds, for example through tenders and licenses, through regulation or by private entrepreneurs, for example by requiring them to provide free basic internet when providing fast internet for a fee.

Case study

Free wifi, Johannesburg

The City of Johannesburg has rolled out over 1,000 free wifi hotspots across the city. The hotspots are located in public facilities such as libraries, swimming pools, clinics and bus stations. Each network user is allowed 300mb of data a day, plus unlimited access to some services via the Maru a Jozi portal.

http://www.maruajozi.joburg

INITIATIVE 8

Digital citizen engagement tools accessible to all

Strategic initiative

PILLAR | **1**

BUILDING BLOCK | **C**

CITY PROFILE | KIGALI, SECONDARY CITIES, TOWNS

Tools for citizen engagement

Rwanda has a long history of citizen engagement, for example by making the annual budget available in an user friendly format or the 2015 Rwanda Citizen Report Card Survey. Building on this, gathering feedback from citizens can be strengthened with the use of digital tools. The growing number of mobile phones smartphones, make mobile engagement the best option.

Municipalities should develop and manage mobile engagement applications or create mobile responsive websites aimed at promoting dialogue with citizens. The following features should be considered:

- Urban complaint reporting - including photographing, geotagging and process dialogue between the reporter and the municipality

- Location-based (municipal, district or neighbourhood) news regarding maintenance schedules, natural hazards, public events and local economic benefits

- Municipal service registration, including payments of taxes and fines

- Crowdsourcing of ideas in new developments as part of the planning process

- E-access to a service center providing information on municipal services

Successful tools, with more data, better design, and good response rates can create higher trust and engagement, with a growing number of citizens giving data and personal feedback willingly. This means that services can be targeted directly to their needs, and complaints and proposals dealt with effectively. The tools can be developed and maintained by local authorities or by the private sector by agreement with the local authority.

Case Study

DigiTel, Israel

A digital service used by nearly 40% of the population of Tel Aviv to pay water and municipal tax bills, order parking permits and send photos of potholes or broken park benches to the municipal complaint line. Linked to the online service, the DigiTel Resident's Card is a smart ID card that provides discounts yn all kinds of shows and cultural events and access to a personalised web page, where citizens can manage their bills and get personalized notifications.

https://www.tel-aviv.gov.il/en/Live/ResidentsCard/Pages/default.aspx

INITIATIVE 9

Urban Data accessible to all

PILLAR	**1**
BUILDING BLOCK	**C**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Information and Open Data

Tools for citizen engagement

The total amount of digital data in the world is expected to mushroom from 4.4 zettabyte in 2013 to 180 zettabyte in 2025. This astounding growth will come from a large increase in devices and sensors connected to the internet. There are now approximately 11 billion connected devices, a figure expected to nearly triple to 30 billion by 2020 and then nearly triple again to 80 billion in 2025. Rwanda will experience similar growth.

Considering Rwanda's relatively low internet and smartphone penetration and the existing digital divide, unless data is made widely accessible, large parts of the community are likely to be left behind. This initiative would minimize this data divide in three ways:

1. Making data accessible to non-internet users. In addition to providing public internet (Initiative 7), information needs to be available to people without computers or smartphones. Public digital "billboards" can provide access to datasets and information about urban services. However, in some areas, lack of digital literacy or connectivity may make digital services unsuitable. In these places effort should be made to provide digital data in analogue form, for example through posters or billboards placed in widely used public facilities such as schools, libraries, places of worships and health clinics.

2. Making data understandable. Often data is available but not presented in ways that make it understandable for the majority of the population. Therefore it must be communicated in ways that makes it accessible to

everyone - including in all Rwanda's official languages, with easy to understand graphics, using simple language and taking into consideration the needs of disabled people.

3. Making data inclusive. Making data accessible and understandable may not be enough to ensure buy-in from citizens. Efforts to make data available need be accompanied by offline ways of building civic trust, for example by making available personnel to support the poorest communities with digital literacy training.

Case study

Buen Comienzo, Medellin

Through the Buen Comienzo, (Good Start) programme in Medellín, mothers-to-be in the city's low-income communities, where access to free internet is scarce, get medical information online at more than 150 public areas that offer computer access, free Wi-Fi and classes. While internet access doesn't substitute for an appointment, it can reduce the need for doctor visits and provide supplemental information about pregnancy.

http://www.americasquarterly.org/content/medellin-smart-city

INITIATIVE 10

Digitally monitor and manage utility networks

PILLAR	**2**
BUILDING BLOCK	**D**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Water and
Sanitation

Energy and
Buildings

Utility networks often experience resource losses as high as 20-30% related to aging and unmaintained systems and low efficiency. Some losses are on the user side (resulting in additional cost of living) while others are on the municipal/utility side (resulting in additional management costs). This is a serious issue in all networks, and crucial for Rwanda. To improve utility network management, Rwanda should install networks utilising online digital tools and scada (supervisory control and data acquisition systems) related to the following:

- **Loss Control** - monitoring networks to detect presence and location of leaks or losses in real or close to real time

- **Water pressure and energy load management** - monitoring distribution quality

- **Event and crisis management** - controlling network maintenance and providing crisis control

- **Quality management** - monitoring the quality of infrastructure (water and sewage) in terms of environment and health

These kinds of data and management systems are mainly useful for the monitoring of water, sewage and energy networks but could also be used for solid waste. Currently, they are being used to monitor medium level power, but as networks are expanded and demand for better service grows, there is a need for better monitoring in all cities. The use of smart networks could also enable better service, improve efficiency and reduce demand (see Initiatives 11 and 12).

Customers get lower bills and better quality service while reducing their use, resulting in reductions in the need for energy and lower investment costs. These systems have proven financial returns but the initial cost may be high, requiring implementation through BOT models. They can also be implemented as energy savings company projects - with partners paying for the system and gaining returns form the reduction of utility costs.

Case Study

TaKaDu water management, Israel

TaKaDu provides cloud-based solutions to connect water pipes to the Internet of Things, enabling a proactive approach to flood control and rainwater collection, and the identification of weak points or blockages in the network before major damage occurs. For example, in Queensland, Australia, Unitywater cut its direct water losses by one billion litres in one year, saving $1.9 million; it reduced the time it took to detect and resolve network events by two-thirds, and increased availability by almost 20%.

http://www.takadu.com

INITIATIVE 11

Explore smart micro grids based on the prosumer model

PILLAR **2**

BUILDING BLOCK **D**

CITY PROFILE | KIGALI, SECONDARY CITIES, TOWNS

Energy and
Buildings

Currently Rwanda is promoting on-grid electricity connectivity in urban areas and off-grid connectivity in some rural areas. However, as energy needs grow, it may be necessary to explore new ways of producing and managing energy, mainly in urban areas, where demand is expected to grow substantially in the future. In Kigali, secondary cities and towns, smart microgrids can help meet energy needs and connect citizens currently lacking access to utility services. According to the IMF and the World Bank, microgrids have real viability and low connection costs - the average individual connection cost starts at $50, while extending the grid to a sufficiently adjacent community can start at $500 (IFC 2012).

Several initiatives, including the collaboration between Rwanda's Energy Development Corporation and Ignite Power which aims to connect 250,000 people to solar energy by 2018 are already underway, although mainly focusing on rural areas. A project funded by the World Bank is also providing smart meters, communications networks, and data management services to Rwanda Energy Group, providing a platform for the development of smart grid functionality.

The "prosumer model" (joint producer and consumer) is an even more innovative model that could have a large impact on energy supply in urban areas. In this approach, a prosumer is a consumer of electricity who also produces it and can sell it back to the grid. For many cities in Rwanda, the prosumer could help meet the growing need for electricity. A model that takes into consideration

issues related to management, maintenance and regulatory frameworks needs to be developed. A key factor in promoting the microgrid prosumer model is investment in testing within existing and new communities.

A possible pilot-site for microgrids may be the Kigali Innovation City, but similar pilot projects should be implemented in other existing neighbourhoods which experience high outage rates. Due to high costs, these projects usually utilise PPP models

Case study

Brooklyn Microgrid, USA

A community microgrid in Brooklyn, New York. The aim of the project is to achieve a sustainable, secure, and cost-effective energy system by providing long-term, locally generated power security within a community. The Brooklyn Microgrid is structured as a benefit corporation, (a for-profit corporate entity that can positively impact society), owned by LO3 Energy.

http://brooklynmicrogrid.com/

INITIATIVE 12

Regulatory frameworks for virtual power plants and other demand-based management solutions

PILLAR	**2**
BUILDING BLOCK	**E**
CITY PROFILE	NATIONAL

Energy and Buildings

With growing demand for energy, power utilities need to expand capacity, ensure better stability and reduce costs while minimising negative environmental and social impacts. Despite steps towards renewable energy generation and the use of new technology to improve efficiency, the best way to reduce carbon emissions is simply to use less energy.

Digital transformation provides new ways to collaborate. In energy, the "prosumer" model (see Initiative 11) is one way of doing so, but peer-to-peer solutions are easier and can act as a starting point for a wider utility revolution. The peer-to-peer concept is based on energy consumers collaborating in the management of the grid by lowering or shifting demand depending on availability. This is done by creating public awareness around managing infrastructure, for example by asking people to reduce the use of AC, shifting working hours or running unmanned machinery at night. In return for reducing peak hour demand, customers receive the benefit of dynamic fees and higher network stability. Introducing these kinds of solutions require less up-front investment than new microgrids, as they are less technology-intensive and focus mainly on a small number of high-use customers such as factories, industrial parks and office buildings, but the savings can be substantial.

Another peer-to-peer system, sometimes called ''virtual power plants'', enables users to sell excessive energy to their neighbours on an open market. This can motivate users to make their buildings more energy efficient or add energy storage systems so that they have more extra energy to sell.

Prosumer and virtual power plant systems require regulatory changes enabling dynamic utility pricing and distributed energy distribution (currently, only the national utility is licenced). They also require personalised energy management software and a registered digital network to manage and share the data (there are several existing startups). Finally pilot projects need to be implemented to create trust in the system. Municipalities or industrial park owners can act as initial matchmakers. The Rwandan Energy Utility Corporation initiated a new electricity tariff system in January 2017, relating rates with consumed units, increasing the viability of such systems.

Case study

Vandebron, the Netherlands

Vandebron is an online peer-to-peer energy marketplace, on which anyone who generates renewable energy can sell their surplus energy directly to consumers. Customers can select their supplier based on the type of energy (wind, solar, water bio) along with other variables such as pricing or location.

https://vandebron.nl/

INITIATIVE 13

Smart, data-led 'door-to door' mobility solutions

PILLAR	**2**
BUILDING BLOCK	**E**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Transportation
and mobility

Although some work is underway to make public transport more efficient, for example through the Kigali smart card system, lack of efficient and widely accessible mobility can be a barrier to eliminating inequality and to creating sustainable growth. One of the main issues, especially in secondary cities is poor connectivity, reliability and efficiency of public transport, partly due to a lack of information regarding needs and financial viability of services. Most of the public transport options outside Kigali run only on the main national and regional roads. To deal with this, connectivity composed of different modes of transport provide citizens door-to-door mobility options.

This could include (gradually, starting in Kigali and secondary cities):

1. Data collection regarding transport needs via aggregation of data from transport operators, municipal apps and accessible citizen engagement tools.
2. Using data to define mobility routes, including large buses/minibuses and taxi-moto and finally safe and accessible walking routes.
3. Creation of a multi-mode mobility app to coordinate:

   • Pricing, availability and safety of transport
   • On demand taxis and dynamic stops for large buses and minibuses
   • Feedback from clients regarding convenience of routes, route hazards and complaints regarding operators

An integrated transport app will help enhance reliability of public transport, while also acting as a strategic tool for designing routes and intervals to assist in route maintenance and to assist with public safety. This is a highly comprehensive proposal which may initiated by the private sector and funded as part of new transport tenders/ new license costs and by additional public transport users.

Case study

Citymapper

Transport app Citymapper, currently available in 40 cities across the world, analyzes real-time data released by local governments, giving users available transport options. For example, the app may recommend the fastest option as a combination of train, tram and bus, or if you've already bought a train card it will give you train-only options. Alternatively, if it is raining it will give you a "rain safe" option that minimizes walking.

https://citymapper.com/

INITIATIVE 14

Digital service points for rural settlements

PILLAR	**2**
BUILDING BLOCK	**E**
CITY PROFILE	NATIONAL, KIGALI, SECONDARY CITIES

Education   Connectivity   Citizen services   Business services   Healthcare

A challenge for Rwanda, which is still predominantly rural, is to limit service dependency on a few urban areas. The Strategic Plan for the Urbanization and Rural Settlement Sector, puts emphasis on creating a hierarchical network of urban and urbanizing centers providing services and attracting economic activities countrywide, and to support the development of secondary cities, districts, towns and rural settlements, as well as Kigali. However, lack of energy and broadband become real barriers to realising this vision.

While the government is aiming to make 4G LTE internet connectivity available countrywide, and has made available a number of e-services for rural areas, uptake is hampered by lack of access to energy and internet. For example, mobile apps for health workers had to be abandoned due to lack of smartphones and data. Compulsory financial payments via Irembo can result in fines when internet is not accessible in rural areas.

To help solve this problem, this initiative recommends the creation of digital service points in rural settlements or clusters of rural settlements. These service kiosks can provide access to e-government services, including the following.

Access for personnel (for example health, security, education) via a smartcard including:

- 24hr/day energy connectivity based on solar and energy storage systems
- Fast broadband connectivity including access to offline content for better stability
- 24hr water and sanitation
- Medical consultation services
- E-government services

Access to specific e-services (pre-registration):

- Capacity building and training, for example trade and business skills and digital literacy
- Computer access for e-government services, digital banking and business management services

Open public access:

- Free public wifi hotspots
- Mobile phone and tablet charging
- Digital billboards
- Pay-as-you-go water

Case study

Mobile Charging Kiosk, Rwanda

A Rwandan company, African Renewable Energy Distributor, produces mobile phone solar charging kiosks on a franchise basis. Customers visit the kiosk, drop off their phone, take a ticket and return a few hours later when the phone is fully charged.

INITIATIVE 15

Smart urban agriculture projects

PILLAR **2**

BUILDING BLOCK **E**

CITY PROFILE KIGALI, SECONDARY CITIES, TOWNS

Citizen
services

Water and
Sanitation

Cross agency
collaboration

As the global population grows, research shows that by 2030 food production will increase by 30%, energy use by 50% and water use by 40%. Considering Rwanda's fast urbanisation rate, food production needs to become more efficient. One way of doing this is through smart urban agriculture - integrating agriculture and food production within the urban fabric. Urban agriculture can bring food production closer to consumers while reducing energy use and transport costs. However, competition for urban space and lack of infrastructure calls for the use of innovative farming techniques and tools.

Smart urban agriculture requires a multi-process strategy, including:

- **Enabling regulation**, including accepting agriculture as an urban land use and allowing access to vacant land.
- **Reducing environmental and health risks**, including better coordination between health, agriculture and environmental departments, taking into consideration health when zoning urban agriculture and providing education for urban farmers.
- **Smart production methods** such as vertical production to deal with the lack of space. However, these can be energy intensive.
- **Precision agriculture**, using sensors and data to create optimised conditions for growth, including monitoring of soil conditions, water, nutrition, light and temperature while also reducing pesticide, water and energy use.

- **Digital product distribution** to deal with issues related to distributed production, for example the need to manage and share production management, listing demands and local capacities and alternative sources.

Some smart agriculture solutions exist, especially in terms of distribution and sensing, but many are still in experimentation stages. This is a great opportunity to test existing solutions, as well as to invite local entrepreneurs to respond to the urban agriculture challenge, while locating relevant beta sites, and developing enabling regulatory frameworks. A possible betasite may be the Kigali Innovation City project which is planned to include urban agriculture spaces. To succeed, a national vision, including enabling regulation should be developed by the Ministry of Infrastructure and the Ministry of Agriculture.

Case study

AeroFarms, US

AeroFarm is a commercial company that does agriculture in a fully-controlled indoor environment without sun or soil. It uses an optimized aeroponic growing system for faster harvest cycles, predictable results, superior food safety and less environmental impact. It uses 95% less water than field farming, 40% less than hydroponics and zero pesticides and cuts growing times in half.
http://aerofarms.com

INITIATIVE 16

Sensor-based environmental data

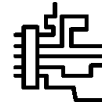|	
PILLAR	**2**
BUILDING BLOCK	**F**
CITY PROFILE	KIGALI, SECONDARY CITIES

Information and
Open Data

Sensing the city

As Rwanda urbanises, pollution and noise are likely to increasingly affect citizen's quality of life. Although Rwanda Climate Observatory is collecting some environmental data there is a need to make it more localised and timely. Many kinds of air, noise and water pollution can be monitored by sensors. Historically, this has required site specific meteorological stations or infrastructure level high-end sensor networks but, recent developments in sensor technology have reduced costs and improved quality, meaning they can be installed fairly easily and even be connected to smartphones. There are now a variety of low-cost sensors available on the global market.

This initiative recommends the implementation of urban environmental sensing strategies, for distribution, management and analysis of urban sensor networks. These should include preliminary sensing of the whole city, using mobile sensors on trucks or motorbikes (already being tested in Kigali) to determine crucial areas for sensing. Based on this, a preliminary risk map can be created to determine the location and size of the sensor array, as well as the data collection strategy (when and what to collect). Data should be analysed at the municipal level with assistance from the Rwanda Climate Observatory, the Ministry of National Resources and Rwanda Environmental Management Authority, analysed and mapped.

The sensor data can then determine actions to be taken, for example dealing with water pollutants, warning people about flooding risks, minimising pollution effects by reducing car traffic at specific hours or informing deci-

sion-making in urban planning (see Initiatives number 1 and 4). Such maps and sensor data can also help local governments with resilience planning, determine the location of new developments and transport routes as well as ensuring more mixed land use and optimal density. The data (considering safety requirements), can also be shared with citizens to help them make better informed decisions on where to live, work and move in the city.

Case study

Chicago "array of things" sensor network, USA

The Array of Things (AoT) is an urban sensing project, comprising of a network of interactive, modular sensor boxes installed around Chicago to collect real-time data on the city's environment, and infrastructure. Currently, the sensors measure temperature, barometric pressure, light, vibration, carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone, noise, pedestrian and vehicle traffic.

https://arrayofthings.github.io/

INITIATIVE 17

Green and smart building labs

PILLAR	**2**
BUILDING BLOCK	**F**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Energy and Buildings

Water and Sanitation

Education

To promote sustainable living and working, buildings should be designed to take into consideration environmental concerns. Green building solutions combined with smart technology can ensure sustainability, but poor design or wrong choice of technology can result in the opposite. Green and smart buildings need to be designed in ways that take into consideration local culture, building materials and experiences.

To promote green and smart buildings in Rwanda, it is important to start with projects that can be showcased. These can be done as experimental labs, where researchers can test smart solutions, but also open to the public and accessible. This usually means selecting centrally located facilities, for example schools, municipal halls, dormitories, retail malls and even petrol stations (which are often strategically located and contain retail and other facilities).

The green and smart buildings should feature:

- High level green building standards (LEED gold-platinum) linked with the ongoing Green Building Organization work at Rwanda Housing Authority
- Best practices for energy and water management (preferably zero-energy)
- Wifi-based multi sensing systems measuring indoor and outdoor environmental indicators, as well as resource performance
- Smart digital management solutions relevant to the use (for example smart school solutions or e-health solu-

tions), as well as high level user engagement tools
- Strategically located screens presenting hr/daily/weekly performance dashboard and analytics (also accessible online)
- Training and demonstration spaces with models or 3D representation technology

Locating these testing labs in schools will have multiple advantages and add value by providing stable energy and internet connectivity, particularly when considering that only 47% of public schools have electricity and only 6% of primary and 18% of secondary schools are connected to the internet (MYICT 2012, Rwanda ICT Sector Profile). This initiative can be funded through energy savings companies (ESCOs) or by inviting companies to install solutions for marketing potential. Some public funding is however likely to be needed.

Case study

HSB Living Lab, Sweden

A sustainability research and demonstration arena, open to the public, which includes homes for 30-40 students at Chalmers University, Gothenburg The building has been fitted with the latest green and smart building technology, and provides researchers with an opportunity to research building sustainability and technology in a real living environment.
www.hsblivinglab.com

INITIATIVE 18

Strategic initiative

Smart, sustainable and shared neighbourhood pilot projects

PILLAR	**2**
BUILDING BLOCK	**F**
CITY PROFILE	KIGALI, SECONDARY CITIES, TOWNS

Energy and Buildings

Water and Sanitation

Transportation and mobility

The next step after the creation of green and smart building labs (see Initiative 17) is to connect them into smart and sustainable neighbourhoods. These require participation and community involvement in urban planning and decision-making, including joint efforts to improve local economies, local resource management (for example peer-to-peer solutions), and providing collaborative services (car sharing, local community working hubs). Such smart and connected neighbourhoods can save resources substantially. They should be initiated in Kigali as well as in secondary cities - in new neighbourhood developments and slum upgrading projects. They should be led by the Rwanda Green Building Council and based on green buildings and sustainable neighbourhood standards (for example the LEED green building standards), including the following:

- New building technologies and techniques and smart open space designs
- Neighbourhood smart infrastructure and multi-utility microgrids using renewable energy
- Smart and shared mobility plans and solutions (transport-oriented development projects)
- Strategic community-based broadband internet solutions (fiber or wireless)
- Environmental sensing arrays where needed
- Local innovation and co-working spaces and beta innovation sites

The projects should be monitored and regularly evaluated based on predetermined indicators, as well as cost-benefits analysis of individual and integrated solutions. Results, including comparisons between individuals, buildings and complexes, should be shared with the community - creating motivation to change behavior. Due to the costs and resources needed, these initiatives should be developed as investor-based initiatives where possible, or as a PPP, including local management and maintenance companies motivating contractors and users to use services and resources more efficiently. After the pilot projects the Ministry for Infrastructure and the Green Building Council can evaluate the success and decide whether they should be mainstreamed

Case study

Hammarby Sjöstad, Sweden

A 25,000 inhabitant neighbourhood in Stockholm. The design of the neighbourhood, including integration of technical infrastructure, mobility and communication infrastructure and building infrastructure has significantly reduced energy consumption and waste. Compared to other neighbourhoods of Stockholm, there have been significant reductions in solid waste (90%), liquid waste (35%), energy consumption (40%) and water use (40%).

http://www.aeg7.com/assets/publications/hammarby%20 sjostad.pdf

INITIATIVE 19

Innovation in education, from primary school to higher education

PILLAR   **3**

BUILDING BLOCK   **G**

CITY PROFILE   NATIONAL

Education

At the national level, innovation is key to creating a knowledge based society. In order to equip students with the skills, expertise and knowledge that they will need in the future, the Rwandan school system needs to teach innovation from a young age. Research shows that learning through real projects has a significant impact on student's engagement and development and all courses should be connected to real problems, ideally those found in the local community. By embedding innovation in the curriculum, for example through innovation courses in primary schools or teaching design thinking and linking with innovation labs at high school and university level, Rwanda will ensure that it has the tech-savvy and innovative workforce required for prosperity in the 21st century.

Innovation does not just mean new technology, it's just as much about changing processes, services, programmes and partnerships, moving away from traditional or rote-learning and encouraging students to solve real-world examples and problems n a simple, clear and demand-driven way. Some innovations and innovation processes do rely on new technologies but they can also draw on the creativity and experience of communities, for example using play to enhance young children's learning and development.

Rwanda's new competency-based curriculum which came into effect in February 2017, is a great way to introduce innovation processes in schools. The curriculum, in development by Rwanda Education Board

since 20013, is based on research of curriculums in East African countries as well as the United States of America, United Kingdom, South Korea and Singapore and will ensure that students learn social skills through crosscutting issues such as hard work, critical thinking, problem solving, creativity, citizenship, national identity, genocide studies, comprehensive sexual education, decision making and financial education.

Case studies

Sometimes the River and The Change, Mozambique

Community learning materials in the form of booklets, cartoons and games developed by UN-Habitat to promote natural disaster risk reduction, for example related to flooding, cyclone-proof construction and rainwater harvesting.

http://mirror.unhabitat.org/pmss/getElectronicVersion. aspx?nr=3382&alt=1 the river game un-habitat

The Young Entrepreneur Programme, Ireland

A Programme that teaches secondary school students to explore and develop entrepreneurial skills through workshops, case studies and interactions with key business people.

http://www.youngentrepreneur.ie

INITIATIVE 20

ICT skills training in education, for local authorities and the general public

PILLAR	**3**
BUILDING BLOCK	**G**
CITY PROFILE	NATIONAL

Education

Although Rwanda has already come a long way in promoting digital literacy, for example through the One Laptop per Child programme, there is still a substantial need for ICT skills education and training in order to reduce the digital divide. Basic computer, software and coding skills should be offered at primary school level and through free courses to the general public. Multi level training in coding, programming, data science and web design should be compulsory at secondary school and higher education level. ICT skills training, including data analysis, basic coding, and the use of professional software should be offered to staff at local and national authorities.

This requires investment in infrastructure such as computer labs, internet connections and server rooms, as well as ensuring that all schools have access to electricity. In addition, the following lessons can be learned from successful integration of ICT in education, according to the World Bank and African Development Bank:

1. A robust policy environment that supports ICT in education policy is an enabling, but not sufficient, condition for ICT roll-out.
2. Policy requires supportive institutional arrangements that may necessitate central-level coordination.
3. ICT integration in education requires national budget support as well as nationally driven partnerships with the private sector. Total reliance on donor-funded projects that are necessarily driven by differing donor agendas will lead to standalone projects that are not

sustainable.
4. National ownership and sustainability planning are critical in all initiatives if they are to go beyond the novelty pilot level to nationwide projects that have real impact.
5. Success of integration of ICT in education requires a change of focus from computer literacy for teachers to understanding ICT integration in education from the pedagogic perspective.

Access to content needs to be improved by open educational resources, which can be copied and adapted without licence fees. Effectively integrating technology into teaching and learning also requires well-qualified educators, a clear focus on equipping teachers with ICT literacy skills and support for teachers to use technology in teaching. It also requires locally-appropriate content, including content in all of Rwanda's official languages, especially Kinyarwanda.

Case study

BBC Schools Computing, UK

An online resource for primary and secondary school teachers to teach coding and other computer skills to their students. A variety of lessons and links to other online resources are available.

http://www.bbc.co.uk/schools/0/computing

INITIATIVE 21

National fund to encourage challenge-based innovation

Strategic initiative

PILLAR	**3**
BUILDING BLOCK	**G**
CITY PROFILE	NATIONAL

Financing

In order to deliver the Ministry for Youth and ICT's ambitious aim of creating a large Rwandan technology startup ecosystem, it is crucial to motivate and promote Rwandan entrepreneurs, innovators and startups at the national level. However, access to financing is highlighted as one of the main obstacles to entrepreneurs in Africa. A lack of available startup funding is a serious problem, and even more so for early stagers that have to decide to keep their existing job or to explore new ideas. A report by Ihub Research found that venture capitalists are seldom seen in Africa and getting seed funding for small startups is therefore difficult. And while it is getting easier than before, venture capitalists (and entrepreneurs) often choose to create solutions with a quick return on investment and better chance for an "exit", instead of developing solutions that create substantial local value by solving local problems.

While some localised startup funds exist in Rwanda, for example the Bank of Kigali Urumuri tech innovation fund, the innovation ecosystem in Rwanda could be greatly strengthened through a national fund. Such a fund should provide both pre-seed funding to very early stage startups (in the idea formulating stage), giving them time to develop ideas and test prototypes as well as funding for initial beta testing, given either directly to the startups or to local authorities hosting the pilot projects.

Funds should be targeted at startups that aim to solve real local urban challenges. This could be ensured by

holding challenge-based innovation contests by local or national government or through regional idea-competitions such as the Climate Launchpad from the EU. The fund itself can be a national effort or a joint venture with investors or global corporations willing to invest in local challenge-based initiatives or as part of corporate social responsibility commitments.

Case studies

Ohio Third Frontier, USA

A series of pre-seed funds to grow local and statewide clusters of excellence in targeted areas of technology. The funds are financed and monitored by the state, and are expected to co-fund (50:50) and mentor companies towards capitalisation.
https://development.ohio.gov/bs_thirdfrontier/default.htm

The National PreSeed Accelerator Fund, New Zealand

Programme designed to support early stage technology commercialisation activities which were developed in publicly-funded research organisations. Grants of up to $250,000 are available to improve the commercial capability and skills of public research organisations and promote business linkages.
www.mbie.govt.nz/info-services/science-innovation/investment-funding/current-funding/pre-seed-accelerator-fund

INITIATIVE 22

Innovation teams in ministries and local authorities

PILLAR **3**

BUILDING BLOCK **G**

CITY PROFILE | KIGALI, SECONDARY CITIES

Cross agency collaboration

Governance

Innovation in local and national government can be difficult to promote. The language and characteristics of innovation can be confusing or impose a perception of suspicion and threat to existing staff and managerial teams. In addition, municipal and national government staff, often have creative ideas but no clear way of implementing them. To get around this problem, establishing innovation teams that can support staff in innovation processes can be useful.

These innovation teams can be connected to the mayor's office or the general director's office and linked to the Joint Action Development Forum (JADF), with two main goals:

1. Promote innovational ideas within the public sector itself
2. Screen and enable community led innovation by coordinating with ministerial and local authority departments, and lead trials and experimentations for the local authority.

The innovation teams should be multidisciplinary, with a variety of skills related to innovation, IT, leadership, urban and public policy. They should be mandated by management to lead and execute projects, test new approaches, and working alongside other municipal and governmental innovation teams, create a national public sector innovation network.

Case study:

The City of Boston "New Urban Mechanics", USA

The City of Boston's civic innovation team, part of the mayor's office, experiments with pilot projects that offer the potential to significantly improve the quality of city services. Through an agile approach focused on delivering transformative city services to Boston's residents, they work on a broad range of projects from increasing civic participation, improving city streets, to boosting educational outcomes.

http://newurbanmechanics.org

INITIATIVE 23

Promote local digital business platforms

PILLAR   **3**

BUILDING BLOCK   **H**

CITY PROFILE   KIGALI, SECONDARY CITIES, TOWNS

Business services

A stable and sustainable local business ecosystem is a crucial component for healthy and resilient cities. However globalisation, the power of e-commerce and business ecosystems are increasingly giving advantages to larger companies and retails centers over small, medium-sized and local businesses. This results in lower local revenues, less tax base and higher costs of living, particularly in secondary cities and towns.

Cities can help local entrepreneurs and businesses compete in national and regional markets, by combining the power of their physical presence, the power of community and innovative digital tools to better understand the market, to ease delivery and to create better business opportunities. This can be done through municipal business platforms, including three main aspects:

1. Municipal commerce data - including data on potential local clients, market analysis, location of competition and business collaboration opportunities.

2. Digital marketplaces - for local and regionally advertising, selling products, publishing local special offers and for purchasing raw materials to competitive prices (small business may act together as a semi-cooperatives with the potential to receive prices similar to big chains) as well as enabling local residents to request products for local clients. The digital marketplace can also be a place to advertise local tenders or grant opportunities.

3. E-commerce assistance and training - including information and support to help small businesses create a digital presence for example websites, online shops, online advertising and electronic payment gateways.

These platforms may be funded by national government, local governments by a collaborative local effort or by collaboration with investors, local or international e-commerce firms (such as Amazon, Ebay, Google) - although the latter should include compulsory guidelines to promote local companies.

Case study

Digital Main Street, Canada

The City of Toronto developed an online business support platform called 'digital main street' to connect Main Street businesses with the digital world. The municipality was joined by the Toronto Association of Business Improvement Areas (TABIA), Google Canada, MasterCard, Rogers Communications, Shopify and Yellow Pages and main street businesses, project facilitators and vendors. Businesses (currently over 200) register for free to get a digital assessment that identifies technologies and service providers and provides business mentoring. The platform was funded by Mastercard, Rogers, Shopify, Yellow Pages and Google, while other companies contribute services.

http://www.digitalmainstreet.ca/

INITIATIVE 24
Create collaborative community co-working spaces and digital excellence centers

PILLAR	**3**
BUILDING BLOCK	**H**
CITY PROFILE	SECONDARY CITIES, TOWNS

Education

Business services

While co-working spaces such as The Office and Impact Hub exist in Kigali, in secondary cities and towns local authorities should support — through regulation, space and financing — the creation of co-working spaces giving the local community access to internet, work spaces and collaboration opportunities. These spaces make it easier for entrepreneurs and small startups to access necessary services while creating benefits for local businesses. Linked to these co-working spaces, (and preferably part of them) local governments should promote the establishment of digital excellence centers for training, demonstration projects and acceleration of digital innovation opportunities.

This could also take the form of creating collaborative community spaces out of unused or under-utilised municipal owned spaces. Public spaces may be used as conference rooms, meeting rooms and brainstorming or other creative usages, thus reducing costs but also allowing for better utilization of urban spaces, while bringing innovation closer to civic centers . These centers can be initiated by the community or local authorities but due to the wide urban and national value, entrepreneurs should be incentivised to contribute.

Case studies

The Civic Technology Center (CTC), Palo Alto. USA

The CTC is the home of the City of Palo Alto's technology department, designed to act as a start-up community. It is designed and managed to enable residents and entrepreneurs to brainstorm ideas for civic technology opportunities. It also provides additional services such as meeting spaces for small civic tech-related events, for working on complex city problems with technology components. The area houses a new smart bar that acts like the popular genius bar at Apple stores, so that City staff can schedule or just walk up with their laptops and smart devices and get immediate assistance.
Http://www.cityofpaloalto.org/ctc

The City of Sydney "Venue to Hire" Initiative, Australia

This initiative allows private use of community venues including rooms, halls and auditoriums that are suitable for either community meetings, conferences, functions or weddings. Rooms may be booked directly through the municipality website using various search criteria including area, size and use. The site also includes online booking, fees (if relevant) and compulsory insurance. Students may book a space to rehearse music or other arts for free.
http://www.cityofsydney.nsw.gov.au/explore/facilities/venues-for-hire#ac=hp_e_toptasks_Book+a+venue

INITIATIVE 25
Establish collaborative urban innovation acceleration labs with academy, community and industry

PILLAR   **3**

BUILDING BLOCK   **H**

CITY PROFILE   NATIONAL, KIGALI, SECONDARY CITIES

Education   Business services

Urban innovation labs that promote change and support innovation, research needs and testing of new solutions can be created in various shapes and forms should be created through collaboration between academic institutions, the private sector and local authorities. The aim of these urban innovation labs should be to connect academic research, municipal know-how and public feedback, while acting also as a house for startup accelerators, focused on challenge based innovation (see Initiative 21).

These labs should reflect the unique factors of the region and aim to solve real urban problems, while creating enabling environments and data for real urban technology businesses as well as ongoing mentoring of student-related innovation. One such lab, Kigali Innovation City, is already being planned in Kigali.

The labs may be situated within academic campuses or in a publicly accessible area, such as the city center, or in transportation hubs. They may be funded by the national government, local authority, the private sector or funded internally by academia (when located within such institutions). Cities and districts that do not have a research organization, but have a strong business base, may create a partnership with an academic "back office".

Case studies

InnoZ, Germany

InnoZ was founded in 2006 as a cooperative venture between a variety of private sector and research institutions with a wide partner base of local and international universities, national and local authorities and business leaders. InnoZ is located in central Berlin and pioneers the development and implementation of systematic, social, and digital innovation in the mobility market, focusing on core sectors of transport, energy and ICT.

https://www.innoz.de/en

European Network of Living Labs

The international federation of benchmarked living labs in Europe and worldwide with over 170 active members. Founded in 2006, ENoLL provides co-creation, user engagement, test and experimentation facilities targeting innovation in many different domains such as energy, media, mobility, healthcare, and agrifood.

http://www.openlivinglabs.eu/

INITIATIVE 26

Introduce personalized e-finance platforms for all life-time services

PILLAR   **3**

BUILDING BLOCK   **I**

CITY PROFILE   NATIONAL

Citizen services

Business services

Information and Open Data

Irembo has revolutionised service provision by making services and payments digital. However, it does not yet consolidate all payment services or remove all silos. Building on the work with Irembo, it is possible to provide online financial tools to help SMEs make smarter financial decisions and manage financial transactions better. The first stage of such a tool is to enable SMEs to manage all financial issues online, including bank transactions as well as taxes, permits and government payments. Following this, it could be built out to provide financial planning and risk reduction services. The system should include at least three main features:

1. Financial profile - consolidating all personal financial data, so that information is not scattered between banks, insurance companies and government offices, including expenses, loans, future payments and tax liabilities.

2. Financial knowledge base - including financial data, information and guidelines, indexed and organised to help users make well-informed financial decisions.

3. Financial action assistance - helping users make sense of financial options by consolidating all information related to taxes, payments and financial decisions in a chronological calendar and reminding users of when action needs to be taken.

Due to issues related to privacy and cyber security as well as legal aspects, this platform needs to be created by or in partnership with the Rwanda Revenue Authority, or by the private sector with guidance or licensing from the government.

Case study

BankID, Sweden

Leading electronic identification in Sweden, with 7.5 million active users. BankD was developed by a number of large banks and is used by citizens, government bodies and private companies. Individuals and companies can use BankID to access their financial data held by financial institutions as well as government financial data such as pensions, taxes and benefits.

https://www.bankid.com/en

INITIATIVE 27

Electronic due-diligence and business loan systems for SMEs

PILLAR **3**

BUILDING BLOCK **I**

CITY PROFILE NATIONAL

Financing

Business services

One of the main obstacles to developing a strong middle class and a knowledge society, is the difficulty for small businesses to expand through financing and loans. This can be particularly difficult for startups and SMEs in secondary cities and towns. A national portal providing business support, financing and loans for SMEs can help significantly. Such a portal can provide SMEs with online assistance related to three main areas:

1. Business regulatory assistance - step by step online guidance related to business regulations, tendering and licensing.

2. Fast track business loans - streamlined process and e-gateway for SME-focused loans and grants including guidance on how to fill out digital forms and gain access to useful documents such as business plan templates.

3. Electronic due diligence - helping organisations review financial records and providing, support prior to entering into agreements or financial transactions with other parties. An electronic due diligence process, developed with assistance through governmental and financial bodies can enable a better and more reliable business ecosystem.

This initiative will need to consolidate many existing initiatives and others that have yet to be created. The portal can be created as part of Irembo, or as a new national initiative,

It may be developed by the private sector, particularly banks, but the government needs to create the necessary regulation and legal frameworks, including standards and guidelines and access to information.

4.3. PRIORITIZING THE INITIATIVES

A long list of 27 initiatives can be difficult to start at once. Issues related to local preparedness, culture, costs and external barriers have great effect on implementation and success. A prioritization system is therefore essential.

A. Strategic value (high=10) Is it of national or regional importance? Is it directly influenced by national policies? Does it have a direct impact on reducing urban challenges?

B. Feasibility (high=5) How mature are the existing tools and solutions? Do they need substantial regulation? Might there be cultural or political resistance? Can it be done without unique skills? Can it be done within the existing public mindset?

C. Implementation (high=5) Can the project achieve success in the short term? Can it be rolled out fast? Is it a long-term project?

D. Finance (high=5) Is it costly to promote? Can it be achieved through direct private or joint public-private initiatives? Does it have a clear ROI? Can it be led by the local communities? Does it promote local business?

Considering that every city and town face unique challenges and opportunities and has different capacity levels, each local authority needs to set its own priorities. Using the prioritization list above, local authorities preparing their own smart city masterplan should choose initiatives from each of the three smart city pillars to ensure maximum value from the smart city process.

Workshop, Rwanda @ UN-Habitat

05

CONCLUSION

**From Smart Rwanda
to Smart Africa**

The Rwandan Smart City Masterplan is part of a wider vision for Africa, harnessing the ongoing twin processes of digital transformation and rapid urbanisation across the continent to make African cities more inclusive, safe, resilient and sustainable. Its starting point is that digital technologies, civic participation and innovation can enhance urbanisation processes to make urban areas better for citizens and businesses.

This Masterplan, the first of its sort in Africa, attempts to create a comprehensive smart city framework based on three smart city pillars, nine strategic building blocks and 27 initiatives. The Plan recommends the implementation of technology solutions, data platforms, internet of things and smart grids, but also the further development of processes in urban planning, governance and finance. It also makes recommendations related to education, digital literacy, innovation and business development.

The Masterplan is not a "one-size-fits-all" plan, but call for evaluation, prioritisation and fine tuning to ensure that it meets the dynamic and changing nature of Rwandan towns and cities. The recommendations found in this document, along with the Smart Africa Alliance's Smart and Sustainable Blueprint for Africa, can be used to provide guidance for future national and local smart city masterplans throughout the continent.

This document is not intended as a rigid and unalterable document, but as a dynamic plan - ever changing and adapting based on the results of each pilot project, one city at a time, and as Rwandan and African cities develop and evaluate their own smart city masterplans. The initiatives that have been recommended will be fine-tuned and changed as evaluations are done, new datasets are established and technology develops. The best way to stay smart is to learn and adjust to the times based on the needs of present and future generations.

Rwanda © Kyle Taylor

The transformation of Rwanda from an agrarian economy into a knowledge-based society is taking place in the context of two of the biggest drivers of change in the 21st century — rapid urbanisation and the increased application of digital technologies in all sectors of society. To meet these challenges, and take advantage of the opportunities of the digital world, Rwandan society is being transformed. Citizens are increasingly moving to towns and cities, acquiring new skills and demanding better services. Cities are growing and require better planning, governance and new financing.

Smart cities, in which leaders and citizens use data, information and knowledge to ensure a co-created resilient and sustainable future, can play a large role in the transformation of Rwanda. By ensuring inclusive data-led management and planning, efficient community-based infrastructure and services and localized and shared innovation, cities can be drivers for economic development and sustainable development.

This Smart City Masterplan is intended as a guide to help Mayors and urban managers go through the process of developing their own smart city strategies and masterplans, as well as providing a strategy for the government to promote the development of smart cities in Rwanda on a national level.