SMART PARKING
in Kampala Capital City

2019 *Final Report*

WeGO Smart Sustainable City Feasibility Study Program

WeGO
World Smart Sustainable Cities Organization

SRPOST
Smart innovation, stronger communities

EXECUTIVE SUMMARY

Project type:	WeGO Smart Sustainable City Feasibility Study Program 2019
Project title:	Feasibility Study on Smart Parking in Kampala Capital City
Project start date:	September 17, 2019
Project end date:	January 17, 2020
Target government:	Kampala Capital City Authority (KCCA), Republic of Uganda
Target government project manager:	Mr. Martin Ssekajja Director in charge of ICT
Contracting party:	World Smart Sustainable Cities Organization (WeGO)
Contracting party project manager:	Ms. Eunbyul Cho WeGO Secretariat Program Manager
Implementation party:	SRPOST Co., LTD
Implementation party project manager:	Mr. Nangyu Kim Head of Strategy&Business Development Division

1. The 2019 WeGO Smart Sustainable City Feasibility Study focuses on analysing public parking environment in Kampala Capital City, Republic of Uganda and assessing the feasibility of its transition to smart parking.
2. The main parties involved in this project are World Smart Sustainable Cities Organization (WeGO), Kampala Capital City Authority (KCCA) and SRPOST Co., LTD (SRPOST).
3. Traffic congestion is a serious issue for Kampala and GKMA due to the rapid urban population increase, national economy growth and traffic load increase. According to the World Bank, the severe peak hour congestion in the GKMA costs the country about USh 2.8 trillion (approximately, USD 800 million) annually in GDP, and poor parking management is a crucial factor contributing to this problem.
4. KCCA and Kampala are ready for technological innovation and system integration related to Smart Parking practices as well as ready for international cooperation with governments pioneering Smart City and Smart Parking projects in their countries and cities. KCCA expresses strong interest and will to solve parking issues in Kampala and processes sufficient ICT and engineering recourses willing to participate in innovative transportation projects to enhance urban environment in Kampala.

5. KCCA has a successfully functioning government structure that would benefit from a small-scale departmental reorganization. KCCA should focus on establishing a Department (Directorate) of Transportation to centralize efficient maintenance and development of Kampala's transportation system and infrastructure as well as smooth transition to and efficient management of all future Smart Parking ecosystem aspects.
6. KCCA is expanding rapidly and as city population increases, the pressure on the city's infrastructure increases. In order to create a successful Smart Parking infrastructure in the future, it is necessary to strengthen the city's ICT level. KCCA is recommended to focus on development on talent and skills, necessary for implementing an efficient Smart Parking ecosystem. The FS also recommends for KCCA to take leadership in driving 5G adoption in Kampala to facilitate faster and more convenient Smart Parking experience in the future.
7. Currently, there are no comprehensive guidelines or explanations on vehicle registration, driver licensing or vehicle number plate types available for public use or study purposes in Uganda. The FS team concluded that a comprehensive research on vehicle number plates in use in Uganda is necessary in order for the future LPR cameras to operate smoothly.
8. Smart Parking ecosystem development requires not only talent, but significant funding and investment, which the local government cannot provide alone. It is recommended for KCCA to keep promoting entrepreneurship, encouraging private sector participation and attracting foreign investment. Possible actions that KCCA can undertake might include promoting digital payments for parking, promoting local public-private partnerships (tendering and encouraging participation by providing incentives and relaxing entry).
9. The study focused on implementing a small-scale off-street project – an Intelligent CCTV Parking system – as it is considered the best approach for Smart Parking beginners as reduces the risk of irreversible mistakes in the future. The pilot project positively assesses the KCCA's readiness to manage and control Smart Parking technology. The FS thus advices for KCCA to prepare for project scale up.
10. The study envisions the following five-year Smart Parking project implementation for Kampala public on-street parking facilities.

Year	Stage	Task
Year 1	Master Plan	Smart Parking system planning
		Smart Parking system analysis
		Smart Parking system conceptual design
		Smart Parking system detailed design

	Business process re-engineering (BPR)	Analysis and design of workflows and business processes within KCCA
Year 2	System development	Smart Parking system software development for KCCA Traffic Control Centre and Smart Parking app for vehicle drivers
	Hardware system installation	Kampala on-street parking facilities and KCCA Traffic Control Room
	System run start	Implementation of the Smart Parking system
Year 3	System maintenance	Smart Parking system maintenance, preparation of documentation and manuals
Year 4	System maintenance	Smart Parking system maintenance
Year 5	System maintenance	Smart Parking system maintenance

11. The estimated budget of a proposed five-year Smart Parking project is 2,632,086 USD.

Category	**Amount (USD)**	**Remarks**
Consulting (Master Plan)	475,431	Year 1
System implementation	1,585,776	Year 2
System maintenance cost	570,879	Years 3 - 5
Total Amount	**2,632,086**	

12. Starting from the 3rd year, KCCA is expected to see a rise in annual profit in parking revenue from USD 1,105,263.16 to USD 3,619,740.56 which is an increase of approximately 328%.
13. The study recommends to either look for internal funding within the Government of Uganda or focus on external sources of financing the project. Apart from government funding, loans provided by the international financial institutions like the Economic Development Cooperation Fund in Korea, World Bank, African Development Bank and East African Development Bank seem to be most viable funding options for KCCA to implement the Smart Parking system in Kampala. International funding from EU, UNDP and various ODA organizations seems to be the next possible option, however, procurement of such funding depends on the list of priority project subjects set by these organizations.

Keywords: *smart parking, smart city, feasibility study, WeGO, WeGO Smart Sustainable City Feasibility Study, WeGO FS 2019, SRPOST, Kampala Capital City, KCCA, Uganda*

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
°C	The degree Celsius
3G	The third-generation wireless technology
4G	The fourth-generation wireless technology
5G	The fifth-generation wireless technology
ADSL	Asymmetric digital subscriber line
AfDB	African Development Bank
AI	Artificial Intelligence
AIRTEL	Air Telecom
ANPR	Automatic Number Plate Recognition
API	Application Programming Interface
App	Application
BOP	Bottom of the pyramid
BPR	Business Process Reengineering
BRT	Introduction and Pre-FS of Bus Rapid Transit
CAGR	Compound Annual Growth Rate
CCD	Charge-coupled device
CCTV	Closed-circuit television
CMOS	Complementary metal–oxide–semiconductor
COEX	Starfield Convention and Exhibition Mall
CSF	Critical success factors
DMB	Digital Multimedia Broadcasting
DUV	Digital Uganda Vision
DVR	Digital Video Recorder
EAC	East African Community
EADB	East African Development Bank
EARNP	The East African Road Network Project (EARNP)
EDCF	Economic Development Cooperation Fund
EGDI	e-Government Development Index
e-Government	Electronic Government

ENG	English
EMEA	Europe, the Middle East and Africa
e-Parking	Electronic parking
EPART	E-Participation
EPI	E-Participation Index
e-Services	Electronic services
EU	European Union
E-waste	Electronic waste
FDI	Foreign direct investment
FS	Feasibility Study
GB	Gigabyte
GDP	Gross Domestic Product
GHG	Greenhouse gas
GII	Global Innovation Index
GKMA	Greater Kampala Metropolitan Area
GNI	Gross national income
GPPP	Global public–private partnership
h	Hour
HCI	Human capital index
HDB	Housing Development Board
HEGDI	High-level of e-government development
HQ	Headquarters
ICT	Information and communications technology
IDI	ICT Development Index
IOT	Internet of Things
IP	Internet Protocol
ISP	Internet Service Provide
IT	Information technology
IXP	Internet exchange point
JICA	Japan International Cooperation Agency
JV	Joint Venture
KAPS LTD	Kenya Airports Parking Services
kbit/s	Kilobits per second

KCCA	Kampala Capital City Authority
KIIDP 1	Kampala Institutional and Infrastructure Development Project 1
KIIDP 2	Kampala Institutional and Infrastructure Development Project 2
KINTEX	Korea Exhibition Center
km	Kilometer
KOICA	Korea International Cooperation Agency
KOR	Korean
KRW	South Korean Won
KTX	Korea Train Express
KUTIP	Kampala Urban Transport and Improvement Plan
LAMEA	Latin America, Middle East and Africa
LCC	Low Cost Countries
LED	Light-emitting diode
LEGDI	Low-level of e-government development
LEV	Low-emission vehicles
LPR	License Plate Recognition
LPWAN	Low-power Wide-area Network
LTA	Land Transport Authority
LTE	Long Term Evolution
m	Meter
MDAs	Ministries, departments and agencies
MEGDI	Medium-level of e-government development
MLHUD	Housing and Urban Development
mm	Millimeter
MoICT & NG	Ministry of ICT and National Guidance
MOU	Memorandum of Understanding
MP	Master Plan
MP	Member of Parliament
MTN	Mobile Telecom Network
Multiplex	Ms. Multiplex Limited
N/A	Not applicable
NDP II	National Development Program
NITA-U	National Information Technology Authority Uganda

NTMP/GKMA	National Transport Master Plan 2008-2023, Including A Transport Master Plan for The Greater Kampala Metropolitan Area
ODA	Official Development Assistance
ONVIF	Open Network Video Interface Forum
OSI	Online services index
P&D	Pay and Display Parking Meters
pc	Per capita
PEST	Political, Economic, Socio-Cultural, and Technological factors
PID	Project Initiation Document
PIN	Personal identification number
PM	Project manager
PoE	Power of Ethernet
PPP	Public private partnership
PSV	Public Service Vehicle
RAFU	Road Agency Formation Unit
RFID	Radio Frequency Identification
RSAIS	The Road Safety Audit and Improvement Study
RSDP-1	Road Sector Development Program 1
SDK	Software development kit
SFR	Strategic Framework for Reform
SMFTA	San Francisco Municipal Transportation Agency
SMG	Seoul Metropolitan Government
SNDGG	The Smart Nation and Digital Government Group
sq.	Squared
SWOT	Strengths, Weaknesses, Opportunities, Threats
TELOS	Technical, Economic, Legal, Operational, Scheduling
TII	Telecommunication infrastructure index
TOPIS	Seoul Transport Operation and Information Service
TSDP	Transport Sector Development Project
TV	Television
UCC	Uganda Communications Commission
UGX	Ugandan Shilling
UICT	Uganda Institute of Information and Communications Technology
UK	United Kingdom

UN	United Nations
UNDP	United Nations Development Programme
UNRA	Uganda National Roads Authority
UPDF	The Uganda People's Defence Force
UPL	Uganda Post Limited
URA	Uganda Revenue Authority
URA	Urban Redevelopment Authority (Singapore)
USD	United States Dollar
USh	Ugandan Shilling
USMID	Uganda Support to Municipal Infrastructure Development
UTL	Uganda Telecom Ltd.
VIP	Very important person
VMS	Visual management systems
WAP	Wireless Access Point
WB	World Bank
WEB	World Wide Web
WeGO	World Smart Sustainable Cities Organization
Wi-Fi	Wireless fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WWAN	Wireless Wide Area Network

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1. INTRODUCTION

1.1. Project background

WeGO – established by 50 founding members in 2010 – is an international association for cities, local and regional governments, smart tech solution providers, national and regional organizations that are concerned with and committed to the transformation of cities into smart sustainable communities. WeGO is run by the Secretariat based in Seoul and is supported by regional offices in East Asia (Chengdu, China), Eurasia (Ulyanovsk Region, Russia), the Mediterranean (Beyoğlu, Turkey) and Latin America (Mexico City, Mexico). WeGO has more than 200 members around the world and serves as their international platform to improve quality of life, innovate delivery of public services and strengthen regional competitiveness.

WeGO carries out a broad range of activities worldwide that include facilitating knowledge sharing, capacity building, action-oriented cooperation and cross-stakeholder partnerships toward urban sustainability. WeGO also provides free consultation services to WeGO members through its annual Feasibility Study (FS) project on smart city and e-government issues. This technical assistance project is designed to help cities around the world address the most pressing challenges in various smart city areas and advance in their transformation into smarter and more sustainable cities. Within the FS program, WeGO annually selects 1-2 WeGO member cities on a competitive basis.

2019 WeGO FS theme is "Generating Actionable Data for Smarter Cities" and it prioritizes areas of mobility and public safety. WeGO has selected Kampala Capital City Authority (KCCA) of the Republic of Uganda as the beneficiary local government for the Smart Sustainable City Feasibility Study 2019. KCCA's project proposal focuses on analyzing the feasibility of introducing a unified smart parking system in the Greater Kampala Metropolitan Area (GKMA).

KCCA is in the process of creating a comprehensive parking policy for the region of GKMA up to 2040 which will manage the population's demand, reduce traffic congestion, decrease illegal parking and create essential revenue. The 2019 WeGO FS project falls in line with the Multi-Modal Urban Transport Master Plan for GKMA – a Master Plan funded by the World

Bank – and will greatly contribute to transforming the parking facilities in Kampala Capital City.[1] The ultimate goal of the Master Plan is to lead to the development of an environmentally friendly transportation system and promote sustainable urban mobility to a level sufficient and necessary for a world-class capital city.

Table 1. Main objectives of the Multi-Modal Urban Transport Master Plan for GKMA

No	Objective	100 %	Description
1	Sustainability	15 %	Reduce the use of non-sustainable vehicles (car, boda boda) and transfer more people to use sustainable vehicles (walking, cycling and public transport)
2	Mobility	20 %	Ensure all citizens are offered affordable transport options that enable access to key destinations and services
3	Accessibility	20 %	Ensure all citizens can reach their destination in a quick and efficient way
4	Safety	10 %	Improve safety and security for all transport users.
5	Environment	15 %	Reduce air and noise pollution, greenhouse gas emissions and energy consumption
6	Economic efficiency	20 %	Improve the efficiency and cost-effectiveness of the transportation of persons and goods

One of the most pressing issues outlined in the Master Plan is the development and implementation of a new public parking plan as it will greatly contribute to achieving the main objectives such as reducing the use of non-sustainable vehicles, ensuring citizen mobility and destination accessibility, improving urban safety, reducing pollution and generating transparent revenue. The 2019 WeGO FS project will introduce KCCA to the best smart parking practices and help identify the right parking plan development direction.

[1] The Master Plan project closing date was envisioned for December 31, 2019. The final report is not yet available for public to download. The presentation titled 'Multi Modal Urban Transport Master Plan for GKMA 'Cities that Work' Workshop on Urban Transport' by Mr. Jacob Byamukama, the Director in charge of Engineering and Technical Services, provides an overview of the Master Plan and its main objectives.
Available at: https://www.theigc.org/wp-content/uploads/2018/04/KCCA-Presentation-Cities-that-Work-Multi-Modal-Urban-Transport-Master-Plan-Apr2018.pdf

1.2. Project organization structure

The main parties involved in the 2019 WeGO FS project are World Smart Sustainable Cities Organization (WeGO), Kampala Capital City Authority (KCCA) and SRPOST Co., LTD (SRPOST). The project participants are outlined in the table below.

Figure 1. 2019 WeGO FS project organization structure

SRPOST FS Team
PM: Mr. Nangyu Kim

WeGO FS Team
PM: Ms. Eunbyul Cho

KCCA FS Team
PM: Mr. Martin Ssekajja

Table 2. 2019 WeGO FS project participants

Org	Full name	Position	E-mail
KCCA	Mr. Andrew Kitaka Mubiru	Ag. Executive Director	akitaka@kcca.go.ug
	Mr. Martin Ssekajja	Director in charge of ICT	mssekajja@kcca.go.ug
	Mr. Jacob Byamukama	Director in charge of Engineering and Technical Services	jbyamukama@kcca.go.ug
	Mr. Frank Batungwa Tumusiime	Manager, Business Processes	fbatungwa@kcca.go.ug
	Mr. Ronald Mayambala	Manager, IT Software Applications	
WeGO	Ms. Eunbyul Cho	Program Manager	eunbyul@we-gov.org
SRPOST	Mr. Nangyu Kim	Project Manager	robin@srpost.co.kr
	Ms. Anastassia Brehhunova	Principal consultant	ana@srpost.co.kr
	Ms. Jiwon Nam	Principal consultant	lima@srpost.co.kr
	Ms. Hyejoo Kim	Research & Study Manager	hayley@srpost.co.kr
	Mr. Yongdon Cho	Principal consultant (Winner Tech)	tosung@hanmail.net

1.3. Project objectives

The short-term project objectives are as follows:

1. To examine all major public on-street and off-street public parking facilities in Kampala and create a parking lot introductory guide;
2. To assess the overall parking environment in the city and identify challenges facing parking management in the area;
3. To understand what government parking policies and strategies are integral to transitioning to smart parking, if and how they need to be modified in order to cope with future parking demand;
4. To recommend new strategies to solve parking challenges in Kampala;
5. To implement a pilot smart parking project to assess the city's readiness to manage and control Smart Parking technology;
6. To understand whether it is feasible to develop and implement a comprehensive Smart Parking System that includes a smart parking mobile app for citizens and a management system for KCCA officials to monitor and manage the public parking spaces;
7. To understand whether such implementation is possible right after completion of the 2019 Feasibility Study and can be finished within two years;
8. To estimate the implementation costs and assess whether the future project can be funded from KCCA budget or needs to attract external investment.

The long-term project objectives are identified as follows:

1. To promote a safer and more efficient parking experience for vehicle drivers in GKMA;
2. To improve urban environment by reducing greenhouse emissions and ensuring safety;
3. To raise positive public awareness toward Smart Parking technologies;
4. To foster KCCA's commitment to addressing public parking issues in an inclusive, smart and sustainable manner;
5. To foster KCCA's commitment to scale up the pilot project after its successful implementation;
6. To facilitate a positive impact of the FS project on the Kampala society and the quality of life of its citizens;
7. To promote intragovernmental cooperation between the Republic of Korea and Republic of Uganda, KCCA and SMG; Korean and Ugandan private enterprises.

1.4. Expected outcomes

The short-term expected outcomes of this FS project are as follows:

1. Comprehensive on-site inspection of all major on-street and off-street public parking facilities in Kampala;
2. Increased understanding of overall parking environment in Kampala;
3. Comprehensive analysis of all parking-related rules and regulations, outlining of possible strategies to solve parking challenges in Kampala;
4. Enhanced understanding of transportation policies of the Republic of Uganda;
5. Successful implementation of Smart Parking pilot project;
6. Active commitment of KCCA to pilot project management and scaling-up
7. Enhanced understanding of economic and technical feasibility of implementing a comprehensive Smart Parking System in Kampala;
8. Enhanced understanding of Smart Parking System implementation timeline;
9. Increased understanding of Smart Parking implementation costs;
10. Increased commitment of KCCA toward addressing public parking issues.

The long-term expected outcomes are identified as follows:

1. Strengthened international cooperation between Korean and Ugandan governments, organizations and private enterprises;
2. Safer and cleaner urban environment;
3. Improved public parking experience and safer a safer parking environment.

1.5. Project outputs

The 2019 WeGO FS project outputs comprise of pilot project hardware installation and project implementation documentation. The pilot project hardware was installed in two locations at KCCA Library & Information Centre and KCCA Traffic Control Centre. For detailed information on the pilot project hardware see Chapter 7.

The 2019 WeGO FS project implementation documentation include the final report “Feasibility Study on Smart Parking in Kampala Capital City” in English, the short final report “Feasibility Study on Smart Parking in Kampala Capital City” in Korean for administrative purposes and the Intelligent CCTV Parking Monitoring System User Manual.

1.6. Project implementation schedule

The project spanned over the period of four months between September 17, 2019 and January 17, 2020. All the tasks required for the implementation of the FS project are outlined according to the project implementation phase in the figure below.

Figure 2. 2019 WeGO FS project implementation schedule

No	Phase	Task	Project schedule									
			Sep		Oct		Nov		Dec		Jan	
1	**Project initiation**	Project planning										
		PID composition										
		Project launch										
2	**Environment analysis**	Macro analysis										
		ICT analysis										
		Policies analysis										
		Case study										
		SWOT analysis										
3	**On-site inspections**	Inspection 1										
		Inspection 2										
		Inspection 3										
4	**Pilot project development**	Service model										
		Site selection										
		Infrastructure										
5	**Pilot project implementation**	Install hardware										
		Install software										
		Test run										
6	**Project finalization**	Final report ENG										
		Final report KOR										
		System manual										

Pilot system run and maintenance is envisioned for the period of one year after the project finalizations (17.01.2020 – 16.01.2021).

The Intelligent CCTV Parking Monitoring System User Manual composition started in January, 2020 and will constantly be updated within one year after project completion.

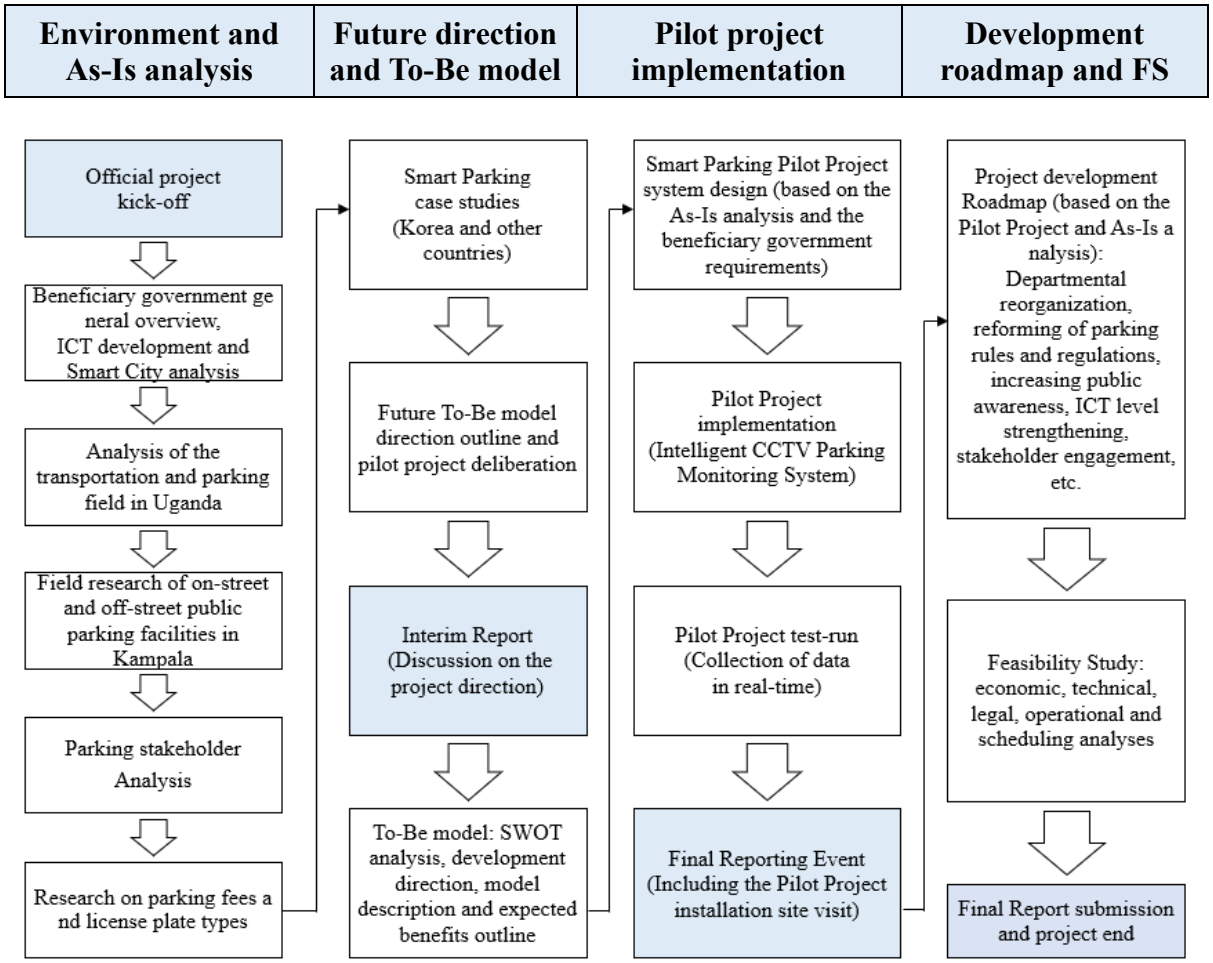
Table 3. 2019 WeGO FS implementation schedule details

No	Phase	Task details
1	**Project initiation**	· Planning of project objectives, expected outcomes, team, collaboration, context and budget · Project Initiation Document (PID) composition · Project launch meeting
	↓	
2	**Environment analysis**	· Kampala macroeconomic analysis · Kampala ICT readiness level and smart city development level assessment · Analysis of policies, rules and regulations related to parking · Case study analysis of international Smart Parking examples · SWOT analysis
	↓	
3	**On-site inspections (3)**	· Kampala on-street public parking facilities inspection · Kampala off-street public parking facilities inspection · Inspection and analysis of Uganda vehicle license plates · SWOT analysis
	↓	
4	**Pilot project development**	· Development of pilot project service model, implementation strategy and schedule · Selection of pilot project implementation site · Planning of pilot project infrastructure
	↓	
5	**Pilot project implementation**	· Pilot project hardware installation · Pilot project software installation · Pilot project test run
	↓	
6	**Project finalization**	· Final Report on Smart Parking in Kampala Capital City (ENG) composition · Final Report on Smart Parking in Kampala Capital City (KOR) composition · Intelligent CCTV Parking Monitoring System User Manual composition · Discussion of pilot project maintenance and technical support

1.7. Project methodology

The FS project was conducted according to the standardized process of the FS consulting methodology.

Figure 3. FS consulting methodology summary



The study utilized the following four analysis methods to collect and examine the data: As-Is status analysis, SWOT analysis, To-Be model analysis and TESOL analysis. Detailed phases, steps and outputs are summarized in the figure below.

1) As-Is status analysis

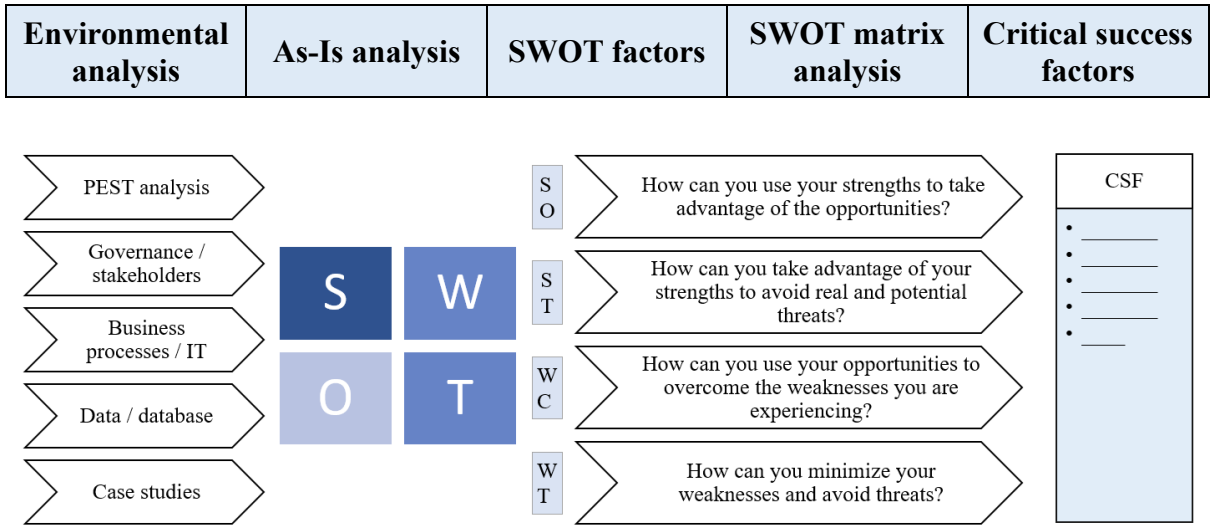
As-Is analysis focused on understanding the current state of parking affairs in Kampala by identifying the overall position of parking management in Uganda's transportation ecosystem, identifying parking management stakeholders, differentiating between public and private parking, analyzing the most prominent public on-street and off-street parking facilities, parking

fees as well as researching the Uganda vehicle number plates. The analysis was concluded by outlining the main challenges of parking environment and its management in Kampala and the main difficulties of implementing a comprehensive on-street Smart Parking System.

2) *SWOT analysis*

SWOT analysis is a strategic planning technique that was used to help the FS team to identify main internal (strengths and weaknesses) and external (opportunities and threats) factors that define the current parking environment in Kampala based on the beneficiary government's environment and As-Is analysis. The FS team identified the following current challenges arising from weaknesses and threats of parking management in Kampala as well as outlined the main obstacles that should be overcome in the process of transitioning to a Smart Parking management system:

Figure 4. SWOT analysis methodology



3) *To-Be model development*

The As-Is analysis introduced the overall parking environment in Kampala and identified that even though off-street parking facilities in the city require innovation to solve their parking problems, the most urgent and pressing issue is on-street parking management. In order to identify the right direction for To-Be model proposal, the FS team considered what do we really want this model to achieve for KCCA and Kampala, what we don't want it to achieve and what assets the city possesses currently that will contribute to the model development process. The proposed To-Be model is expected to ideally meet the needs of Kampala vehicle drivers, municipal authorities and local residents.

4) *TELOS assessment*

The feasibility assessment of Smart Parking project implementation in Kampala is based on the TELOS methodology of project assessment.[2] TELOS covers the following aspects:

1. *Technical*: Is the project technically possible?
2. *Economic*: Can the project be afforded?
3. *Legal*: Is the project legal? What are the legal determinants / are there any conflicts?
4. *Operational*: How will the current operations support the change? What is the organizational framework? Can adequate procedural changes be made, sufficient personnel retrained and new skills obtained?
5. *Scheduling*: Can the project be done in time? Estimating how long the system will take to develop. Schedule feasibility is a measure of how reasonable the project timetable is (i.e. a project will fail if it takes too long to be completed before it is useful).

[2] Hall, James A. *Information Technology Auditing*. Cengage Learning Asia Pte Ltd, 2016.

Picture 1. Administrative map of the Republic of Uganda

2. PROJECT BENEFICIARY PROFILE

2.1. General overview

2.1.1. Republic of Uganda

Uganda is a landlocked country located in the East African region bordering with Kenya to the East, Tanzania to the south, Rwanda to the south-west, Democratic Republic of Congo to the west, and Sudan to the North. Uganda is also known as "the pearl of Africa" because of its unique position, and its soils are generally fertile, and those in the region of Lake Victoria are considered as ones of the most productive in the world.

Uganda established a strong record of efficient macroeconomic management and structural reform in the 1990s and has been steadily growing ever since. Uganda's population continues to increase rapidly and reached around 45 million in 2019 compared to 24.2 million in 2002. With such sustained and high economic growth, Uganda has substantially reduced poverty.

The country continues to face some economic challenges. Uganda's economy mostly relies on agricultural sector employing about 65% of the work force. Given the high reliance on rain-fed agriculture, there still remains a downside risk to growth, as well as export earnings, due to possible adverse climate changes. Therefore, the growth of the services and industry sectors shows important progress towards structural transformation, shifting labor out of unstable and less productive agriculture and into more productive sectors. The following table provides general information on the Uganda country profile.

Table 4. Republic of Uganda profile (Central Intelligence Agency data)

Fact	**Details**
Name	Republic of Uganda (Short name: Uganda)
Government	Presidential Republic
Independence	9 October 1962 (from the UK)
Legal system	Mixed legal system of English common law and customary law
Capital	Kampala
Area	Total: 241,038 sq. km; Land: 197,100 sq. km; Water: 43,938 sq. km

Land boundaries	Total: 2,729 km (Border countries (5): Democratic Republic of the Congo 877 km, Kenya 814 km, South Sudan 475 km, Tanzania 391 km, Rwanda 172 km)
Coastline	Landlocked; fertile, well-watered country with many lakes and rivers; Lake Victoria, the world's largest tropical lake and the second largest fresh water lake, is shared among three countries: Kenya, Tanzania, and Uganda
Population	44,939,831 (August 2019 est. by UN)
Population growth rate	3.3% (2017)
Urbanization	Urban population: 24.4% of total population (2019) Rate of urbanization: 5.7% annual rate of change (2015-20 est.)
Nationality	Ugandan(s)
Ethnic groups	Baganda 16.9%, Banyankole 9.5%, Basoga 8.4%, Bakiga 6.9%, Iteso 6.4%, Langi 6.1%, Bagisu 4.6%, Acholi 4.7%, Lugbara 4.2%, other 29.6%
Languages	English (official language), Swahili (second official language since 2005). Over 40 living native languages which can be grouped into three main language families: Bantu, Central Sudanic, and Nilotic
Religions	Protestant 45.1%, Roman Catholic 39.3%, Muslim 13.7%, other 1.6%, none 0.2%
Currency	UGX Ugandan Shilling
GDP (PPP)	$102.66 billion (2019 est.); $95.07 billion (2018 est.); $88.61 billion (2017 est.); $83.39 billion (2016)
GDP per capita (PPP)	$2,566 (2019 est.); $2,448 (2018 est.); $2,352 (2017 est.); $2,280 (2016)
Temperature	Falling in the 25–29°C range on an average, the evenings can be chilly with temperatures in the 17–18°C range
Precipitation	Annual amounts range from less than 500 mm in the northeast to a high of 2,000 mm in the Sese Islands of Lake Victoria
Land use	Arable land: 69,000 sq. km 41%; permanent crops: 22,500 sq. km 11.22%; forest cover: 28,100 sq. km 14.01%; other: 80,931 square km 40.36%
Irrigated land	140 sq. km (2012)
Natural resources	Copper, cobalt, hydropower, limestone, salt, arable land, gold, gas, oil
Current environmental issues	Draining of wetlands for agricultural use, deforestation, overgrazing, soil erosion, water hyacinth infestation in Lake Victoria, widespread poaching

2.1.2. Kampala Capital City

Kampala Capital City (short name: Kampala or City of Kampala) is part of Greater Kampala Metropolitan Area that also includes the surrounding districts of Mpigi, Mukono, and Wakiso. The GKMA region is tightly bound together economically and has a population of about 4 million people – about 1.7 million (1,680,800; 2019 et.) lives and works in the core and a further two million commutes into the centre of the city to work during the day and then return to the outskirts at night. Kampala lies between hills with its valleys on the shore of Lake Victoria. Kampala is one of the fastest-growing cities in Africa. Kampala covers a total of 189 sq. km (land: 176 sq. km; water: 13 sq. km).

Picture 2. Map of Greater Kampala Metropolitan Area

Kampala Capital City – managed by the KCCA – is the economic, political and administrative capital of Uganda. Kampala is the center of trading agricultural goods, from Kampala coffee, cotton, tea, tobacco, and sugar are exported. Already three times Kampala has been ranked as the best city to live in East Africa.[3]

[3] 'Kampala ranked best city in East Africa', *New Vision*. February 26, 2016.
Available at: https://www.newvision.co.ug/new_vision/news/1418082/kampala-ranked-city-east-africa

2.1.3. Kampala Capital City Authority

KCCA is a corporate body responsible for administering Kampala Capital City on behalf of central government subject to the KCC Act 2010.[4] Its administrative area is divided into 5 divisions (Central, Kawempe, Makindye, Nakawa & Rubaga) and 99 parishes.

The KCCA leadership comprises from the elected political leaders and the appointed technical management. Elected political leaders include a Cabinet Minister, State Minister, Lord Mayor and Deputy Lord Mayor. The technical management is comprised from Executive Director and 10 Service Directorates. The following table represents KCCA organizational structure.

Table 5. KCCA organizational structure

KCCA (technical management)	→	Public Account Committee
↓		↓
Executive Director		Directorate of Internal Audit
↓		

Ag. Deputy Executive Director	Directorate of Treasury Services
Directorate of Education and Social Services	Directorate of Revenue Collection
Directorate of Gender and Community Development	Directorate of Administration & HR
Directorate of Public health and Environment	Directorate of Legal Affairs
Directorate of Physical Planning	Town Clerk
Directorate of Engineering and Technical Services	Public & Corporate Affairs
Department of ICT	Metropolitan Police
Department of Public and Corporate Affairs	
Department of Procurement and Disposal Unit	
Department of Research and Strategy Management	

[4] Uganda Legal Information Institute. 2010. Kampala Capital City Act, 2010. Available for download at: https://ulii.org/ug/legislation/act/2015/1-8

2.1.4. Diplomatic relationships with Korea

The Republic of Uganda and the Republic of Korea officially established bilateral relations on 26 March, 1963 – the year after Uganda attained its independence. The Embassy of the Republic of Korea in Uganda is located in Kampala and is headed by Ambassador Byungkyoo Ha (as of 2019). Uganda, however, does not have an embassy in Korea and Ugandans living in Korea have to rely on the Embassy in Tokyo, Japan.

In 2010 the Korean government selected Uganda as one of its ODA (official development assistance) recipient nations. Following this decision, KOICA Uganda Office was founded in September, 2010 and the office representatives have been striving to satisfy different development necessities and to attain development goals by using Uganda's potential and ability. Since then Korea's annual ODA to Uganda increased by more than 42 times, recording $29m (USh106b) in 2017. Still, Korea's ODA toward Uganda is small compared to other large donors in terms of quantity.[5]

As laid out by Korea's Partnership Strategy 2016-2020, Korea works hard to assist Uganda in achieving its Vision 2040 and the National Development Plan II. Korea prioritizes three cooperation areas – rural development, education and healthcare – and various multi-year projects in these areas have come to completion in 2018. In addition, training facilities such as the "New Village Movement (*Saemaeul Undong*)" and "Canaan Farmer's School" offer great opportunities for Ugandans to travel to Korea and learn how to develop their agriculture.

From 2000 there were more than 15 high-level visits from Korean officials to Uganda and more than 20 high-level visits from Uganda officials to Korea. Most prominent visits include the official state visit of President Park Geunhye in May, 2016 to promote international cooperation across a wide range of sectors, including the economy, development and national defense and the official state visit of President Yoweri Museveni in May, 2013 for the Korea-Uganda summit in the Korean presidential office.[6] In case of municipal international cooperation, an

[5] Byungkyoo Ha, 'South Korea's contribution to Uganda's development journey', *Daily Monitor*, September 17, 2019.
https://www.monitor.co.ug/OpEd/Commentary/South-Korea-s-contribution-to-Uganda-s-development-journey/689364-5276072-wm0tff/index.html

[6] Full list of state-level visitations is available on the official homepage of the Ministry of Foreign Affairs of the Republic of Korea. http://www.mofa.go.kr/eng/nation/m_4902/view.do?seq=180

MOU on friendship and cooperation between KCCA and SMG was signed on September 19, 2019.[7]

2.2. ICT development analysis

Smart Parking technology is an integral part of smart cities that heavily rely on the use of ICT to implement their smart city strategies and to collect and deliver information to all users. This section focuses on analyzing the ICT sector in Uganda to understand the level of Smart City development in Uganda and understand what the current environment holds for the future Smart Parking project implementation.

The Government of Uganda recognizes ICT as the most critical sector to the delivery of its national Vision 2040. Since 2017 Ugandan economy's growth was driven largely by growth in information and communication technology (ICT) services and favorable weather conditions for the agricultural sector.[8] Currently, Uganda has one of the most progressive ICT sector policy and regulatory environments in Africa.

In line with global commitments to improve digital inclusion and to realize the Sustainable Development Goals for 2030, the Government of Uganda has committed the country to developing a national policy and strategic framework "Digital Uganda Vision" (DUV)[9].

The DUV aims to build a digitally-enabled society that is "… secure, sustainable, innovative, transformative … to create a positive social and economic impact through technology-based empowerment".[10] The DUV provides an overarching framework that responds to the national Vision 2040 by providing a unified ICT policy direction. It further provides the Government's integrated policy and strategic framework to show how information and communication technologies (ICT) can empower Ugandan citizens and achieve the goals of universal inclusion, sustainable development, economic progress and poverty eradication through digital innovation.

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[7] Full list of Seoul's Sister and Friendship Cities is available on the official SMG homepage. http://english.seoul.go.kr/policy-information/international-exchange/sister-cities/
[8] The World Bank in Uganda, country overview. https://www.worldbank.org/en/country/uganda/overview
[9] Digital Uganda Vision homepage: https://ict.go.ug/initiatives/digital-uganda-vision/
[10] Policy Paper Series No. 5 After Access: Paper No. 8, "The State of ICT in Uganda" by Research ICT Africa. https://researchictafrica.net/wp/wp-content/uploads/2019/05/2019_After-Access-The-State-of-ICT-in-Uganda.pdf

The DUV motivates creative industries to facilitate e-content growth, digitalization of government and other indigenous content, promote trust and confidence of consumers (cyber security, data protection, etc.). The Initiative seeks to integrate various government systems, create digital identification as well as introduce e-payment and financial services for e-transactions. The ultimate goal is to promote efficient use of resources amongst the government and to provide efficient governance, empower citizens, create jobs & knowledge, spur innovation, help local manufacturing, as well as promote and open up App based markets.

The Digital Uganda Vision provides an overarching framework that responds to the national Vision 2040 by providing a unified ICT policy direction. It further provides the Government's integrated policy and strategic framework to show how information and communication technologies (ICT) can empower Ugandan citizens and achieve the goals of universal inclusion, sustainable development, economic progress and poverty eradication through digital innovation.

As such innovation performance improvement is one of the most important goals of Digital Uganda Initiative. In 2019 Uganda ranked 103rd in the Global Innovation Index (GII), which indicates a negative performance improvement since 2017 when Uganda was ranked 102nd.

Table 6. Uganda global innovation index, 2018[11]

	Rank	Score
Overall	103	25.30
Innovation Efficiency Ratio	108	0.45
Innovation Input Sub-index	98	34.96
Innovation Output Sub-index	111	15.96

The preconditions for the digital take-off envisaged by the Digital Uganda Vision have not been met, with poor infrastructural development being the primary driver of low Internet use and mobile phone penetration in Uganda. Furthermore, recently, the Government of Uganda behind has implemented a number of regressive tax policies, which inhibit the majority of Ugandan residents from taking up digital technologies and slow down the digital infrastructure development. For example, in 2018, the Government of Uganda introduced social media and

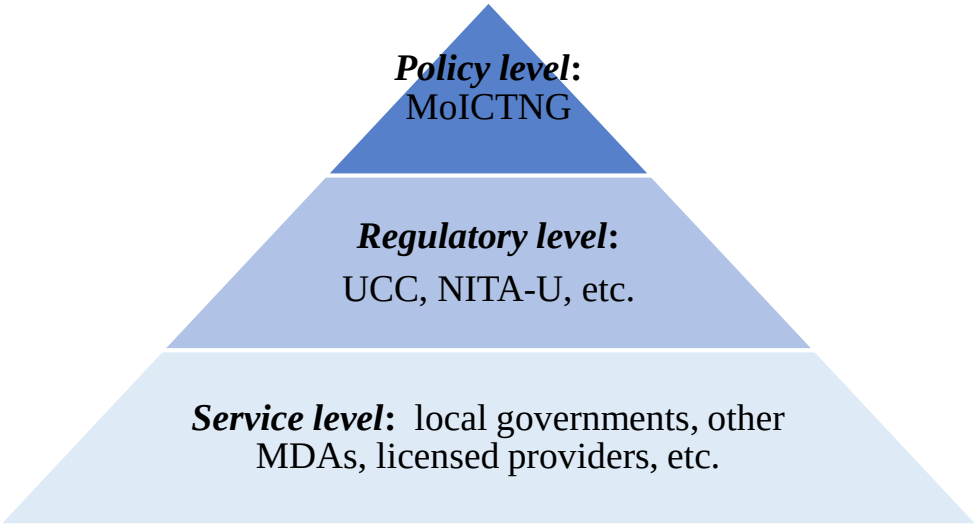
[11] Source: Global Innovation Index https://www.globalinnovationindex.org

mobile money taxes, which put a serious break on Internet access and use.[12] This initiative might constitute a problem for the future of Smart Parking in Kampala, as citizens usually heavily rely on social media to learn about innovative trends and mobile money to pay for their on-street parking.

2.2.1. ICT sector stakeholders

The ICT sector in Uganda is organized in three functional levels.

Figure 5. Functional levels of ICT sector in Uganda



The Ministry of ICT and National Guidance (MoICTNG) at top oversees the sector and provides the necessary policy framework to guide implementation. The MoICTNG is supported by regulatory agencies that include the Uganda Communications Commission (UCC)[13]; – regulating the telecommunications sector and also responsible for management and implementation related to the Rural Communications Development Fund; and the National Information Technology Authority Uganda (NITA-U) [14] – regulating the IT sector and also responsible for roll-out and operation of the National Backbone and e-Government Infrastructure. Uganda Post Limited (UPL) [15]; and Uganda Institute of Information and

[12] "Millions of Ugandans quit internet services as social media tax takes effect", *The Guardian*, February 27, 2019.
https://www.theguardian.com/global-development/2019/feb/27/millions-of-ugandans-quit-internet-after-introduction-of-social-media-tax-free-speech
[13] The official homepage of UCC is as follows: https://www.ucc.co.ug/ .
[14] The official homepage of NITA-U is as follows: https://www.nita.go.ug/ .
[15] The official homepage of UPL is as follows: https://www.ugapost.co.ug/ .

Communications Technology (UICT) [16] both are also crucial agencies supporting the Ministry's work.

At the bottom or the service provision level are the public and private players that provide services directly to citizens of Uganda. Public sector players include local governments, other relevant ministries, departments and agencies (MDAs) as well as licensed and supervised private sector players.

2.2.2. ICT development indices

There has been relatively little change in the ICT Development Index (IDI) rankings for most world economies between 2016 and 2017 (no statistical data is available for 2018-2019 yet). Uganda was one of the most dynamic countries in IDI 2016-2017 rankings and values rising 6 positions up.

Table 7. Uganda ICT Development Index (IDI), 2016-2017[17]

	2017	**2016**
IDI Value	2.19	1.90
IDI Rank, Global	152	158
IDI Rank, Regional	20	24

Uganda also made the largest upward movement in the regional rankings because it improved significantly more than almost every other country in the third quartile of the regional distribution. It also saw its use sub-index value rise by more than 5%, driven by mobile-broadband subscriptions, and it enjoyed significant improvements in the mobile-cellular subscriptions and the proportion of Internet users within the population. Unfortunately, the overall ICT indices for Uganda are still considered comparatively low due to the poor information infrastructure and low levels of Internet penetration in the country (compared to other countries).

Uganda has one of the most crowded mobile markets in Africa, with eight active operators. However, two account for almost 90% of subscriptions: MTN, a subsidiary of the South African mobile group; and AIRTEL, a subsidiary of the Indian mobile group. Other mobile operators

[16] The official homepage of UICT is as follows: https://www.uict.ac.ug/ .
[17] Source: International Telecommunication Union (ITU) http://www.itu.int/

include the incumbent Uganda Telecom Ltd. (UTL)[18]; Africell, subsidiary of a Lebanese mobile group that took over Orange's operations in 2014; Smile, a venture between Kenya's Industrial Promotion Services and a Cyprus-registered mobile group; Vodafone, a subsidiary of the United Kingdom mobile group; Sure Telecom, a Singaporean based Telecom; and K2, an indigenous Telecom Company. Despite the large number of operators, it has been a challenge to extend coverage to rural areas.

According to the 2016–17 Uganda National Household Survey, 68.6% of households owned mobile phones, 61.8% in rural and 86.1% in urban areas.[19] All of the operators have deployed mobile-broadband networks, including the latest generation LTE by Smile in 2012, Africell and MTN in 2013, and Vodafone in 2015.

Uganda Telecom Ltd. is the main provider of fixed-telephone service through copper lines and wireless local loop. On the fixed broadband market, it offers fixed ADSL and fixed wireless broadband. It is joined by a number of ISPs (Internet Service Provides) offering fixed wireless broadband access. Tech giant Google has invested in the CSquared project, building metro fiber networks in Entebbe and Kampala. It offers wholesale Wi-Fi access as well as optical fiber to the premises for resale by ISPs. Uganda's National IT Authority provides free Wi-Fi in select parts of the city at select times.

The first two phases of the Government's National Backbone Infrastructure[20] have been completed, with 1,590 km of fiber-optic cable stretching to the Kenyan and South Sudan borders.[21] Operators have also been deploying fiber-optic networks in the landlocked country mainly to the Kenyan border for access to undersea cables and for those also operating in Rwanda, to that country. The Uganda IXP (Internet Exchange Point) is one of the oldest in Africa, launched in 2001, and has more than two dozen members peering traffic.

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[18] Uganda Telecom Ltd. was privatized in 2000, when 51 per cent of its shares were sold. The Libyan Government investment arm purchased the stake of the original buyers as well as additional shares from the Government, resulting in a 69 per cent stake. UTL has faced operating challenges and, in 2017, the Government retook control of the company.

[19] "Uganda National Household Survey Final Report (2016)", prepared by Uganda Bureau of Statistics. https://www.ubos.org/wp-content/uploads/publications/03_20182016_UNHS_FINAL_REPORT.pdf

[20] MoICTNG. Ongoing. National Backbone Infrastructure Project (NBI/EGI). https://ict.go.ug/projects-programmes/national-backbone-infrastructure-project/

[21] More information on National Backbone Infrastructure Project (NBI/EGI) can be found on NITA-U official website. https://www.nita.go.ug/projects/national-backbone-infrastructure-project-nbiegi

Table 8. Internet Service IDI Index[22]

	Uganda	Africa	World
Percentage of households with computer	7.6	9.6	46.6
Percentage of households with Internet access	8.9	16.3	51.5
Percentage of individuals using the Internet	21.9	19.9	45.9
Int. Internet bandwidth per Internet user (kbit/s)	5.5	51.0	74.5

2.2.3. E-Government development indices

Electronic Government (e-Government) focuses on the use of ICT to assist the transformation of government structures and operations to a cooperative and integrated service delivery environment. There are currently around 70 e-services provided by major government organizations in Uganda and it is one of the top 10 countries for e-government among Least Developed Countries.

Table 9. Uganda, UN e-Government Development Index (EGDI), 2018[23]

Country	2018 Rank	EGDI Lvl	EGDI	TII	HCI	OSI
Uganda	135	Medium	0.4055	0.1566	0.4906	0.5694

Uganda's e-Government Development Index was steadily declining between 2008 and 2014. However, the ranking has significantly improved by 2016 by growing 18 positions. By 2018 the ranking has slightly declined again, however, that does not necessarily imply a negative performance, rather than a slower development process compared to other high-performing countries. Uganda also displayed a notably steady increase in e-Participation rankings.

Table 10. Uganda, UN e-Government Development Index 2008 - 2018[24]

EGDI Rank	2018	2016	2014	2012	2010	2008
Uganda	135	128	156	143	142	133

Table 11. Uganda, E-Participation Index (EPI) 2018 - 2008[25]

EPART Rank	2018	2016	2014	2012	2010	2008
Uganda	87	91	152	109	117	98

[22] Source: International Telecommunication Union (ITU) http://www.itu.int/
[23] Source: UN E-Government Knowledgebase https://publicadministration.un.org
[24] Source: UN E-Government Knowledgebase https://publicadministration.un.org
[25] Source: UN E-Government Knowledgebase https://publicadministration.un.org

2.3. Smart City analysis

2.3.1. Current Smart City status

The Ministry of ICT and National Guidance is responsible for overseeing Smart City sector development in Uganda. Until recently, the MoICTNG has introduced the following laws and policies that are contributing to the Smart City development.

1. E-Government Framework Policy (2011)[26];
2. Electronics Signatures Act (2011)[27];
3. Electronic Waste (E-Waste) Management Policy for Uganda (2012)[28];

Nevertheless, Smart City development in Uganda is at its early stage with Kampala Capital City Authority pioneering its development agenda. President Yoweri Museveni promised that Kampala will be transformed into a modern smart city; where there is more reliance on technology than human capacity to fight criminality.[29]

According to The ICT Head at KCCA, Mr. Martin Ssekajja, the early Smart City implementation currently focuses on institutional strengthening, network extension and capacity enhancement to all offices, traffic signals, key hospitals and automation of payments to facilitate revenue growth.[30]

2.4. SWOT analysis

Once a local government decides upon transforming the city into a smart sustainable environment, it must assess its basic requirements, opportunities and set the clear goals, prioritize the development efforts as well as quantify the success metrics to assess the smart city progress.

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[26] The full version is available to download at the official website of Ministry of ICT & National Guidance. https://ict.go.ug/wp-content/uploads/2018/06/National_E-Government_Policy_Framework_2011-2.pdf
[27] The full version is available to download at the official website of Ministry of ICT & National Guidance. https://ict.go.ug/wp-content/uploads/2019/12/UGANDA-Electronic-Signatures-Act-No.-7-of-2011.pdf
[28] The full version is available to download at the official website of Ministry of ICT & National Guidance.. https://ict.go.ug/wp-content/uploads/2018/06/Electronic-Waste-Management-Policy-for-Uganda.pdf
[29] 'Museveni unveils smart, safe city solution for Kampala', *The Observer.* 17 September, 2018. Available at: https://observer.ug/news/headlines/58688-museveni-unveils-smart-safe-city-solution-for-kampala
[30] Eronie Kamukama, (2019), Uganda: Turning Kampala Into a Smart City, 21 May, AllAfrica. Available at: https://allafrica.com/stories/201905210557.html

In order to identify the Uganda's roadmap toward Smart City transition, this FS analyzed the main internal (strengths and weaknesses) and external (opportunities and threats) factors that define the current Smart City situation as they are directly linked to the future development of Smart Parking environment in Kampala city.

Table 12. Smart City transformation framework.[31]

Strengths	**Weaknesses**
1. Readiness for technological innovation and integration; 2. International cooperation with governments pioneering Smart City projects in their countries and cities; 3. Readiness for expansion of Smart City projects to other infrastructure-ready countries in the African region.	1. Insufficient ICT progress overall; 2. Managerial and organizational issues; 3. Cross sectoral cooperation challenges; 4. Lack of multi-source and multi-temporal data; 5. Lack of real-time decision mechanism; 6. Citizen awareness and involvement.
Opportunities	**Threats**
1. Large scale space-time and service platform; 2. Handling of multi-source heterogenous systems; 3. Institutional interactions; 4. Innovation and entrepreneurship; 5. Citizen-centric governance.	1. Lack of standardized frameworks; 2. Information security and risk control; 3. Data privacy and security issues; 4. Standards and interoperability issues; 5. Economic uncertainty; 6. Political components and policy contexts; 7. Continuous taxation of mobile payments and social media use.

1) *Strengths*

For the success of any Smart City project or initiative, governments have to take the initiative to promote urban management and information system development. Governments need to motivate all citizens, business communities, public and private enterprises to actively take part in smart city transformation process by sharing information, development plans, process frameworks, and implementation scenarios for smooth collaboration. Coordination between national and international business markets is also necessary to facilitate Smart City development.

[31] The following analysis was based on the following Smart City transition SWOT research. Halepoto, Irfan & Sahito, Anwar & Uqaili, Mohammad & Chowdhry, Bhawani & Riaz, Tahir. (2015). Multi-criteria assessment of smart city transformation based on SWOT analysis.

For example, in line with KCCA's Smart City initiatives, KCCA has signed a Memorandum of Understanding with a Korean software development company SRPOST Co., LTD on cooperation on developing several Smart City cooperation on development and implementation of various Smart City and e-Governance projects.[32] By 2021, SRPOST will finish the development and implementation of an integrated Civic Participation System & Smart Call Center System bundle to improve transparency, accountability, integrity, responsiveness of KCCA as well as promote government's participation when solving Kampala citizens' everyday difficulties.

Such cooperation proves KCCA's readiness for technological innovation and integration and places KCCA on the right way to promoting international cooperation on Smart City projects implementation. KCCA also expressed their sincere interest in benchmarking successful Smart City projects to other infrastructure-ready countries in the African region.

2) *Weaknesses*

Despite the country's policy of using ICTs to enhance its social and economic performance, there is consensus in the global ICT indices that Uganda is not making sufficient progress towards the objectives in the NDP II and those proposed in the Digital Uganda Vision. Uganda's position has been undermined by lack of co-ordination across government and the actions of one arm of government pursuing its objectives without considering the negative impact on another arm. Although the various global indices are highly problematic for different reasons, they are indicative of Uganda's least developed country status and its relatively poor performance, which has been highlighted by the Government of Uganda in preparing for the Digital Uganda Vision.[33]

Uganda faces large challenges to developing Smart City infrastructure due to the lack of sufficient infrastructure in place and due to its sizeable large rural population and low disposable income. In addition, the opportunities offered to citizens, small, medium and micro enterprises and the public sector by new technologies and platforms also present some dangers. Although these digital platforms and services operate across borders and are governed to some degree by global governance technical standards, and increasingly also legal conventions, they need to be implemented at a national level to have effect. A clear digital governance framework

[32] "KCCA, S.Korean Software Firm Sign MoU To Implement Smart City Projects", *Softpower News*, February 4, 2019.
https://www.softpower.ug/kcca-s-korean-software-firm-sign-mou-to-implement-smart-city-projects/

[33] Policy Paper Series No. 5 After Access: Paper No. 8, "The State of ICT in Uganda" by Research ICT Africa, p. 7.

to deal with issues of cyber-security, privacy and data protection is needed to create a trusted Smart City environment to bring citizens safely online.

Furthermore, Uganda still faces such challenges as the need to resolve managerial and organizational issues, cross sectoral cooperation challenges, lack of multi-source and multi-temporal data, lack of real-time mechanism and citizen awareness and their involvement in the decision-making process.

3) *Opportunities*

Governance – as one of the key enabling components of smart city – is responsible to make sure the participation and services collaboration among different functional sectors and stakeholders such as political forces, business communities, academics, non-profit and voluntary organizations to manage resources more effectively to better serve the citizens. Citizen-centric governance not only needs to regulate the outputs of economic, but also smart living of citizens with different aspects of quality of life. Uganda, especially KCCA, is on the right way to building a citizen-centric governance with its Civic Participation System & Smart Call Center System project.

In addition, the Ministry of ICT and National Guidance has formulated some legislation and regulations with the support of NITA-U and UCC. If successfully implemented, this will provide a key pillar in the Digital Uganda Vision and facilitate better transition to a Smart City environment in Uganda.

Smart City development will promote Smart City services to citizens of Uganda. The content available on ICT media such as TV and Internet are mostly foreign and does not meet the needs and aspirations of the majority of, the would-be, consumers. This has negatively affected the uptake of e-Services. There is need to deliberately promote and support development of local content, in local languages and tailored to the needs of the population. There is overreliance on imported software solutions which is costly and the local software development industry is still under-developed.

Smart City development will boost telecommunication sector investments. At the macro level, the posts and telecommunications subsector has been one of the fastest growing sectors in the economy with an average growth rate of 19.7% over the last 5 years. One of the key challenges Uganda faced prior to the reforms was securing sufficient investment to revamp a dilapidated

telecommunication network and expand it to extend services to the entire country.[34] Investment especially by the Private Sector has shown a steady increase over the years and Uganda should continue to foster the Public Private Partnerships to achieve higher levels of success.

With a sizeable mobile market, and strong growth in 3G and 4G connectivity, Uganda is an exciting market in which to explore digital identity solutions at significant scale to boost its smart city development.

4) *Threats*

There is no "universal solution" to ensure the success of KCCA in its path towards transitioning to a smarter city by implementing a comprehensive Smart Parking system. Each Smart City has its own version of Smart Parking services and every case is different. Uganda and KCCA must thus city adapt its resources and improvement efforts to meet its specific needs.

Smart City raises certain questions regarding information security and associated risks in the process of development. Smart Parking platform, for example, requires data storage security, protected information processing, public information property rights are all important issues to be addressed systematically. These issues need to be resolved so that citizens right towards information security when using the Smart Parking in the city can be guaranteed.

Economic uncertainty is definitely one of the biggest threats that Uganda and KCCA face as the lack of substantial necessary funding is what is slowing down the development of Smart City phenomenon in Uganda.

Lastly, continuous taxation of mobile payments and social media use is perceived as a considerable threat as many rely on them extensively especially in the GKMA area. However, development of Smart Cities in Uganda expects to lower high costs of ICT services relative to other countries in the region. Hopefully, this will positively affect affordability and, consequently, usage of services such as Internet as well as abolishment of taxation on social media and mobile payments.

[34] Uganda Communications Commission. 2005. RECOMMENDATIONS ON PROPOSED REVIEW OF THE TELECOMMUNICATIONS SECTOR POLICY.
Available at: https://www.ucc.co.ug/files/downloads/UgTelecomsSectorPolicyReview_31_Jan_2005.pdf

3. AS-IS ANALYSIS

3.1. Transportation and parking sector overview

As Uganda is a landlocked country, its transportation system relies mostly on roads. Roads in Uganda account for 96.5% of the freight cargo, whereas the railway accounts for only 3.5%. As far as passenger traffic is concerned, road accounts for an average of 95%.[35] Most of the anthropogenic greenhouse gas GHG emission is from the road sector. That is because most of the vehicles imported were previously owned. In general, the maintenance practice and culture in Uganda is not considered adequate.[36] However, Uganda continuously makes an effort to improve the situation. In 2016 Uganda launched its National Greenhouse Gas (GHG) Inventory System that was widely appraised as a critical step in the country's efforts to meet its contribution to the global effort of emission reduction under the Paris Agreement for Climate Change.[37]

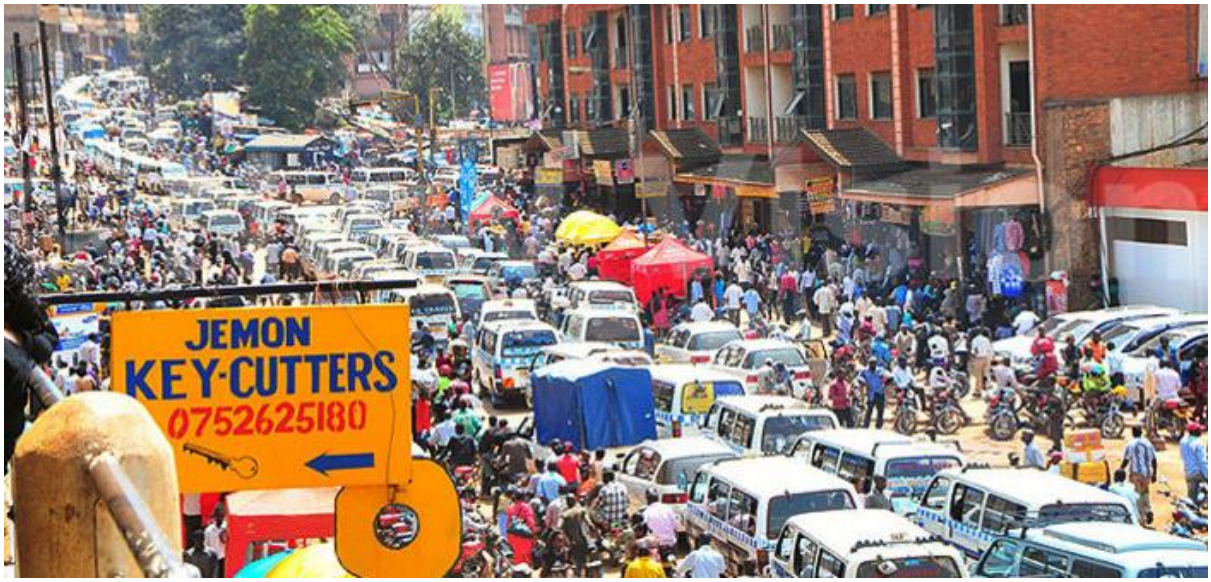
There is no formal mass public transportation system to date in Kampala. Public transportation is mostly represented by "matatu-taxies" (minibuses or commuter vans which run fixed routes) or "boda-bodas" (motorcycle taxies). In 2003 KCCA estimated that there were nearly 7,000 minibuses based in the GKMA. Of these, approximately 5,000 were used for providing local services while the remainder for inter-urban services throughout the country.[38] There is no current statistical data on the minibuses with the actual number considered to be much higher compared to 2003.

Even though there is visible improvement in the infrastructure, traffic congestion is still a serious issue for Kampala and GKMA due to the rapid urban population increase, national economy growth and traffic load increase. According to the World Bank, the severe peak hour congestion in the GKMA costs the country about USh 2.8 trillion (approximately, USD 800

[35] JICA. 2010. "The Study on Greater Kampala Road Network and Transport Improvement in The Republic of Uganda", p. 1-1.
[36] Ministry of Water and Environment. 2015. 'Green House Gas Inventory Manual for Uganda'. Available at: http://ccd.go.ug/wp-content/uploads/2019/10/Final_GHG_Inventory_Manual_Uganda.pdf
[37] 'Uganda launches digital Greenhouse Gas Inventory System', *UNDP*, October 21, 2016. https://www.ug.undp.org/content/uganda/en/home/presscenter/pressreleases/2016/10/21/uganda-launches-digital-greenhouse-gas-inventory-system-.html
[38] JICA. 2010. "The Study on Greater Kampala Road Network and Transport Improvement in The Republic of Uganda", p. 3-47.

million) annually in GDP, and poor parking management is a crucial factor contributing to this problem.[39]

From an urban development level standpoint, heavy traffic congestion in Kampala is mostly due to its inadequate current transport infrastructure. Kampala has a total road network of 2,110km of which 575km (27.3%) are paved roads and 1,535km (72.7%) are unpaved roads. A significant portion of the unpaved network is heavily trafficked with over 300 vehicles per day.[40] With the ever-increasing traffic volumes, it is becoming very expensive and unsustainable to maintain them in good condition and provide adequate traffic management including the on-street parking management and parking facilities expansion. Such situation is partly due to insufficient physical planning in the past, poor engineering practices and lack of a functional organization to meet the needs of a growing urban population. Currently, Kampala is undergoing a road network reform process, it also includes prospects of improvement of the transport system and the ways how it can be successfully carried through.



Picture 3. Traffic congestion in Kampala

In addition to that, some streets have no names in Kampala or are up for renaming to the name's colonial origin.[41] Many city buildings in Kampala have been built without adequate, or

[39] The statistical data is provided by KCCA and mentioned in their WeGO Smart Sustainable City Feasibility Study Program 2019 Project Proposal. The full version of the project proposal can be viewed on the official website of WeGO. http://we-gov.org/wp-content/uploads/2019/07/WeGO-Smart-Sustainable-City-Feasibility-Study-2019-ext_Final-1.docx

[40] Lotti Ingeneria news portal, "Kampala Infrastructure Development Projects", November 2018. https://www.lottiassociati.com/index.php?option=com_content&view=article&id=149&Itemid=629

[41] "Renaming of Kampala roads: Let's not go there", *Daily Monitor*, 15 August, 2019

sometimes any, provision of parking. Some sites have been opened up for commercial parking, but are quite insufficient to meet the demand.

From a financial standpoint, government officials mention the possible presence of some corruption among traffic management, parking management agents and unsystematic parking management result in poor performance in revenue collection and lack of transparency in the government system. In addition, the officials recognize that continuous lack of funds contributes to poor transportation and parking management in Kampala.

There is no clear record of public transportation infrastructure-related master plans, feasibility studies, programs and projects in Uganda[42] and the following table focuses on summarizing the most prominent projects that have established the ground or are working toward transitioning to a smarter transportation in Kampala.

Table 13. Uganda transportation infrastructure-related projects

No.	Type	Name	Funding source	Completion date
1.	Plan	Kampala Structure Plan (Land Use Plan)	Kampala Structure Plan (Land Use Plan)	1994
2.	MP + FS	Master Plan and Feasibility Studies of Improvement of Trunk Road at Kampala Urban Interface Sections	Government of Japan, JICA	1997
3.	Study	The Road Safety Audit and Improvement Study (RSAIS)	Government of Uganda	2000
4.	Strategy	Road Sector Development Program 1 (RSDP-1)	Government of Uganda	2002
5.	Plan	Kampala Urban Transport and Improvement Plan (KUTIP)	World Bank	2003
6.	Program	Ten-Year Road Sector Development Program (1996-2006)	Government of Uganda	2006
7.	Strategy	Road Sector Development Program 2 (RSDP-2)	Government of Uganda	2008
8.	MP	National Transport Master Plan 2008-2023, Including A Transport Master	Government of Uganda	2009

https://www.monitor.co.ug/OpEd/Commentary/Renaming-of-Kampala-roads/689364-5235578-15g7jsf/index.html

[42] The Final Report paper on "The Study on Greater Kampala Road Network and Transport Improvement in The Republic of Uganda" submitted by JICA to the MoWT in November, 2010 provides a comprehensive review of transportation related projects up until 2010.
http://open_jicareport.jica.go.jp/pdf/12013025_01.pdf

		Plan for The Greater Kampala Metropolitan Area (NTMP/GKMA)		
9.	Project	Kampala Northern Bypass construction	EU	2009
10.	Strategy	Strategy for the Improvement of Traffic Flow in Kampala	Government of Uganda	2009
11.	Study	The Study on Greater Kampala Road Network and Transport Improvement in the Republic of Uganda	Government of Japan, JICA	2010
12.	Pre-FS	Introduction and Pre-FS of Bus Rapid Transit (BRT)	World Bank	2010
13.	Project	Technical Assistance to RAFU/UNRA	EU	2012
14.	Program	Kampala Institutional and Infrastructure Development Project 1 (KIIDP 1)	World Bank	2013
15.	Support funding	Transport Sector Development Project (TSDP)	World Bank	2014
16.	Program	Uganda Support to Municipal Infrastructure Development (USMID)	World Bank	2018
17.	Project	Kampala Street lighting Project	French Development Agency	2019
18.	FS	WeGO Smart Sustainable City FS	WeGO	2020
19.	Project	Improvement of Traffic Control in Kampala City	Government of Japan, JICA	Ongoing (until 2022)
20.	Program	Kampala Institutional and Infrastructure Development Project 2 (KIIDP 2)	World Bank	Ongoing (until 2022)
21.	Project	Kampala City Roads Rehabilitation Project	AfDB	Ongoing (until 2024)
22.	Program	The East African Road Network Project (EARNP)	East African Community (EAC)	Ongoing (until 2030)

Kampala set to become Uganda's first smart city to significantly improve the efficiency of government services in order to meet citizens' expectations. All KCCA smart city projects should be aligned with the National Vision 2040[43], the Greater Kampala Metropolitan Area Development Framework 2040 and National Transport Master Plan Including A Transport Master Plan for The Greater Kampala Metropolitan Area (NTMP/GKMA).

[43] Uganda Vision 2040 provides development paths and strategies to operationalize Uganda's Vision statement which is "A Transformed Ugandan Society from a Peasant to a Modern and Prosperous Country within 30 years" as approved by Cabinet in 2007. It aims at transforming Uganda from a predominantly peasant and low-income country to a competitive upper middle-income country. https://www.gou.go.ug/content/uganda-vision-2040

There is no separate master plan focusing on parking and KCCA is in the process of creating a comprehensive parking policy for the region of GKMA up to 2040 which will manage the population's demand, reduce traffic congestion, decrease illegal parking and create essential revenue. One of the most pressing issues outlined in the National Transport Master Plan is the development and implementation of a new public parking plan, as it will greatly contribute to achieving the main objectives, such as reducing the use of non-sustainable vehicles, ensuring citizen mobility and destination accessibility, improving urban safety, reducing pollution and generating transparent revenue. As such, the 2019 WeGO FS is the first project to provide a comprehensive analysis of parking in Kampala and is expected to greatly contribute to transforming the parking facilities in the city. The 2019 WeGO FS project aims at introducing KCCA to the best smart parking practices and help identify the right parking plan development direction.

3.2. Parking management stakeholders

The parking management stakeholders in Kampala can be classified into three categories: KCCA departments responsible for Smart Parking infrastructure development, central government organizations responsible for Smart Parking infrastructure development in Kampala, international organizations and other private stakeholders.

3.2.1. KCCA

KCCA actively participates in smart city development and promotions, and all related projects are monitored by the Engineering and Technical Services, Treasury Services, Physical Planning and Revenue Collection Directorates. These teams are and will remain central agents at KCCA in charge of implementing the comprehensive Smart Parking System in Kampala.

KCCA Engineering Team is part of KCCA Engineering and Technical Services Directorate, which is responsible for designing, implementation and maintenance of infrastructure, giving technical support and controlling infrastructure developments in the city, in terms of defining structural designs, carrying out road works and maintenance of city infrastructure. The Engineering Team is responsible for managing information on city traffic and on-street parking and will oversee the transition to Smart Parking System from the technical aspect.

KCCA Physical Planning Team is responsible for urban development and urban design, infrastructural improvement and land development, compilation of related master plans, rules and regulations applicable to private physical infrastructure, management of information on public bus terminals, urban mapping, etc. The Physical Planning Team is responsible for parking infrastructure outline requirements mapping and will oversee the standardizing of public on- and off-street parking facilities during their transition to Smart Parking System.

KCCA Revenue Collection Team is responsible for all city revenue payment and collection affairs, which also includes revenue collection and enforcement at public parking lots. The Revenue Collection Team will have to not only enforce revenue collection at public parking lots, but also work toward establishing parking fee guidelines for the future Smart Parking System.

3.2.2. Government organizations

The key government stakeholders that are directly involved in parking management or will play a crucial role of facilitating the transition to Smart Parking in future are the Government of Uganda, Ministry of Works and Transport, Ministry of Lands, Housing and Urban Development (MLHUD), Uganda Revenue Authority (URA), Uganda Police Force, Military Licensing Board.

The Government of Uganda is a crucial financial stakeholder and plays a central role in country's parking management, as all parking facility improvement works are funded by the government and are carried out sequentially according to the Transportation Master Plan.

All public and private parking spaces in Kampala adhere to the National Physical Planning Standards and Guidelines document published by the Ministry of Lands, Housing and Urban Development (MLHUD) in 2011 that outlines the scale, location and site requirements various land uses and facilities.[44] All future Smart Parking facilities should be in compliance with this document.

The Uganda government license plates are issued by the Ministry of Works and Transport, military vehicle license plates are issued by the Military Licensing Board and the rest of the

[44] The full document can be downloaded on the official homepage of Ministry of Lands, Housing and Urban Development.
http://mlhud.go.ug/wp-content/uploads/2015/10/National-Physical-Planning-Standards-and-Guidelines_-2011.pdf

license plates in Uganda are issued by the Uganda Revenue Authority (URA). It is necessary to understand the license plate issuance and management organizations, license plate types and characteristics for the implementation of License Plate Recognition algorithms within the future Smart Parking System.

3.2.3. International organizations

Several international organizations can be considered as indirect parking management stakeholders as they have been contributing to the parking development in Kampala to a certain extent. Most prominent examples include World Smart Sustainable Cities Organization (WeGO), the World Bank and Japan International Cooperation Agency (JICA). International organizations that can contribute to Smart Parking in Kampala in the future are discussed in detail in Chapter 8.

WeGO has selected KCCA as the beneficiary local government for the 2019 Smart Parking Feasibility Study and will continue to support KCCA in their search for external funding as a comprehensive Smart Parking System will require substantial investment at first.

The World Bank representatives in Kampala have also been looking for opportunities to invest into Kampala parking. The representatives noted that until recently they were focusing too much on the traditional infrastructure instead of the Smart City infrastructure, that is why they could not find the right approach to implementing a Smart Parking System in the city. The representatives expressed his interest in the 2019 WeGO Feasibility Study and the prospects of shifting toward Smart Parking.[45]

The World Bank representatives also mentioned their work on the integrated revenue system development – a smart system for people to generate the payments, assessments, certificates – which in future can also be also provide KCCA officials with essential parking revenue management and monitoring functions. The work on this project is planned to start soon and its beneficiary is KCCA.

JICA has started a new project for the improvement of the traffic control in Kampala and the project beneficiary is KCCA. Japan is providing up to 93 million Japanese yen (approx. 0.84 million USD) for the construction of a new Traffic Control Centre for the KCCA, installation

[45] These points were discussed during the official meeting between the World Bank, WeGO and SRPOST representatives at the World Bank office in Kampala on Wednesday January 8th, 2018.

of traffic control system and ICT equipment as well as signalization of 30 junctions.[46] As the Smart Parking System shall be incorporated in the KCCA Traffic Control Centre, the implementation of this project is closely connected to the implementation of a comprehensive Smart Parking System.

3.2.4. Private stakeholders

Most on-street parking in the City is managed by Multiplex Limited Uganda and currently it is the most important direct stakeholder in Kampala. In 2002 the parking management contract was awarded to Multiplex Limited Uganda and was renewed every 4 years until 2010, however, the direct contract was not with KCCA. KCCA contracted Multiplex directly in August 2010 and signed a contract for a period of 10 years. In March 2019 KCCA extended Multiplex contract for 7 more years.[47]

Other indirect stakeholders present in Kampala are five mobile network operators: MTN Uganda, Airtel Uganda, Africell Uganda, Uganda Telecom and Smile Telecom. Multiplex, for example, entered into partnership with MTN and Airtel and the vehicle owners are able to pay for their parking fees using MTN and Airtel Mobile Money. These mobile operators will become crucial direct stakeholders in the future Smart Parking System as the vehicle owners will rely even more heavily on mobile payments and mobile network.

3.3. On-street parking

3.3.1. Multiplex on-street parking

In 1997, KCCA developed a set of reforms designed to bring change to the KCCA's approach to delivering public services. These reforms were first documented in the Strategic Framework for Reform (SFR), where KCCA pledged to "provide and facilitate the delivery of quality,

[46] The official press release document can be downloaded from the official website of the Embassy of Japan in Uganda.
https://www.ug.emb-japan.go.jp/files/000452792.pdf
[47] "KCCA extends Multiplex street parking contract", *Daily Monitor*, March 22, 2019.
https://www.monitor.co.ug/News/National/KCCA-extends-Multiplex-street-parking-contract/688334-5036292-ubhnguz/index.html

sustainable and customer-oriented services effectively and efficiently". The first Kampala paid public on-street public was introduced by the said Framework.[48]

Currently, public on-street parking in Kampala is based in the central business area and cover the following streets: Lumum Street, William Street, Market Street, Burton Street, Ben Kiwanuka Street and Channel Street. On-street parking also include some areas of Kampala Road and Jinja road, along the main Kampala Business area. The detailed on-street parking map, however, is not available. KCCA envisions the expansion of paid on-street parking to the other areas of Kampala, however, it will probably be only possible in the long-run due to the urgency to address parking in the city center as well as difference in infrastructure development level, security and income level of citizens living there.

In July, 2003, KCCA estimated a total of 5341 parking spaces in the city. Over the next 16 years, there has been no update of the total count, yet due to constant change of the on-street environment and the suspension of on-street parking on some streets the actual number was constantly changing. The common reasons for parking suspensions in the past include suspensions for security reasons (i.e. parking suspension along Parliamentary Avenue, suspensions near Bank of Uganda) and suspensions due to intersection improvements (i.e. parking suspensions at the approaches to Kitgum House and Entebbe Road/Kampala Road signalized junctions).

Furthermore, the concession fee (the amount cannot be disclosed) for the street parking management contract with Multiplex Limited was revised and the main ground for negotiations was the number of parking bays stipulated in the gazette.

In 2018, KCCA carried out a study to determine the actual number of the parking spaces in the city.[49] A team comprised of 7 KCCA officials and 3 Multiplex representatives verified the parking spaces during one week from January 31 to February 5, 2018. The study accounted for 5782 parking spaces in the city, however, mentioned that the number should not be regarded as conclusive as many of the parking spaces are not clearly marked and numbered. The study also

[48] Rye T, (2010), p.12. Parking Management: A Contribution towards Liveable Cities. Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Germany

[49] The "Street Parking Bays Verification Report: Kampala City" was implemented by the KCCA Road Management Team for the KCCA Engineering and Technical Services and the KCCA Revenue Collection Directorates and officially submitted for internal reference on March 5, 2018.

mentioned that management of boda-boda vehicle parking should be readdressed as it remains an important issue for revenue collectors.

Picture 4. On-street parking in Kampala

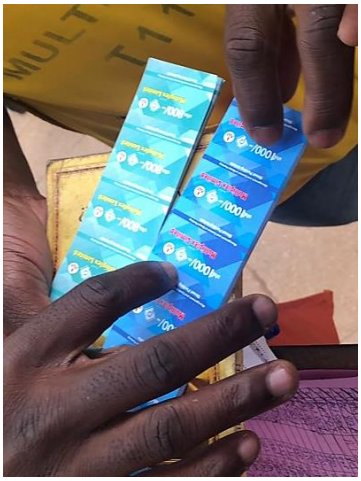
Table 14. Overview of Kampala on-street parking

Characteristics	Details
Parking management	Multiplex Limited Uganda
Parking reinforcement	1 parking manager per 30 parking spaces + parking ticket sellers
Parking ground	Asphalt in a relatively good condition
Parking position	Most are parallel to the kerb, some are at an angle
Parking space count (as of February 2018)	5782 (approximate value)
Parking space size	Length varies from 5m to 6m (5.5m on average)
Parking lines	Some clearly marked
Parking space numbers	Some clearly marked
Parking fees (as of January 2019)	1 hour: USh 1,000 (approx. 0.27 USD) 2 hours: USh 2,000 (approx. 0.54 USD) Over 2 hours: Ush 800/30 min (approx. 0.21 USD) KCCA vehicles are exempt from parking fees
Parking fee payment type	Cash or MTN and Airtel Mobile Money

The first public on-street parking management contract was awarded in 1997 to the Green Boat Entertainment and the company was in charge of enforcing and administering public parking within the city until 2002. In 2002 the parking management contract was awarded to Multiplex Limited Uganda that continues to manage the on-street parking. Parking spaces are assigned to Multiplex managers on a daily basis at 07:00.

Picture 5. Multiplex workers

Picture 6. Parking fee payment receipt



Picture 7. Multiplex parking tickets

Picture 8. Out-of-order parking meter (front)

Picture 9. Out-of-order parking meter (back)

Picture 10. Out-of-order parking meter front panel

Under the first contract, Multiplex was required to roll out the Pay and Display Parking Meters (P&D), procure and deploy handheld meters on roads where P & Ds were considered unsuitable and increase the number of Automated Number Plate Recognition units to ease Enforcement. 30 on-street parking meters were installed on streets of Kampala by Multiplex as a pilot On-Street Parking project. The meter originally has a coin device, a smart card and a sensor. The pilot project operation time was limited and operated only from 7:00am to 6:00pm. This project, however, is largely considered unsuccessful due to the destruction of the installed meters and difficulty of their use – most of them are no longer operational and citizens avoid paying the parking fees using the meters.

3.4. Off-street parking

3.4.1. KCCA off-street parking

Even though KCCA focuses on the city's public on-street parking transition to Smart Parking management, New Taxi Park, Old Taxi Park and Usafi Taxi Park transportation terminals are considered as the next priority in the Smart Parking implementation roadmap. These terminals are the largest transportation terminals in Kampala with the biggest parking capacity and busiest traffic environment in the whole city. In addition, New Taxi Park and Old Taxi Park are complex public transportation terminals with difficult entry and exit points as well as unorganized free-of-charge parking areas which result into absence of revenue. The terminals are widely considered as drop-pick-and-go platforms. However, the reality is that these parks represent short to medium-term parking lots that are not managed as such.

Picture 11. Satellite view of New Taxi Park

New Taxi Park is next to Namirembe and is located in Kampala District, Central Region. The reconstruction of the New Taxi Park in Kampala Capital City was commissioned by President Museveni in October, 2013. The reconstructed park now accommodates less vehicles than it did before the renovation in 2013. Its redevelopment cost USh 6.3billion (approx. 1,709,652 USD) and was completed by M/S Stirling Civil Engineering company. Formerly it hosted more than 600 commuter taxis. According to official statement, the park capacity is about 350 vehicles[50], however, in reality it is more congested as it still remains the most popular parking facility in Kampala.

[50] "New Taxi park launched", *Daily Monitor*, October 9, 2013. https://www.monitor.co.ug/News/National/New-Taxi-park-launched/688334-2024350-15js7wwz/index.html

Picture 12. Satellite view of Old Taxi Park

The Old Taxi Park is also congested and chaotic but overall is a very functional taxi park with thousands of drivers navigating their taxi vans. Passengers have to wander from one taxi van to another to find the taxi going to their destination. Vendors wander in-between vehicles selling water, ice cream and snacks to drivers and passengers waiting to get out. Over 200,000 people commute daily through the Old Taxi Park to connect to different destinations within the greater Kampala metropolitan area and beyond.

According to the official, KCCA is planning a feasibility study to redevelop the Old Taxi Park. In 2018 KCCA received 4 billion shillings (approx. 1,084,746 USD) from the Netherlands Government to conduct the study.[51] KCCA plans to have a storied taxi park with a parking lot and commercial area. KCCA also plans to meet private real estate owners during the feasibility and design phases to ensure their views and plans are incorporated in the final plan. KCCA expects for the renovated Old Taxi Park to increase the economic potential of more than 25,000 people who work in this area. KCCA is also confident that the renovation will benefit passengers, taxi drivers, conductors, food vendors and small business owners.

The Usafi Taxi Park is located near the clock tower roundabout, specifically known as Mu Kalitunsi. The area near the clock tower is heavily congested during peak hours. Usafi Park also stands in front of the local Usafi market. Usafi Taxi Park is a relatively new taxi park for vehicles heading to such destinations as Kansanga-Ggaba, Entebbe road, Masaka-Mbarara, Makindye, Busaabala, Gangu, Bunnamwaya, Kitebi, Sembule and others. According to the

[51] "KCCA Secures UGX 4 Billion for Redevelopment of Old Taxi Park", *URN*, July 26, 2018. https://ugandaradionetwork.net/story/netherlands-govt-gives-kcca-ugx-4-billion-for-redevelopment-of-old-taxi-park

KCCA's directives in October 2019, travellers heading toward the Entebbe road will no longer get taxis in the Old Taxi park but will have to walk to Usafi Taxi Park. This directive was an attempt to alleviate heavy traffic at the Old Taxi Park and improve the overall flow of traffic during construction of the Flyover Project (funded by the Japan International Cooperation Agency) at the clock tower. Usafi Taxi Park is less congested compare to the New and Old Taxi Park with fewer passengers catching taxis here. Some taxi operators stated that they were losing profits after their relocation to the Usafi Taxi Park. Before the relocation the Usafi Taxi Park was abandoned by some drivers who also argues that the Park has a low passenger turn up rate.[52]

Picture 13. Satellite view of Usafi Taxi Park

Table 15. Overview of the largest public transportation terminals in Kampala

	New Taxi Park	Old Taxi Park	Usafi Taxi Park
Ownership	Public	Partially public	Public
Parking ground	Concrete	Soil	Asphalt
Parking lines	x	x	x
Parking spaces	Approx. 350	N/A	N/A
Entrance/exit	√	√	√
Parking fees	Monthly payment	Monthly payment	Monthly payment
Peak time	Daytime	Daytime	Daytime

[52] "Vendors flock Usafi market as more taxis enter park", *The Independent*, November 5, 2019. https://www.independent.co.ug/vendors-flock-usafi-market-as-more-taxis-enter-park/

KCCA is planning to redevelop the Old Taxi Park, Usafi Park and the New Taxi Park into modern public transport terminals and a number of carefully selected places into multistoried parking facilities. In order to do so, KCCA proposes to enter into Public Private Partnerships.[53]

3.4.2. Government off-street parking

The Parliament of Uganda parking premises belong to the Government of Uganda and are not under the jurisdiction of KCCA, even though they are located in the center of Kampala city. In 2014 the Parliament has installed a ZTE-ICT Smart card Parking System at the South Wing entrance, the North Wing and Underground Parking. The system was reportedly procured from China under the Police classified expenditure at the tune of Ush 13 Billion (approx. USD 3,541,000). The implementation process was overseen by the Chinese experts who also provided system maintenance training to the local police officers. In 2015 the Parliament disclosed that the total cost of the system was Ush 28 billion and stated that the completed package includes electronic parking system, access blocks at all entrances, CCTV cameras and electronic voting devices.[54]

Picture 14. Entrance to the Parliament of Uganda parking premises

The system is based on an entry/exit card that all members of Parliament (MPs) and parliamentary staff use to pass into the parking facilities. They simply have to validate the card at the entry and exit points to gain access. The system records the number of incoming and outgoing vehicles as well as registers the number of available and occupied parking spaces.[55]

[53] KCCA. 2014. *Strategic Plan 2014/15 – 2018/19.*
Available for download at: https://www.kcca.go.ug/uploads/KCCA_STRATEGI_PLAN_2015-2016.pdf
[54] "UGX 28 billion Spent on Integrated Security System of Parliament", *URN*, February 23, 2015.
https://ugandaradionetwork.com/story/ugx-28-billion-spent-on-integrated-security-system-of-parliament
[55] "Parliament Gets Smart Card Parking System", *URN*, November 20, 2014.
https://ugandaradionetwork.com/story/parliament-gets-smart-card-parking-system

The information available about this parking to public is insufficient to judge whether the system can qualify as Smart Parking or not. However, the parking system implemented on the premises of Parliament can probably be considered as one of the best first attempts to introduce a smarter automated parking management system.

3.4.3. Private off-street parking

The FS team carried out one on-site inspection to a private on-street parking facility for comparative purposes. One of the most well-managed off-street parking facilities in Kampala is the automated parking system at the Acacia Mall (one of the largest shopping centres in Kampala) that includes automated parking entry barriers, parking ticket dispensing machines, parking ticket payment kiosks and surveillance CCTVs. The system was installed by the Kenya Airports Parking Services (KAPS LTD)[56]. KAPS is the company that installed the Entebbe Airport system and supplied Multiplex with the on-street parking equipment.

Picture 15. Parking entry & exit at the Acacia Mall

The parking at Acacia Mall is a garage-type off-street parking facility with a total of 570 parking spaces. A separate parking control room is located on the premises where the staff monitors the overall parking environment security through installed CCTV cameras. The parking system in place cannot be considered as Smart Parking due to lack of characteristic

[56] Official webpage of the KAPS Ltd is as follows: http://www.kaps.co.ke/

hardware and software. There are no sensors, occupancy displays and navigation displays. The entry, exit and payment processes do not include the LPR. The information available about the parking system in the control room is also insufficient to judge the system software component. However, the parking facility itself is considered most suitable for implementation of a comprehensive Smart Parking management system in the future.

3.5. Parking fees

The Ministry of Local Government is in charge of drafting parking guidelines, rules and regulations for on-and off-street public parking fees. The guidelines focus on overall pricing and do not introduce any parking discounts or social benefits for socially disadvantaged, children, pregnant women, elderly and disabled.

The public on-street parking fares are then regulated by KCCA and reinforced by Multiplex, the only authorized on-street parking agent. In 2012 past there was a clash between KCCA and local motorists over the reasoning behind and necessity of paying for on-street parking.[57]The current parking fares were introduced in September 2017.[58] The first hour of parking costs Ush1,000 (up from Ush 400), which applies to the first two hours of uninterrupted parking in the same space. After the first two hours, parking costs Ush 800 for every 30 minutes (doubled from Ush 400).

On the 13th February 2017, the Ministry of Local Government issued Policy Guidelines on Management and Levying of Parking Fees in Local Government's Public Service Vehicle (PSV) Parking Areas. According to the Policy Guidelines no vehicles shall pay a daily parking fee in the public service vehicle parking areas. Instead, the government directs that all vehicle owners and drivers shall pay a monthly parking fee to a local government or urban authority's bank account, where the vehicle picks and drops passengers routinely.[59]

However, the new guidelines were not fully implemented by the relevant urban authorities and were not fully complied to by the Park operators due to misunderstanding of its intended

[57] "Street parking fees challenged in court", *New Vision*, May 22, 2012.
https://www.newvision.co.ug/new_vision/news/1301831/street-parking-fees-challenged-court
[58] "KCCA hikes parking fees", *Uganda Business News,* August 28, 2017.
https://ugbusiness.com/3826/kcca-hikes-parking-fees
[59] Ministry of Local Government Press Release, "Government Position On The Policy Guidelines On The Management And Levying Of Parking Fees In Urban Authorities' Public Service Vehicle (PSV) Parking Areas 2017", September 28, 2017.
https://molg.go.ug/sites/default/files/Ministry%20of%20local%20Government%20press%20release%201..docx

objectives and operational procedures. On September 28, 2017, the Ministry of Local Government issued a press release to clarify and inform the general public, local government and taxi/bus operators about monthly parking fee levies for gazetted/designated parking areas were reduced by 44% for taxis (from Ush 360,000 to Ush 200,000) and reduced by 60% for buses (from Ush 1,200,000 to Ush 480,000).

3.6. License plates and vehicle registration

License Plate Recognition (LPR) technology will play a crucial role in implementing a comprehensive on-street Smart Parking System in Kampala that will reinforce not only parking management and traffic control, but also monitor parking violations and parking accidents. However, the LPR system is an analytic software that captures the image of a passing vehicle and its license plate, and then translates that captured image into machine-readable characters. Thus, the LPR system requires a quality license plate image database where multiple license plate images are gathered, which allows the system algorithm to find a match between the two images.

The Uganda government license plates are issued by the Ministry of Works and Transport, military vehicle license plates are issued by the Military Licensing Board and the rest of the license plates in Uganda are issued by the Uganda Revenue Authority (URA)[60]. The official homepage of URA provides only general information on the motor vehicle registration process and citizens must visit the local office for details and registration. The list of license plates provided on the URA webpage is very concise and does not provide insight into the numbering and lettering order, colour and size choices of the license plate itself. [61]

The FS team analyzed various license plate types independently, as official information on all Uganda licence plate types and characteristics is property of Uganda National Police and the KCCA was unable to negotiate the disclosure of this information.

[60] The Uganda Revenue Authority is a government revenue collection agency established by the Parliament of Uganda. URA the URA is responsible for enforcing, assessing, collecting, and accounting for the various taxes imposed in Uganda. URA is also responsible for vehicle registration https://web.ura.go.ug/Pages/Home%20page%20services/All-you-need-to-know-about-your-motor-vehicle.aspx

[61] Motor vehicle plate categories issued by Uganda Revenue Authority as at 20th December 2016. https://www.ura.go.ug/Resources/webuploads/INLB/Plate%20categories_Visual.pdf

Table 16. Uganda license plate types

Licence plate type	Front	Back
Private vehicle licence plate (cars)		
Public vehicle licence plate (boda bodas, motorbikes)		
Private vehicle licence plate (motorbikes)		
Tractor licence plate		
Vehicles exempt from transportation tax payments (cars) (tours and travel businesses, racing vehicles, non-government organizations and more)		
Vehicles exempt from transportation tax payments (motorbikes)		
Diplomatic mission vehicles (cars)		
Diplomatic mission vehicles (motorbikes)		
Car dealers' vehicle license plate		

Customized vehicle license (can be customised up to 9 characters)		
KCCA vehicle license plate (cars)		
KCCA vehicle license plate (motorbikes)		
Government of Uganda vehicles (cars)		
Military vehicle license plate, Security Forces, the UPDF, the Uganda Police Force vehicle license plates		
Statutory vehicles (including engineering plants) such as URA, UNRA, Uganda Free Zones Authority, UCC		

It is recommended to open a dialogue about carrying out a comprehensive research on vehicle number plates in use as well as the necessity of changing vehicle number plate format to a unified new security embossed number plate format as this will simplify the LPR technology introduction in Uganda. The absence of comprehensive guidelines and explanations on vehicle registration, driver licensing or vehicle number plate types available for public use or study purposes should be considered a good opportunity for reforming the transportation sector in Uganda.

3.7. SWOT analysis

The following SWOT table represents main internal (strengths and weaknesses) and external (opportunities and threats) factors that define the current parking environment in Kampala based on the beneficiary government's environment and As-Is analysis.

Table 17. SWOT analysis

Strengths	**W**eaknesses
1. Strong interest and will to solve parking issues in Kampala; 2. Sufficient ICT and engineering resources; 3. Efforts to procure external funding for project implementation; 4. Existing Traffic Control Centre in process of a major upgrade; 5. Experience in international infrastructure enhancement projects; 6. Openness to international cooperation on Smart Parking.	1. Lack of available data (lack of prior research on parking; lack of comprehensive parking rules and regulations guide) 2. Lack of internal funding recourses; 3. Strong will to implement innovative projects large-scale while skipping the small-scale stage; 4. Road maintenance is not up to date.
Opportunities	**T**hreats
1. Rapidly developing domestic market; 2. Easy access to neighboring African countries ready to adopt the Smart Parking technology; 3. Investment in parking infrastructure improvement projects; 4. Possibility to encourage intradepartmental and intragovernmental cooperation.	1. Difficulty to procure necessary funding for Smart Parking implementation; 2. Reluctance to share relevant data; 3. Negative customer (vehicle drivers) attitude toward Smart Parking adoption; 4. Possibility of theft.

1) *Strengths*

The most important strength of KCCA is that it acknowledges all negative factors related to public parking in GKMA and is prepared to search for best solutions, build out related goals and work on their competitive advantage. With regard to that KCCA also employs sufficient ICT and engineering resources that are eager to participate in innovative Smart Parking projects and possess the ability to change and adapt quickly to new technologies.

In 2011, KCCA introduced eCitie – its non-tax revenue collection system. In the following eight years, the city saw a 300% increase in non-tax revenue collection, establishing a

foundation for the revitalization of the city's infrastructure, service delivery and image.[62] Costs of tax collection reduced, city fund management improved, and cases of corruption and fraud significantly reduced. As a result, KCCA obtained a credit rating on the back of these improvements, allowing it to access funding and loan facilities from international financial institutions, which can also be considered a major strength factor.

Furthermore, KCCA is in process of establishing a new Traffic Control Centre on the KCCA premises. As the future Smart Parking will also be located within and managed at this new Traffic Control Centre, it will provide for smarter, easier and more transparent management.

Lastly, as seen from the transportation and parking sector overview, KCCA has experience in cooperation on international infrastructure enhancement projects and is thus open to cooperating internationally on Smart Parking projects.

2) *Weaknesses*

There is no prior comprehensive study on public and private parking environment in Kampala. As this FS paper is first of its kind, the reference materials are very limited. Some materials are property of various Uganda government organizations and KCCA's active support is needed to obtain them. Such process involves time-consuming negotiations and several materials were not obtained due to the project's limited time constraints. For example, the study on the exact amount of public on-street parking spaces was successfully completed by the KCCA, however, no parking maps outlining their exact location were submitted. The maps are necessary for understanding the installation locations and quantity of Smart Parking hardware. Another example is the lack of information on license plate issuance and management organizations, license plate types and characteristics.

Another weak point is the lack of internal funding within KCCA for Smart Parking project implementation, which led the authorities to seek for external domestic and international funding. This might be connected to the fact that authorities are looking forward to start with a large-scale Smart Parking project that requires substantial financial support, instead of implementing a series of smaller-scale projects on a step-by-step basis.

Lastly, road maintenance is not up to date in some places in GKMA, adding to the congestion

[62] Amy Fallon, 'How Kampala Is Building a Culture of Taxpaying', *Citylab*, September 26, 2016. https://www.citylab.com/life/2016/09/how-kampala-is-building-a-culture-of-taxpaying/501695/

and road safety problems, and increasing travel costs. This factor might negatively contribute to any on-street parking construction works in the future, unless approached and handled by KCCA in a timely manner.

3) *Opportunities*

Uganda is a substantial and rapidly growing consumer market. Uganda's economy rebounded in the latter half of 2017, driven largely by growth in ICT services, strong consumer spending and sustained levels of public and private investment. Such positive economic outlook brings upon great prospects for Smart Parking in the domestic market. This outlook assumes continued good weather, favorable external conditions to boost demand for exports and an increase in foreign direct investment (FDI) inflows as oil production draws closer, and capital investments executed as planned.

There are many prospects for KCCA to encourage the private sector to build Smart Parking and contribute to alleviating the traffic in the city. There is also great potential of marketing the Smart Parking technologies as Uganda's market is dominated by regional trade with her neighbors.

Furthermore, as Kampala improves its credit rankings, there will be more and more opportunities for procuring necessary funding for Smart Parking from international financial organizations. In addition, as Uganda's economy continues to grow, KCCA will have more internal support from the Government of Uganda.

There are also tremendous opportunities for KCCA policymakers to shape the rules and regulations for public and private parking in Kampala. KCCA has the power to encourage intradepartmental and intragovernmental cooperation in order to create a comprehensive parking policy that will be used everywhere in the country as transportation infrastructure continues to grow.

4) *Threats*

Procuring necessary funding for the Smart Parking project implementation can also be considered a challenge, as many funding organizations focus on improving poverty and providing social welfare for the citizens. This factor is considered one of the biggest threats. As Smart Parking might not be considered as an equally important and urgent project.

Data sharing is a common part of modern governance and the delivery of public services. Reluctance to share data between Uganda's government organizations, KCCA and private project participants might result into a poor implementation of Smart Parking in Kampala and uninformed parking policy-making.

Another concern is the lack of public awareness toward Smart Parking technologies and practices. The local media and the local government should start providing the information to the citizens beforehand to ensure smooth synergy of parking users and parking management. The possibility of negative customer (vehicle driver) attitude toward Smart Parking in GKMA should be considered as an important threat, as there were precedents in the past regarding the parking fee regulations.

Lastly, the main safety concern is vandalism and stealing. The road safety in many areas of Kampala is compromised by the rapid growth of the boda-boda fleet, many of which are driven recklessly by untrained drivers. For example, vandals have stolen at least 100 batteries installed to power the city streets solar lighting system, plunging the World Bank-funded project into problems.[63] This is considered a potential threat as Smart Parking hardware is envisioned to be installed on the same streets.

[63] "Vandals steal city street lights batteries", *Daily Monitor*, May 7, 2019. https://www.monitor.co.ug/News/National/Vandals-steal-city-street-lights-batteries/688334-5103226-su1akmz/index.html

4. SMART PARKING OVERVIEW

4.1. Definition of Smart Parking

Parking is the act of stopping and disengaging a vehicle and leaving it unoccupied. Parking on one or both sides of a road is often permitted, though sometimes with restrictions. Some buildings have parking facilities for use of the buildings' users. Countries and local governments have rules for design and use of parking spaces. Parking coordinates land use and transportation in urban areas, and it is also one of the most important assets, bringing revenues to cities.

1. *On-street parking*

On-street parking stands for parking facilities designed for vehicles to park on the street or along the curb (edge of the sidewalk) of the street, typically with a limited parking duration. More developed on-street parking facilities provide such fee payment options as payments via meters, subscription or smartphone. Less developed on-street parking facilities charge vehicle drivers in cash that is collected by the traffic wardens or marking managers. Some places provide free on-street parking at all times or for a limited time.

As the number of vehicles in towns and cities is constantly increasing, it is the number of on-street parking that remains restricted, compared to various possibilities of expanding the off-street parking facilities. One of the solutions to relieve the stress that comes by experiencing congested and stressful on-street parking is introducing innovative technologies that are nowadays classified as smart parking technologies.

2. *Off-street parking*

Off-street parking refers to underground and other car parks with access controlled by entry and exit barriers. On-street parking differentiates between outdoor and indoor parking lots. Outdoor parking lots are open-space facilities on the ground level. The indoor are typically located in a multi-storey building architecture or underground garages.

Expansion of off-street parking is one of mains solutions to aleviating growing traffic congestion due to the growing number of vehicles circling around in search of available parking locations.

3. *Smart Parking*

As metropolitan areas around the world grow, they begin facing growing traffic congestion that typically results in uncertainty in or insufficient supply of parking availability. As cities stand to face the challenge, they often face such problems as uncertain parking payment regulations, problems with observing traffic laws, corruption in revenue collection and poor infrastructure. Cities turn to Smart Parking which ultimately is a parking strategy that combines technology and human innovation in an effort to use as few resources as possible—such as fuel, time and space—to achieve faster, easier and denser parking of vehicles for the majority of time they remain idle.

Smart Parking is defined as connected parking management solutions deployed on public on-street and/or off-street parking facilities where the occupancy of a parking space is determined by sensing devices such as cameras or sensors embedded in the ground/pavement of individual parking spaces that can feed data to help/direct drivers to find a vacant parking space, and enable remote payments. Solutions can be comprised of vehicle detection sensors, license plate recognition systems, smart payment infrastructure (e.g. connected parking meters and Pay-by-Phone functionality for paid parking spaces), and middleware / IoT platforms which are networked via wireless and wired connections to transmit information to various channels such as mobile applications, web applications and dynamic digital signage.

What makes on-street and off-street parking smart for the vehicle driver is the use of such technologies as on-street parking occupancy monitoring with use of sensors and detectors, availability of information on parking on smartphones, possibility of payment by smartphones, appropriate signage with unoccupied space availability on the streets, enforcement optimization, dynamic pricing, etc.

Furthermore, what makes on-street and off-street parking smart for the management agents is the analysis of and cross-reference of various parking data collected in real time from various parking stakeholders, hardware and connected systems to enhance the quality of street parking for vehicle drivers. Collecting, cross-referencing and analyzing data provides for smart decisions in smart city parking management.

4.2. Smart Parking advantages

In general, Smart Parking gives municipalities and private companies the opportunity to make parking a more fluid and efficient process. Furthermore, it saves drivers a great amount of time, money, and reduces the frustration that a person might have when wanting to find a parking spot.

Table 18. Advantages of Smart Parking for drivers and municipalities

	Advantage	Details
Advantages for vehicle drivers	Optimizing the driving experience:	Using a Smart Parking system saves a lot of time for drivers since they know where to find a vacant parking spot. The amount of time the driver spends looking for a parking spot is be minimized. Because these people will know where they are going, they can simply navigate to their parking spot and they will not have to stress out about it.
	Optimizing the payment experience	By using the Smart Parking app, the drivers are able to find the parking spot they are looking for, without having to browse through the streets. Vehicle drivers can also quickly pay for their parking via their smartphones rather than worry about coins or cards for payment machines.
Advantages for municipalities	Less pollution	Smart Parking contributes to a cleaner environment. Reducing the time necessary to find a parking spot reduces the amount of fuel that is used when looking for a parking space. This makes the process of finding a parking spot contribute to less pollution, which is beneficial for both the citizens and municipalities.
	The space of a municipality will be utilized more efficiently	As Smart Parking hardware (sensors, cameras, etc.) transmit live data, drivers have a real-time overview of the occupancy of parking bays. This means that free spots can be filled quicker, which will reduce the time that a parking spot is empty. This in turn will result in a higher revenue collection.
	Safety	The use of Smart Parking can optimize safety within the city. Real-time data (i.e. from the CCTV cameras) can be provided to parking lot municipalities and security services to help with violations and in cases where suspicious activity may be present.
	Real-time parking analytics for cities	Parking space becomes intelligent by use of the smart parking hardware (i.e. sensors in the parking bays). The municipalities are able to see historical data on parking, which collected, stored and visualized for the decisionmakers to make data-driven decisions and predictions.

4.3. Smart Parking market

4.3.1. Market size

According to the report published by Allied Market Research, the global smart parking was valued at USD 5,001.1 million in 2017, and is projected to reach USD 11,553.6 million by 2025, registering a compound annual growth rate (CAGR) of 11.2% from 2018 to 2025. According to the research, North America is expected to account for the highest revenue in the global market throughout the forecast period (2018-2025) followed by Asia-Pacific, Europe, and LAMEA (Latin America, Middle East and Africa). However, Asia-Pacific is expected to develop at a higher growth rate, predicting a lucrative market for smart parking. [64] Amano Mcgann, Inc., Urbiotica, Smart Parking Ltd., IEM SA, IPS Group Inc., Klaus Multiparking Systems, Swarco AG, PArklayer, Omnitec group, Dongyang Menics Co. Ltd., Skidata AG, and Mindteck are the key market players that occupy a significant revenue share in the smart parking market.[65]

Table 19. Smart Parking market segments

Segment type	Details
Parking type	· On-street · Off-street
Technology	· Internet of Things (IOT) · Ultrasonic · RFID
Application	· Security & surveillance · Smart Payment System · E-parking · License Plate Recognition (LPR)
End user	· Commercial · Government
Region	· North America · Europe · Asia-Pacific · Latin America, Middle East & Africa (LAMEA)

[64] "4Global Smart Parking Market (2018-2025): Analysis by Type, Technology, Application, End-User, and Region", Research and Markets official report.
https://www.researchandmarkets.com/research/zjs3kd/global_smart?w=4

[65] "Smart Parking Market by Type (Off-street and On-street Parking), Technology (IoT, Ultrasonic, and RFID), Application (Security & Surveillance, Smart Payment System, E-parking, and License Plate Recognition), and End User (Commercial and Government) - Global Opportunity Analysis and Industry Forecast, 2018-2025", Allied Market Report.
https://www.alliedmarketresearch.com/smart-parking-market

Smart Parking market growth is largely driven by the increase in parking concern across the globe triggered by the increase in transportation vehicle numbers and growth in demand for Internet of Things (IoT) based technology.

Table 20. Challenges that promote Smart Parking market

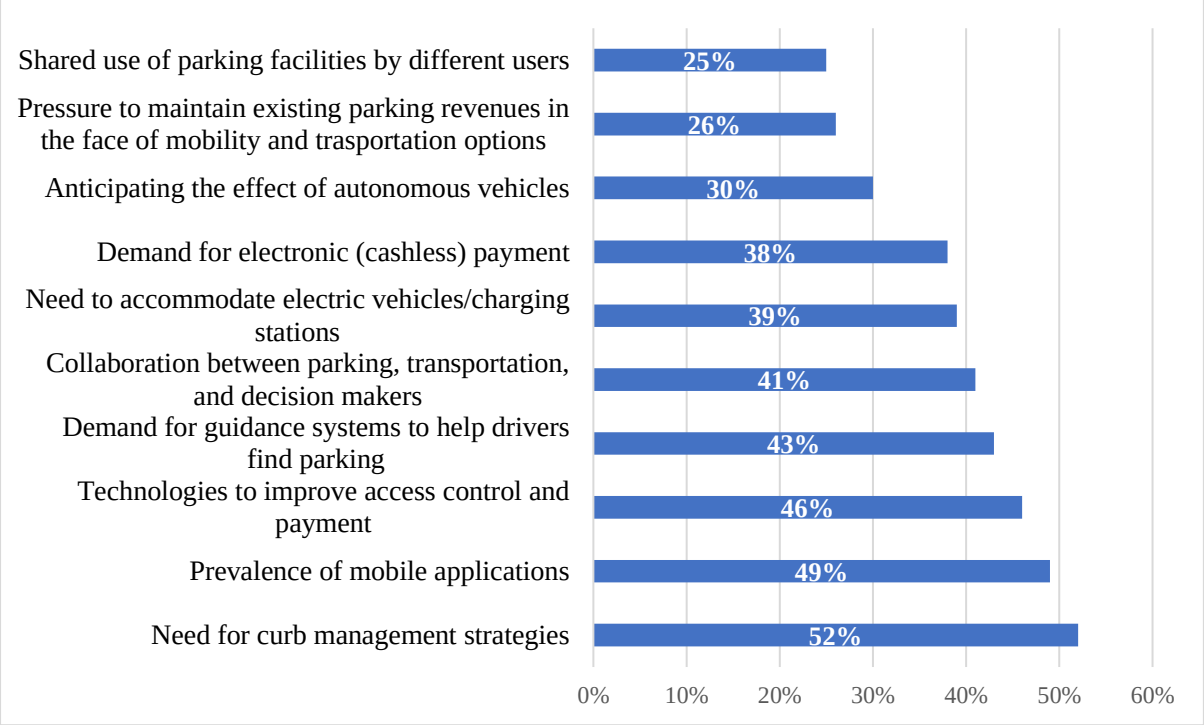
Challenge	Details
Increase in the number of vehicles	Finding a vacant parking space during peak hours is very difficult task for many drivers in metropolitan areas. In addition, the rise in number of vehicles globally results in problem related to the limited parking spaces in residential as well as commercial areas, traffic congestion combined with improper management of parking space. Global governments are striving to solve such parking related crisis by raising funding for new infrastructure and sharing experience.
High implementation cost & configuration complexity	There is necessity to frequently upgrade the system and software required to keep them compatible with external environment due to constant technological advancements. As many component and sensors are assembled in a single dielectric plate in accordance with the compatibility, it incurs higher cost. This bulky system takes higher implementation cost as it needs to be connected with the wireless devices for its proper operation. Therefore, high configuration complexity coupled with higher initial implantation cost hinder the wide adoption of the smart parking market.
Unified urban mobility infrastructure	Currently there is a huge void in the urban areas' ability to adequately plan and regulate parking. This is due to the lack of accurate real-time and historical data. The fast-paced changes in the urban areas, in many cases, quickly outstrip our ability to plan and build an infrastructure that can keep up. Furthermore, there is a great disconnect and lack of collaboration between parking operators and municipalities.
Societal changes	Societal changes are often disregarded; however, they should also be considered as major contributing factors to Smart Parking market change. These changes include the increased use of ride-hailing/ transportation network companies (Uber/Lyft), desire for more livable and walkable communities, changes in the way people commute to work and personal focus on the environment and sustainability.

4.3.2. Leading trends

The rise in investment on building driverless vehicles, and rise in various government initiatives in building smart cities across the globe are creating more and more opportunities for the market. The rising trends of the new decade is an increasing demand for intelligent

technologies that can deliver accessibility, affordability, convenience, and efficiency. Unfortunately, creating and developing highly innovative technologies is coupled with some interrelated challenges. These factors are projected to drive the growth of the smart parking market.[66]

Figure 6. Top emerging trends in Smart Parking



Leading trends hugely reinforce the transformation of roles of parking professionals into transportation experts. They are coordinating car-sharing services (48%), operating shuttles (45%), and collecting data to influence service and policies (44%). Many work to improve access for cyclists through bicycle improvements (43%), bike-sharing (40%), and bike/transit integration (36%); they're also focused on easy access for pedestrians (35%). Even industry titles have changed; nearly 44% note their department/entity names encompass both parking and transportation, and 32% of departments have been renamed in the past five years. Nearly 60% identify as "parking, transportation, and mobility professionals" and more than 50% agree that perceptions of their profession have improved during the past five years, as more planners,

[66] "2018 Emerging Trends in Parking. Report on a survey conducted by the International Parking Institute" by IPI International Parking Institute.
https://www.parking.org/wp-content/uploads/2018/05/0509_2018_Emerging-Trends_blue_printPages.pdf

architects, and decision-makers realize the importance of parking expertise at the earliest stages of a project. Some 69% would encourage students to pursue parking-industry careers.

Figure 7. Parking trends transformation

4.4. Smart Parking technology

Smart Parking technology consists of four crucial components – software, hardware, middleware and connectivity. Hardware includes all necessary hardware for running the smart parking lot. Software is the operating program operating the parking apps and management systems. Middleware incorporates all important parking system functionalities. And connectivity enables all devices to communicate with other devices and to the cloud via wireless and wireline networks.

Table 21. Four main components of Smart Parking technology

Software	Hardware	Middleware	Connectivity
· Smart Parking app for vehicle drivers · Smart Parking management system	· Parking barrier gate, sensors, parking meter, CCTV, control room computers · License Plate Recognition unit · Ticket dispenser · Radio frequency tag reader · Digital signage	· Connectivity & normalization · Rule engine · Visualization · Analytics · Application management · Device management · Data management	· Gateway · WWAN · Cellular networks · LPWAN

4.4.1. Software

1) *Smart Parking app*

The typical minimum of a Smart Parking application includes such functions as finding a parking space, comparing parking prices and features, parking reservation, various parking payment options, guidance to the selected parking space and "Find my car" option. The typical Smart Parking application for vehicle users nowadays must at least have the following four features.

The app should be reliable and provide a safe communication system to the vehicle drivers such as technical support and nnotifications via messages. The app should be secure. The collected individual data from the driver's device must be highly protected from the viruses. The cloud information of spot finder app must be protected from the unauthorized usage. The app should the provide the drivers with up-to-date information and notifications regarding the process of parking directly to the user's device. The app should be user-friendly. The screen status should not block the key elements of mobile device navigation, plus drivers or app users should not be distracted.

2) *Smart Parking management system*

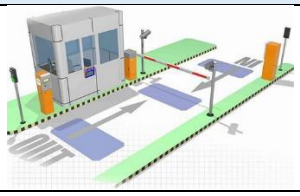
The Smart Parking management system is an intelligent car parking solution that digitizes the entire parking process end-to-end, optimizes parking space and makes the parking processes efficient. Such system is based on technologies such as mobile, cloud, IoT, etc.

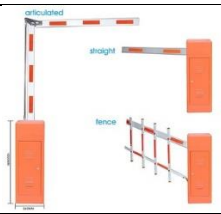
The typical system should have a user-friendly graphical interface, include reporting and statistics functions, provide real-time monitoring of parking space availability by facility, level, and single space, status monitoring of all relevant hardware (sensors, signs, etc.), provide system alerts for exceeding parking duration, vehicles in transit, share data with city way finding systems, etc. The system allows users to manage and analyse parking events and information, as well as allowing users to identify trends and interpret data.

4.4.2. Hardware

Smart Parking hardware should be weather resistant, easy to deploy and provide parking automation. Typical Smart Parking hardware is, but not limited to, as follows:

Table 22. Smart Parking hardware overview

Hardware	Functions	Image
Loop detectors	Installed at the parking entrance roadway. When the vehicle approaches the parking gate and steps over a loop detector (magnetic loop detector is the most popular vehicle sensor), it senses the car and its presence is signalled to the LPR unit.	
LPR (license plate recognition) unit	1) CCD Camera 2) Complex unit Installed at the parking entrance, captures full log of the vehicle's license plate, date of entry and photo of the vehicle. Upon vehicle exit, system can calculate and display parking fees.	
Parking payment machine	Walk-up parking machines that allow parking payment for Pay & Display, Pay by License, or Pay by Space. A Flat-Rate Parking System is the most basic starting system. This involves a flat-rate payment on entry or exit. If there were two laneways (i.e. one Entry Lane + one Exit Lane), then only one lane would require a parking payment machine. The other lane would have a barrier gate that detects the presence of a vehicle, which opens the gate or a “free” in/out gate. This second gate prevents vehicles from driving out the wrong way and avoiding payment.	
Entrance display	Display is well positioned at the entrance to the parking garage and displays the open or available parking space count on signs in a parking lot or garage.	

Long range RFID reader	Tracks vehicles across large areas and spaces. Installed at the entrance to the parking garage. Requires for vehicles to have a card installed in the vehicle that can be read by the reader.	
Barrier gate	Barrier gates are installed to block vehicular access through a controlled point. Can be articulated, straight or fence.	
Ticket dispenser	Installed before the barrier gates. Press the button to take the parking ticket, wait for barrier gate to open and proceed. Can be customised: intercom, security camera, card reader + PIN pad, etc.	
Guiding display	Guiding display signs are well positioned for the drivers to see them. Displays present information in real time about vacant parking spaces and where to go to reach them.	
Sensors	Sensors detect whether the sparking spot is occupied or available (in-ground sensors, surface mount sensors)	
LED indicators	Lights guiding drivers to open parking spots, that make it easier to check whether or not spots are from afar. The light is typically red if the parking spot is taken, green if it is free, blue for handicap spaces and pink or purple above the electric car charging stations.	
Computers, servers, etc.	Parking control room computers, entrance fee calculator computer, etc.	

4.4.3. Middleware

Middleware enables communication and data management for parking systems and applications. Middleware includes web servers, application servers, content management systems, and similar tools that support application development and delivery. Middleware is responsible for the following functions:

1. Application management that includes reservation, enforcements and parking guidance functions;
2. Analytics that includes various algorithms, machine learning and stream analytics;
3. Visualisation that includes system dashboard and various statistical reports;
4. Data integration that includes data collection, data storage, data exchange services and mobile data provisioning;
5. Device management that includes asset monitoring, over-the-air programming, billing;
6. Connectivity normalization that includes API/SDK and gateways, etc.

4.4.4. Connectivity

Smart cities are using connectivity to source real-time information on the availability of parking spaces. That information can help drivers find available spaces and enable the city to introduce dynamic pricing, in which the cost of parking can be adjusted in line with demand. Connectivity is key to communication between all components of Smart Parking and includes such parameters as link budget, module cost, nodes per gateway/cell, bandwidth, message frequency, battery life, topology, licensed spectrum.

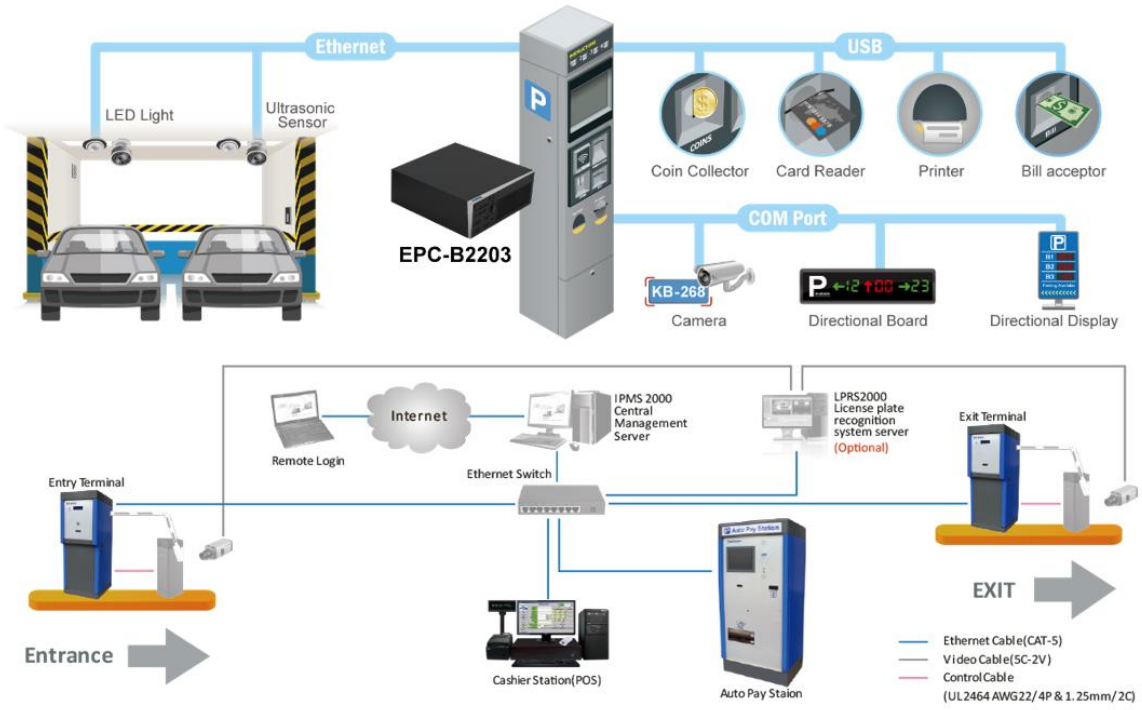


Figure 8. Examples of parking system connectivity

4.5. Case study

Four case studies involving an up-close, in-depth and detailed investigation of smart parking environment were carried out to address the case of Kampala Capital City. Both on-street and off-street Smart Parking cases were reviewed to understand the big picture of the global Smart Parking industry. Three of the cases were selected for their successful implementation experience with implementing smart parking initiatives by the international municipalities. One case study was selected as the best example of Korean smart parking market.

1. *On-street*: USA, San Fransicso SFpark;
2. *On-street*: UK, London Smart Parking Ltd.;
3. *Off-street*: Korea, Seoul Darae Parktech;
4. *Off-street*: Singapore, Singapore Parking.sg.

These case studies provided a means for highlighting and extracting practical principles and methods for shaping and accelerating the smart parking development progress in Kampala. The importance of these case studies is as follows:

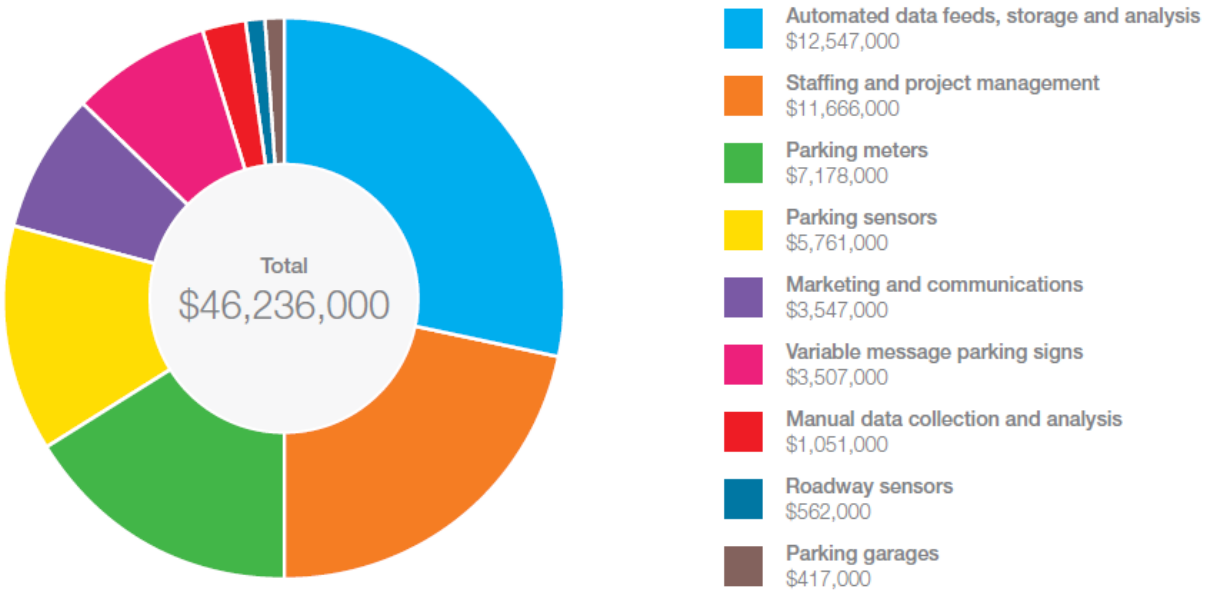
1. Enable a holistic review of best smart parking cases and build a detailed understanding on the smart parking system development and implementation;
2. Build upon or enhance a body of knowledge and understand what works and what does not work when implementing smart parking system for municipalities;
3. Find valuable suggestions about things to try and directions to further develop the installed pilot smart parking system in KCCA;
4. Highlight and learn from errors and mistakes (if there were any) made in order to avoid similar problems when planning and executing a similar project in Kampala;
5. Compare specific similar aspects of smart parking technologies across case studies;
6. Study and understand the importance of including people in the smart parking system implementation;
7. Dig into specific situations and extract ideas from municipalities that can be generalized into principles for KCCA to apply to future smart parking ecosystem.

4.5.1. San Fransicso

The Bay Area in San Fransicso is recognized as one of the first smart parking systems. In 2011, the city's SMFTA (San Francisco Municipal Transportation Agency) implemented the SFpark

initiative[67].SFpark was first a demonstration project funded through the Department of Transportation's Urban Partnership Program. SFpark was funded primarily through a $19,800,000 grant from the United States Department of Transportation, a $22,000,000 loan from the Bay Area's Metropolitan Transportation Commission, and local matching funds totaling $4,950,000.[68]

Figure 9. SFpark program cost distribution



Publications, organizations, and government agencies around the world have recognized the SFpark project, from its technology to its unique pricing policies, for its innovative solutions to urban parking management. This pioneering parking management system has brought forth many innovations, including:

1. *Demand-responsive pricing*: Rates for metered parking space vary depending on location and demand at a particular time of the day. As a result, hourly parking rates vary from $.50 to $7. This enables a more efficient usage of available parking spaces. Wireless sensors are deployed throughout the city to optimize the system, which is also used in 14 public parking structures;

[67] The official website is as follows: http://sfpark.org/.
[68] The full overview of the SFpark pilot project can be found on the official website. http://sfpark.org/wp-content/uploads/2014/06/SFpark_Pilot_Overview.pdf

2. *Mobile apps*: The SFpark app (which is completely free) informs drivers about parking space availability in real time. The data feed also includes information about the variable payment system;
3. *PayByPhone*: Although San Francisco has modern parking meters available for use, drivers also have the option to pay for parking via phone;
4. *Open data and source code*: In the interest of promoting access to data, the SFpark API is fully public, with open data and open source code. This enables developers and researchers to implement their own innovations to improve the parking system in San Francisco.

Picture 16. SFpark web application

In addition to the parking information map available on the SFpark.org homepage, information on parking availability is distributed via a free SFpark iPhone app, Android app, and the region's 511 phone system. While the SFpark pilot project had many goals, its primary focus was on minimizing the driver's time in finding a parking space and improving the utilization of garages. Other benefits were also expected, such as reducing circling, double parking and greenhouse gas emissions.

Picture 17. SFpark mobile app

As part of the SFpark pilot project, the SFMTA added nine variable message signs (to the city's existing five) that inform approaching drivers about the availability of garages. The sign type is consistent with the city's existing signs. In addition to that, over 300 static directional wayfinding signs were installed to help direct drivers to municipal garages and lots. All of the static signs were designed to match the look and feel of the rest of the SFpark materials, especially the garage branding. As part of the project, SFMTA also installed parking meters that accept payment by coin, credit card, the SFMTA parking card, and phone.

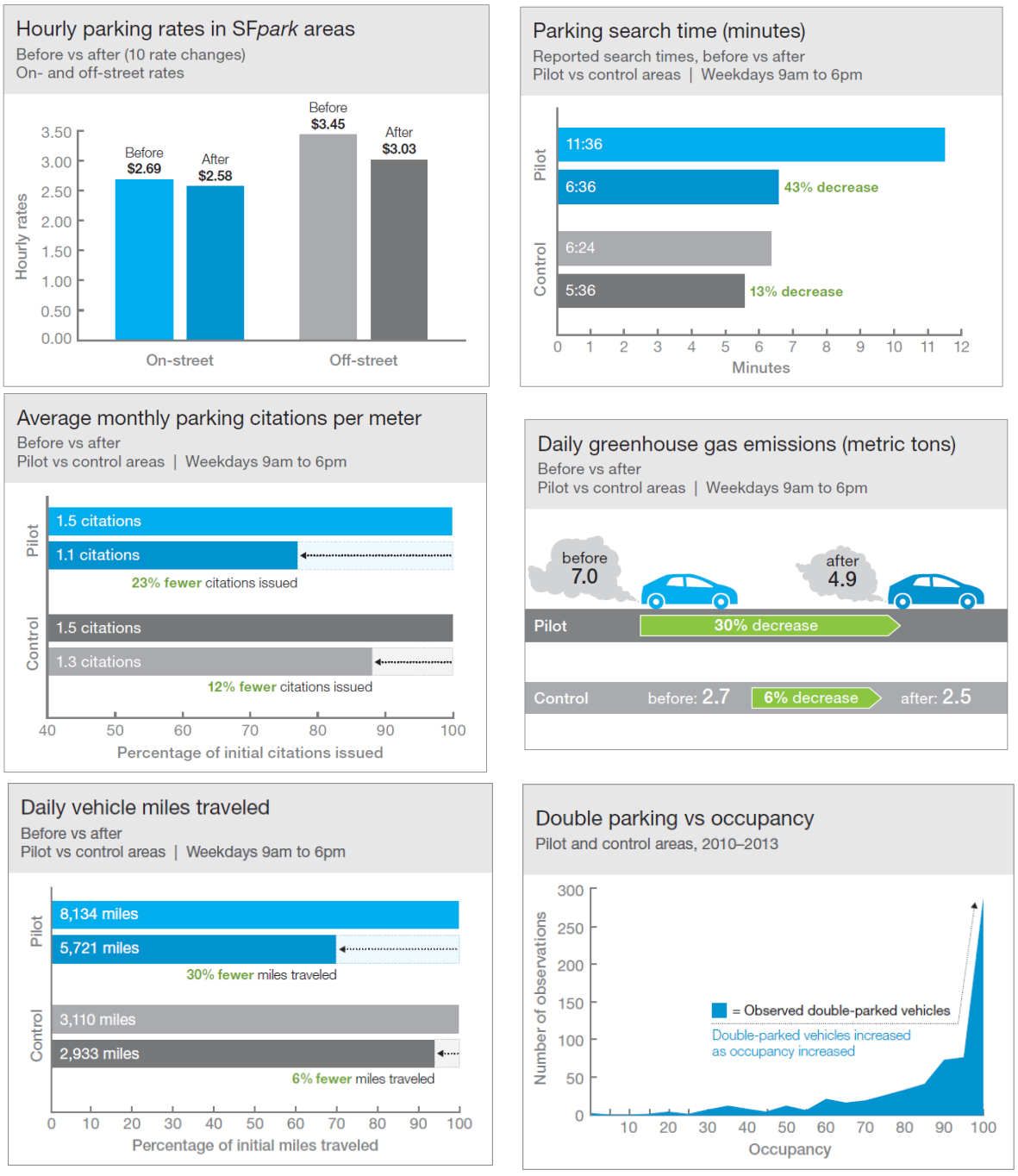
Picture 18. SFpark signage and parking meters

Sensors and meters can both communicate wirelessly. One repeater at almost each intersection completes wireless mesh networks. 85% of the events can be received in the central server within 60 seconds.

Over the course of the SFpark pilot project, the SFMTA managed to obtain impressive quantitative data on parking environment in the city.

1. SFMTA lowered the average hourly rate at meters by 11 cents from $2.69 to $2.58 and average hourly rates at SFpark garages by 42 cents from $3.45 to $3.03. It is easier for drivers to find a parking space. In SFpark pilot areas, the amount of time most people reported that it took to find a space was decreased by 43%, compared to a 13% decrease in control areas.
2. Greenhouse gas emissions decreased. Drivers generated 7 metric tons of greenhouse gas emissions per day looking for parking in pilot areas. This dropped by 30% by 2013, compared to a decrease of 6% in control areas.
3. It is easier to pay and avoid citations. SFpark also sought to create a parking experience that is simple, consistent, easy to use, and respectful. The pilot project improved the experience of parking by lengthening time limits and making it much easier to pay.
4. Peak period congestion decreased. SFpark encouraged people to drive at non-peak times and improved parking availability when it mattered most.
5. Traffic volume decreased. In both pilot and control areas, where parking availability improved, traffic volume decreased by approximately 8%, compared to a 4.5% increase in areas where parking availability worsened.
6. Traffic speed improved. While overall traffic speed decreased, it decreased by 3% in areas with improved parking availability, compared to a decrease of 6% in areas with worsened parking availability.
7. Vehicle miles traveled decreased. As a result of less circling, pilot areas saw a 30% decrease in vehicle miles traveled from 8,134 miles per day in 2011 to 5,721 miles per day by 2013. Control areas saw a 6% decrease.
8. Double parking decreased when parking availability improved. Double parking increases as parking gets harder to find, and it increases dramatically as parking occupancy exceeds 80% In pilot areas, double parking decreased by 22% versus a 5% decrease in control areas.
9. Other secondary benefits reported were improved transit speed, slight increase in net parking revenue, improved economic vitality, safer streets because of reduced vehicle miles traveled and less distracted driving.

Figure 10. Positive results of SFpark project



SFpark is a pilot program to examine the feasibility of adjusting prices to manage parking occupancy, and it appears largely successful. Los Angeles has already adopted a similar program called LA Express Park, and other cities are closely monitoring the results.

4.5.2. London

Smart Parking Ltd.[69] is a global parking business that is present in many countries and regions around the world, with a real in-depth presence in the UK, Australasia, EMEA (Europe, the Middle East and Africa) and South East Asia. Smart Parking Ltd has extensive experience working with councils and municipalities, airports, parking operators, shopping centers and educational organizations. The company has adopted a strategy that focuses on differentiation through experience, continual innovation, and value-added services, with a special emphasis on smart city integration technology.

The company offers advanced parking information to smartphones and rich information to smart cities via SmartCloud IoT platform, resulting in greater convenience for motorists and operators alike. The platform enables not only collection and analysis of parking data, but also – thanks to the open connectivity of our SmartSpots and the highly integrated nature of SmartCloud – connect any other IoT sensor into the system. This enables the city operators to manage a raft of smart city services such as public Wi-Fi, surveillance, lighting, air quality, digital displays and more, all through the same data intelligence platform.

Picture 19. SmartCloud Platform dashboard

The SmartCloud Platform incorporates the following features and functions

1. Customizable live information dashboards that can be displayed via any web browser;
2. Industry-leading Big-data storage and query technology, which enables megabytes to petabyte scales of data analytics and on-demand reporting;

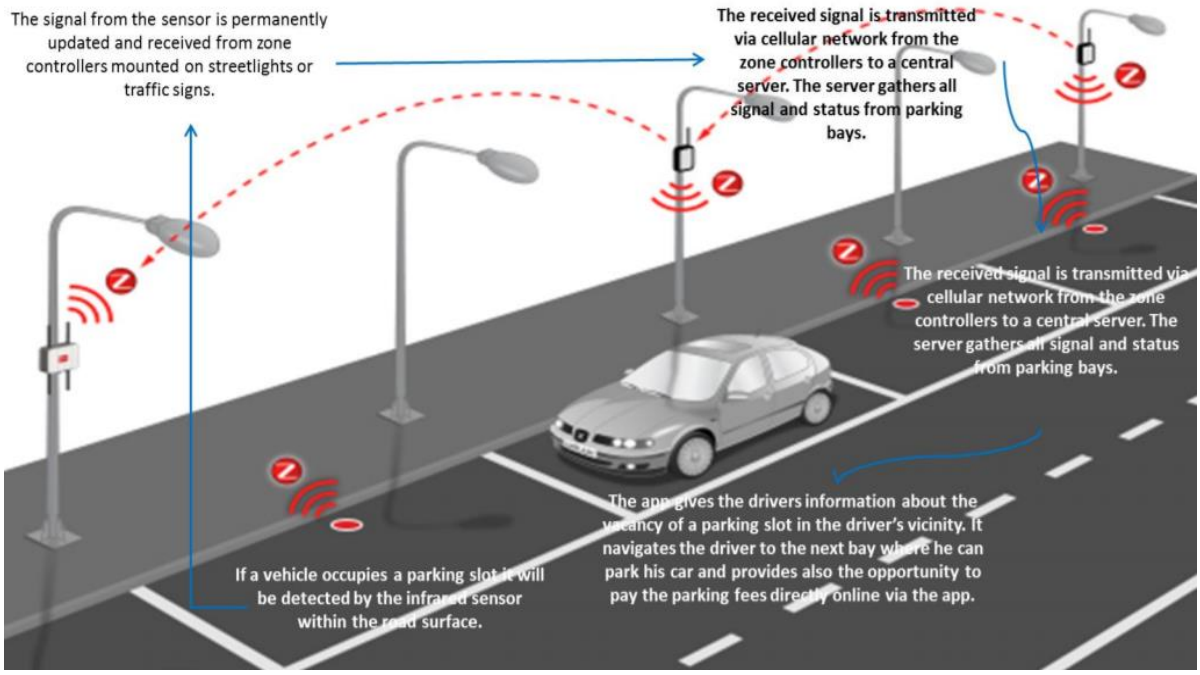
[69] Smart Parking Ltd official homepage is as follows: https://www.smartparking.com/.

3. Broad range of default analytical reports for common types of analysis requirements;
4. Rules definition and processing functionality that enables powerful capability to specify business rules for all types of desired data driven outcomes;
5. Service packs that deploy the comprehensive and advanced suite of smart parking solution capabilities onto SmartCloud. This extends from management and maintenance of parking space sensors, counters, indicators, signs and displays, through to the provision of sophisticated parking operational services for guidance, payment, enforcement, organization, monitoring, and analytical reporting;
6. Supports both direct and federated user account access login mechanisms, while also enforcing secure roles and access rights for every user for all data and functionality;
7. Data security, locality and resilience - all data in SmartCloud is encrypted in-flight and at-rest;
8. SmartCloud API library – the platform is created and delivered via a comprehensive library of web service APIs that adhere to the OpenAPI and other industry standard specifications;
9. The platform is completely based upon a cloud based serverless micro-services architecture;
10. SmartZone network communication environment for sensor and device management and monitoring;
11. Universal device connectivity - secure and open expandability to embrace all types of sensor or device with the ability to be network connected.

Smart Parking Ltd. provides solutions for both on- and off-street parking. One of the most outstanding on-street parking cases is parking in Westminster, London, UK. The diverse nature of Westminster, and the many people who live, work and visit, create high demand for the limited parking space available on the daily basis. City-wide parking occupancy averages levels of more than 70%, and often in excess of 80% in the West End where demand is most acute.

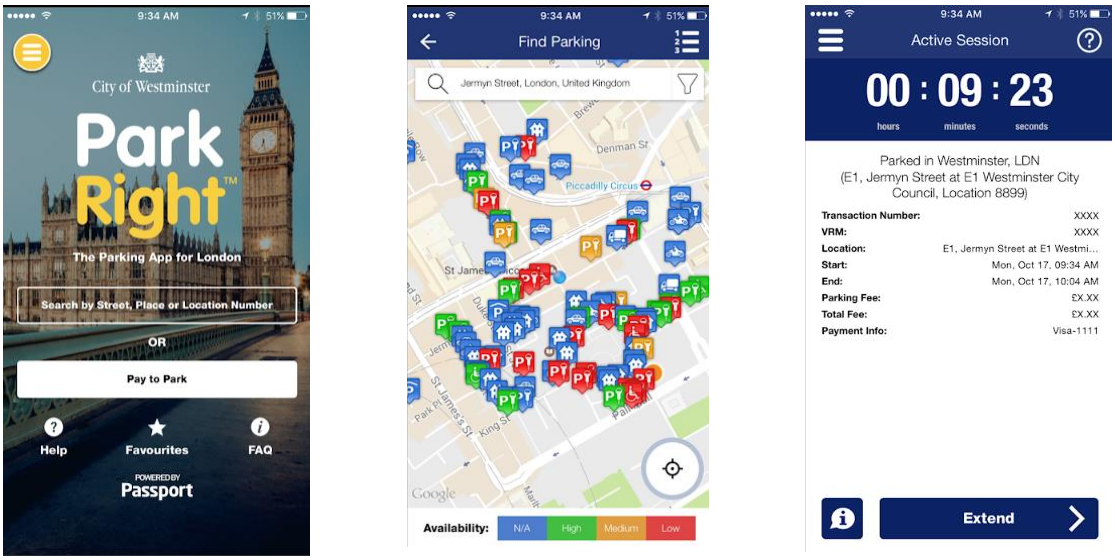
Westminster City Council adopted the SmartPark solution by Smart Parking Ltd. in October, 2014. As a result of installing the SmartPark system, Westminster City Council has been recognized and awarded with the Tech Success Awards (2013); the Innovation in Technology at the Real IT Awards (2014 & 2016) and the prestigious British Parking Technology award (2014).

The deployment included a network of over 3,400 RFID-equipped in-ground vehicle detection sensors which register whether each parking space is occupied or vacant. This information is then relayed live to SmartRep, Smart Parking Ltd.'s powerful car parking management software tool, which collates and analyses the data.



Picture 20. Smart Parking Ltd, parking data transmission

The information is fed instantaneously to the council's ParkRight - a simple to use app which drivers can install on their smartphone.



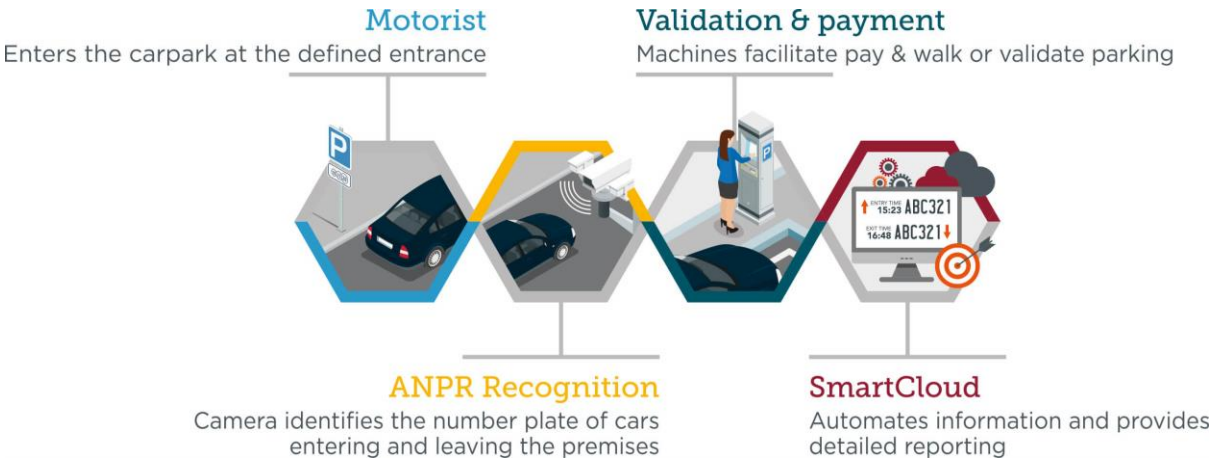
Picture 21. ParkRight app for City of Westminster

The driver uses ParkRight to identify the best available parking space and receive clear, precise, GPS-based directions to get them to it. In addition to on-street public parking, ParkRight also displays the locations of resident parking, coach parking and motorcycle bays - up to the 41,000 on street parking spaces covering the whole borough, including well known locations such as Leicester Square, Covent Garden, the West End and Oxford Street. The app also includes the off-street car park locations.

Once the vehicle driver arrives at the selected parking, she/he can pay for the parking fees in the app. SmartRep software data can also be used for vital future planning to make further improvements to Westminster's parking systems.

Smart Parking Ltd. uses their ANPR (Automatic Number Plate Recognition) system mainly at off-street parking facilities, such as supermarkets, shopping centres, gyms, business estates, hotels, public council-run land, and more.

Figure 11. Smart Parking Ltd. ANPR System



ANPR-run car parks can be configured to allow for a range of parking options, including:

1. Maximum stay, for example a two-hour limit;
2. Permit only, where approved vehicles have their details pre-loaded to an approved white list;
3. Limited free time parking, such as the first three hours being free which reverts to paid parking for longer stays;
4. A range of all of the above options, on the same car park site.

The data from both the ANPR camera and the on-site ticket validation is wirelessly sent to Smart Parking's powerful and robust SmartCloud API dashboard.

4.5.3. Seoul

Darae Parktech[70] is a major industry player in South Korea, which holds 15 parking related patents, its annual sales reached about 29.2 billion won last year. Darae Parktech' off-street smart parking systems are implemented at many major facilities around country: COEX, Seoul Arts Center, Seoul World Cup Stadium, KINTEX, 5 major parking lots of KTX stations, Gangnam Finance Center, Seoul Forest, Busan International Finance Center, etc. Darae Parktech is a company with more than 30-year-old experience in providing parking consulting services, that featuring automated smart parking solutions, including parking reservations, route guidance, fare collection and parking control.

Picture 22. Official visit of KCCA and FS teams to COEX Smart Parking in October, 2019

KCCA and the FS teams visited Darae Parktech's off-street Smart Parking facilities in COEX, Korea in October, 2019 to learn about their parking hardware, software and management strategies. COEX off-street parking is a large-scale fully-automated parking garage that allows for parking of 2,700 vehicles across 3 underground floor and one roof-top floor. COEX parking system incorporates real-time monitoring of vehicles from their entry to the parking lot, during

[70] Official Darae Parktech website is as follows: http://en.daraeparktech.com/ .

the parking activity and until leaving the parking premises. There is an Integrated Control Center on the premises that provides efficient monitoring and management 24/7/365, including such services as prompt response to emergency actions and customer complaints in real-time. The Control Center managers are also responsible for all parking related data management.

Picture 23. Integrated Control Center example

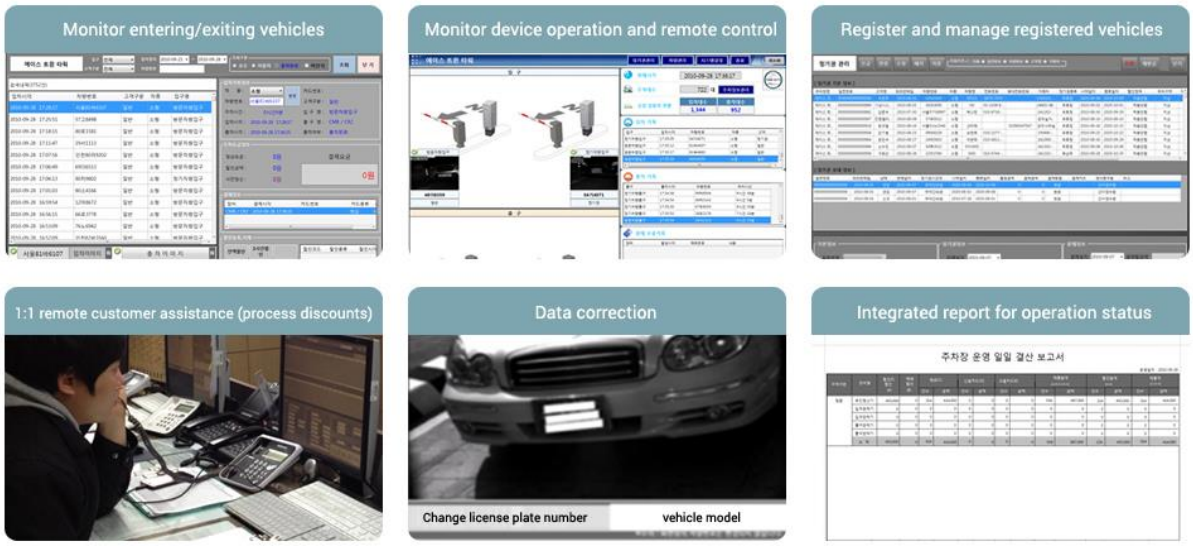


Figure 12. Working with parking data in Darae Parktech Parking System

All parking information can be easily accessed via smart phones, DMB & navigation panels in vehicles, visual management systems (VMS), traffic broadcasting, information kiosks and internet browsers. Available parking information includes: parking lots near destination, information on fees and discounts, available spaces/total parking spaces, location and distance to parking lots. Additionally, the system is designed to provide a speedy and accurate settlement for complaints due to vehicle damage by recording vehicle appearance at both entrance and exit.

COEX parking is an unmanned system. Entry and exit processes to the parking lot are non-stop provided by the LPR cameras that recognize the license plate, register it in the system and let the vehicles in and out considering all parking fees were paid.

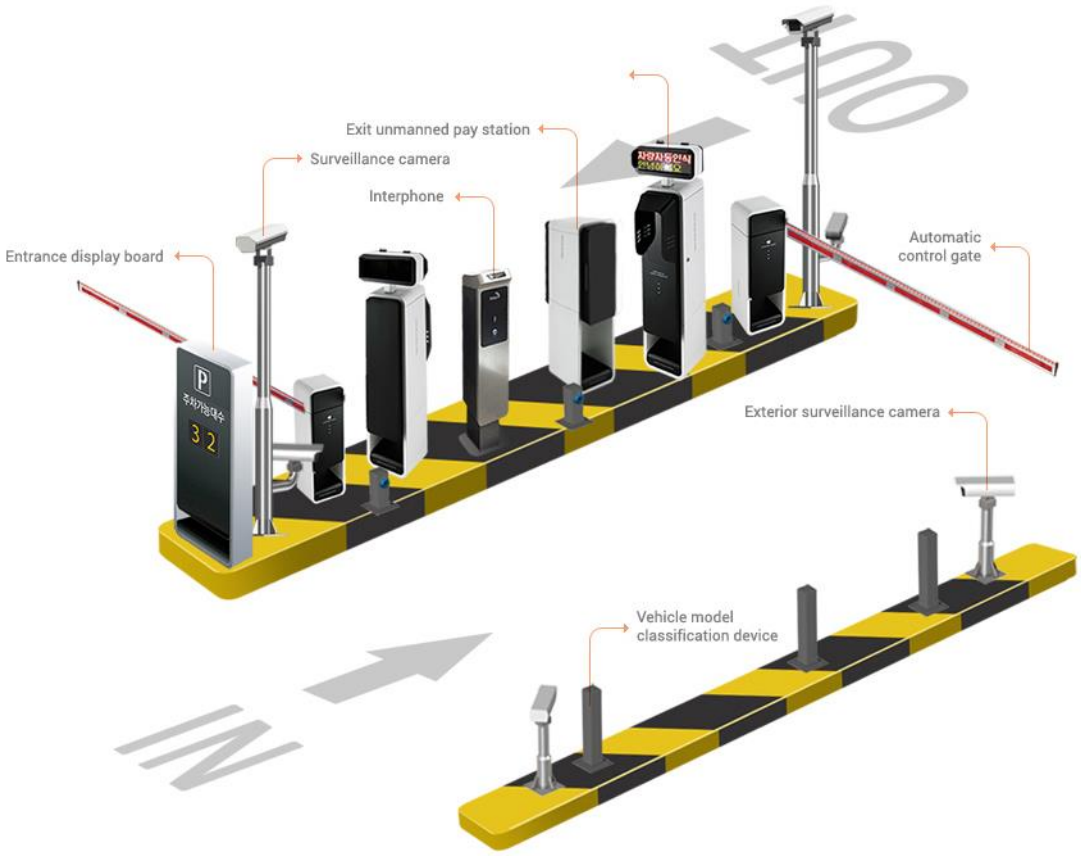


Figure 13. COEX parking entrance & exit hardware composition

The parking grounds use visual management system (VMS) hardware to provide vehicle drivers with correct real-time information on parking occupancy. There are display panels installed at the parking entrances to notify the entering driver of parking occupancy on each floor. and for a desirable district (shows spaces available for a designated area of the floor and direction). There are additional floor guidance displays installed at the entrances to each floor and notifying the drivers of the overall parking occupancy on that floor. There are guidance displays installed at entrance of each zone that show the number of the vacant parking lots and directions to them.

Picture 24. Darae Parktech entry display

Picture 25. Darae Parktech floor guidance display

Picture 26. Darae Parktech zone guidance display

To monitor and display the parking occupancy in real-time, Darae Parktech installed ultrasonic vehicle detection sensor above each parking space exactly in the middle point to detect the presence of the vehicle (the sensor color changes from green for empty and red for occupied). However, as the sensor is installed in the middle of the parking space, it might not appear visible to the vehicles entering a specific zone. Darae Parktech installed additional LED indicators at above the entry to each parking space for better visibility and navigation (LED color changes from green for empty and red for occupied).

The ultrasonic sensor recognizes only the parking space occupancy. To control what vehicle is parked in which spot, Darae Parktech installed additional cameras – one per three parking spaces – that recognize license plates and signal the Control Center of their exact location.

Picture 27. Darae Parktech parking location recognition camera

Picture 28. Darae Parktech ultrasonic vehicle detection sensor

Picture 29. Darae Parktech parking space vacancy LED

As COEX parking is a large-scale facility, information kiosks (stand-alone units) were installed to deliver information about parked car's location by inputting the vehicle's plate number. After the vehicle number's last four digits are input, the driver confirms whether the displayed vehicle is indeed his/her own and checks the displayed location information on the map.

Picture 30. Vehicle location, step 1

Picture 31. Vehicle location, step 2

Picture 32. Vehicle location, step 3

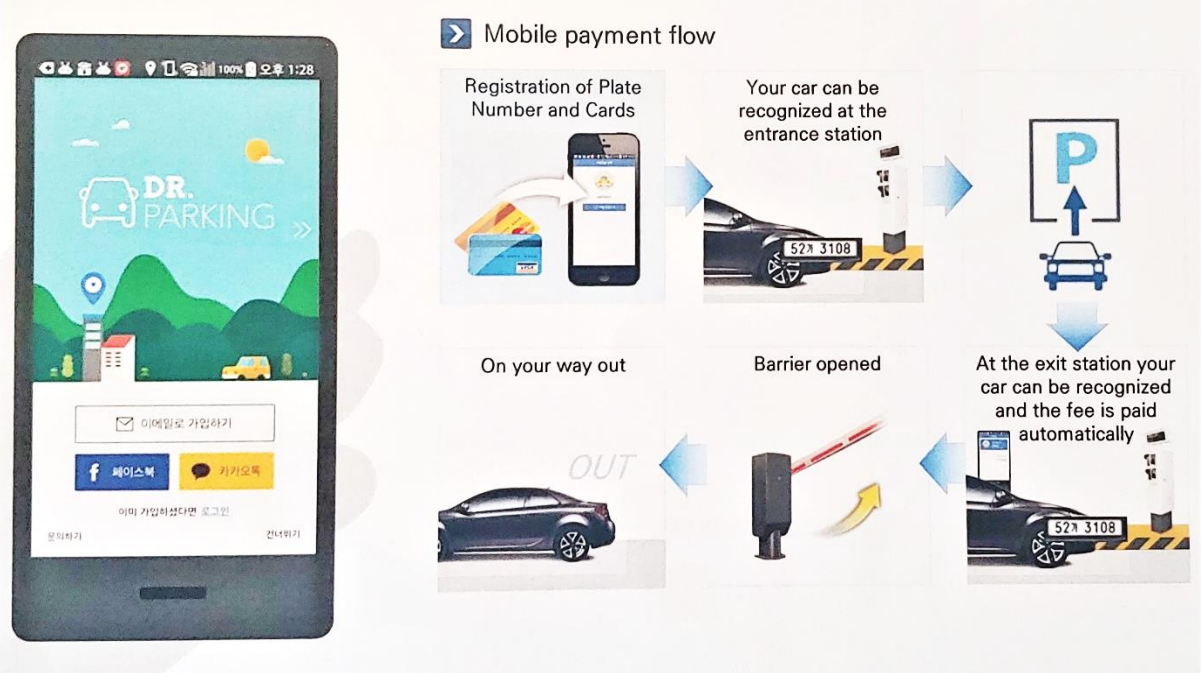
The kiosk payment system in COEX supports payments by debit/credit cards, transportation cards and mobile phone cards (the latter two options are one-touch payment methods that do not require any action apart from touching the validator with the card).

Picture 33. COEX parking fee payment kiosks

The parking fee can also be paid during exit; however, most vehicle drivers pay in advance either through kiosks or mobile parking app – Dr. Parking – that is recommended for frequent users of COEX parking facilities. Vehicle drivers need to create a user account, register their

vehicle number and add their debit/credit card details and their parking fees will be processed automatically.

Figure 14. Mobile app for COEX parking fee payments



COEX parking includes a well-established comprehensive parking fees system calculates the parking fees depending on the following criteria:

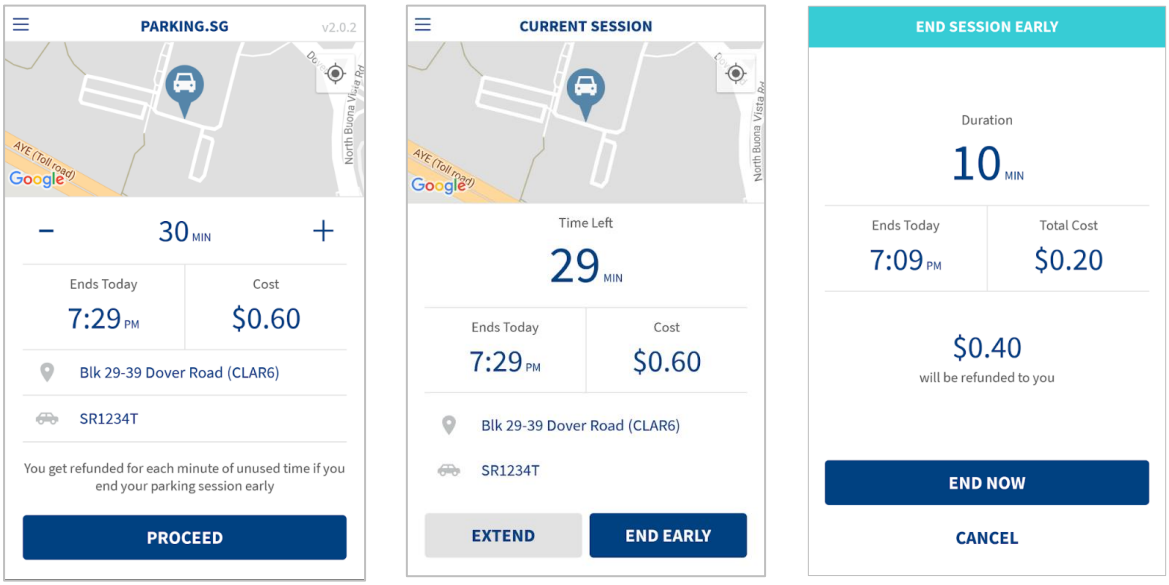
1. Parking duration;
2. Parking vehicle type (environmentally friendly vehicles receive additional parking discounts);
3. Other applicable discounts (drivers with disabilities, registered VIP vehicles, etc.)
4. Use of COEX shopping facilities (calculation of discounts based on the shopping receipts) and use of COEX facilities requiring long-stay parking, such as cinemas or aquarium (calculation of discounts based on the ticket receipt). In this case the driver can provide their license plate number at the counter when paying for his/her shopping and the shop worker will automatically register it with the parking discount system.

Darae Parktech's Smart Parking management system is considered the ideal To-Be model for any off-street garage-type parking facilities in Kampala.

4.5.4. Singapore

As one of the world's leading centers of technology and finance, the small Republic of Singapore is seeking to become the world's first true Smart City. In 2014, a systematic installation of sensors proliferated throughout the island. The data collected from this sensor network constitutes an open data platform, with the primary goal of optimizing the city's transportation system, including parking.

In accordance with the Smart Nation initiative, in 2017, Singapore rolled out its Parking.sg[71] application that is revolutionizing parking environment in the city by covering all the 1,100 public car parks in Singapore. The application is the collaboration result Urban Redevelopment Authority (URA), Housing Development Board (HDB) and GovTech Singapore. A lot of effort was made to develop the app, including extensive trials to check its efficacy in phases from May to June and from July to September, 2017 to make sure that it could withstand a high user load. About 15,000 public officers and people signed up for the trials.[72]



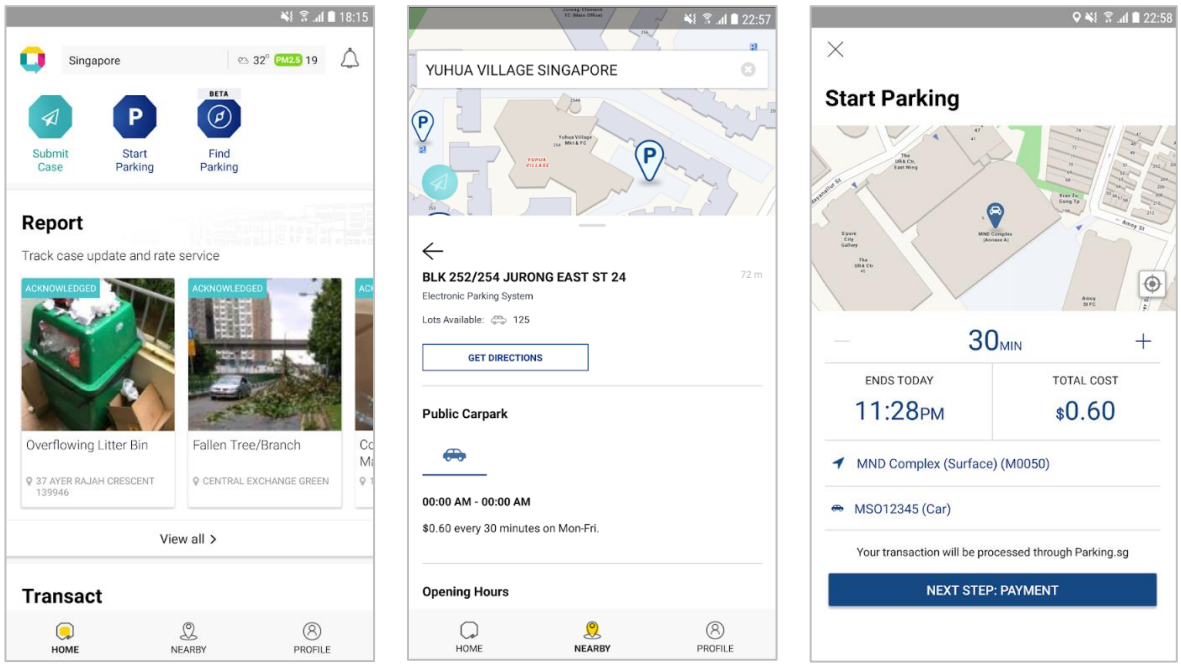
Picture 34. Singapore.sg parking app

Vehicle drivers simply enter in relevant basic information such as vehicle number, car park code, and payment info to pay for a public parking space on a per-minute basis. The app sends users notifications about meter status, and enables people to view their full parking history.

[71] Official website of Parking.sg is as follows: https://www.parking.sg/.
[72] 'Smart parking to be available in Singapore from October 1 with launch of Parking.sg app', *Connected to India*, September 29, 2017. https://www.connectedtoindia.com/smart-parking-to-be-available-in-singapore-from-october-1-with-launch-of-parkingsg-app-2815.html

Vehicle drivers can pay for the indicated parking duration via credit or debit card. Fees are based on the length of time a car is parked on a per-minute basis. The app also notifies drivers when their parking sessions expire, allowing them to extend their parking sessions remotely and to view their parking history.

The on-street parking in Singapore, however, does not include sensors. In 2019, the GovTech Singapore, URA and Municipal Services Office agreed to trial the installation of smart sensors to start providing drivers with real-time availability of on-street parking spaces. The Smart Nation and Digital Government Group (SNDGG) planned the trial of new parking service from the end of June and will be held for six months at the on-street parking lots in Telok Ayer and Temple streets.[73] Depending on the trial's outcome, the information on the availability of on-street parking spaces could be included in the Parking.sg app later. At the moment, the information from sensors is available on OneService mobile app.



Picture 35. Smart Parking in OneService app

In an effort to clamp down on illegal parking and improve traffic conditions in Singapore, the Land Transport Authority (LTA) started deploying closed-circuit television (CCTV) cameras in April, 2014 in more than 150 locations and is adding new cameras every year. After the installation of the cameras, the daily average number of summonses per location has dropped

[73] 'Parliament: Digital help for drivers searching for street parking', *The Straits Times*, March 1, 2019. https://www.straitstimes.com/politics/digital-help-for-drivers-searching-for-street-parking

by 90%. The cameras have proved effective in enforcing parking offences along roads where traffic was previously slowed down by rampant illegal parking. To remind motorists of the enforcement, zones with CCTV cameras are indicated by signs at lamp posts, such as at passenger pick-up points and congested road stretches and at MRT stations, where motorists are not allowed to wait or park there.[74]

Picture 36. CCTV cameras in Singapore

The Land Transport Authority also installed the parking location and availability signs to display the parking availability to drivers in real-time.

Picture 37. Parking Location and Availability Sign in Singapore

[74] 'CCTV and illegal parking enforcement', *Roads.sg*, Novermber 29, 2019. https://www.roads.sg/cctv-and-illegal-parking-enforcement/

5. TO-BE MODEL

5.1. Model proposal

The transformation of public parking system in Kampala requires a combination of hardware and software that could be integrated and installed seamlessly. Based on the project beneficiary profile analysis, As-Is analysis and case study analysis, the FS team concluded that a Smart Parking system based on AI and computer vision is the best cost-efficient and sustainable option for Kampala's environment. In order to differentiate between various Smart Parking systems, the proposed system shall be referred to as *Intelligent CCTV Parking*.[75]

The proposed Intelligent CCTV Parking will incorporate the process of machine vision technology, enhanced by artificial intelligence and deep learning that extracts data from video imaging. The role of the AI in the envisioned camera system is simple: each street is different and the system learns in the process to efficiently identify different environments. The proposed system will eliminate such hardware as sensors and especially parking meters, since their installation has proved unsuccessful in the past. Moreover, installation of sensors, especially in-ground, might also prove a difficult task as Kampala is in the process of improving its road infrastructure.

Figure 15. Intelligent CCTV Parking Platform proposal

Mobile app/web (for parking owners)	**Parking Management System (for KCCA)**	**Mobile app/web (for drivers)**
· Management of parking lot general information (location, fees, parking duration, etc.); · Management of information on parking lot manager/owner.	· Efficient data visualization; · Generation of reports and statistics; · Management of parking information; · Parking fees management; · System administrator information; · User information; · Settings management;	· General information on parking lots; · Navigation to the selected parking lot; · Information on the parking location; · Information on the parking fees; · Payment of parking fees.
Database		

[75] The system proposal is based on the Smart Parking technology developed by Cloud Parc INC. http://cloudparc.com/a/

1) On-street hardware

The proposed To-Be model envisions the installation of high-resolution connected cameras on light poles or buildings near the public street parking in Kampala for monitoring the street and spotting vacant parking spaces. Typically, a single camera can cover a relatively wide area and its cost is significantly lower than conventional parking meters. Using information linked to their license plates, drivers are charged directly and only for the time they are parked according to the data received from the cameras.

Additional LPR camera units are envisioned to be installed at street entry and exit points to extract the license plate numbers of the moving vehicles. The license-plate recognition camera captures and reads the license plate as the car enters the street. The plate information is passed to the monitoring camera which accurately tags this information to the right vehicle image.

Picture 38. Examples of installed monitoring and LPR cameras on the street

The Intelligent CCTV Parking also envisions installation of parking location and availability signs on entrances and exits of all roads with public on-street parking. The signs will display in real-time parking space availability and directions to the available parking.

Picture 39. Example of parking location and availability sign

Connectivity is one of the most crucial things in the envisioned system, as it will be key to communication between all components of the system.

2) Monitoring center system

The status of parking spots captured by the camera shall be monitored by the Intelligent CCTV Parking platform in real-time. The inventory of parking spots will be continuously updated as cars vacate parking spots, and the data will be continuously sent to the driver's mobile app.

Picture 40. Examples of system operator screen (1)

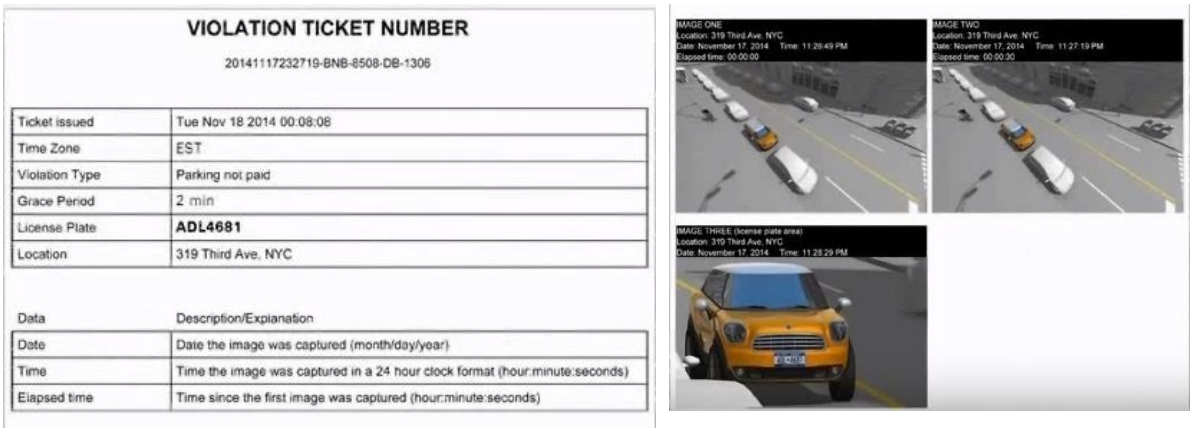
The parking process captured by the cameras and transmitted to the Intelligent CCTV Parking platform is as follows:

1. First, the installed LPR camera captures the moving vehicle, its algorithm recognizes the vehicle license plate number and passes it to the cameras that tag it to this vehicle and monitor the street (the vehicle data and the licence plate data is transferred from one camera to another one using a handoff region of overlapped views);
2. The monitoring cameras track the vehicle as it moves down the street until it parks (or leaves the monitored area);
3. When the vehicle pulls up to an empty slot, the system recognizes that this parking place is now occupied. The system then begins to record the vehicles time in this space;
4. Parking fee payment by the driver (according to the parking location, vehicle type, plate data and parking duration);
5. When the car leaves the parking lot, the system recognizes that it is vacant and updates the information in real-time to reflect it for the app users and parking management monitoring.

Parking enforcement and fee collection usually add to the cost and aggravation of municipalities. The proposed Intelligent CCTV Parking envisions for all parking fee payments to be made in the city mobile parking application. All that needs to be done is for the driver to create an account, register the vehicle license plate number and add the bank card details for faster payment. This way, when the driver parks, goes away on his business and then comes back and drives away, the system automatically calculates the parking fare and automatically deducts it from the driver's registered bank card. When the payment is finished, the program will send an automatic payment confirmation to the driver. Alternatively, mobile money payments used Uganda can also be added as a substitute payment method, depending on the negotiations with the mobile operators in Uganda.

In case, when the vehicle driver parks and leaves without paying in his app for the parking ticket, the system will automatically produce a parking ticket based on the parking duration and the vehicle license plate, and mail it to the driver.

The Intelligent CCTV Parking will charge the drivers for the exact duration of parking activity, no more, no less. Parking rates can be adjusted based on the time, on the day and if an event is taking place. This will help KCCA to increase parking revenues while reducing congestion as well as encourage vehicle drivers to use nearby spots that cost less.



VIOLATION TICKET NUMBER

20141117232719-BNB-6508-DB-1306

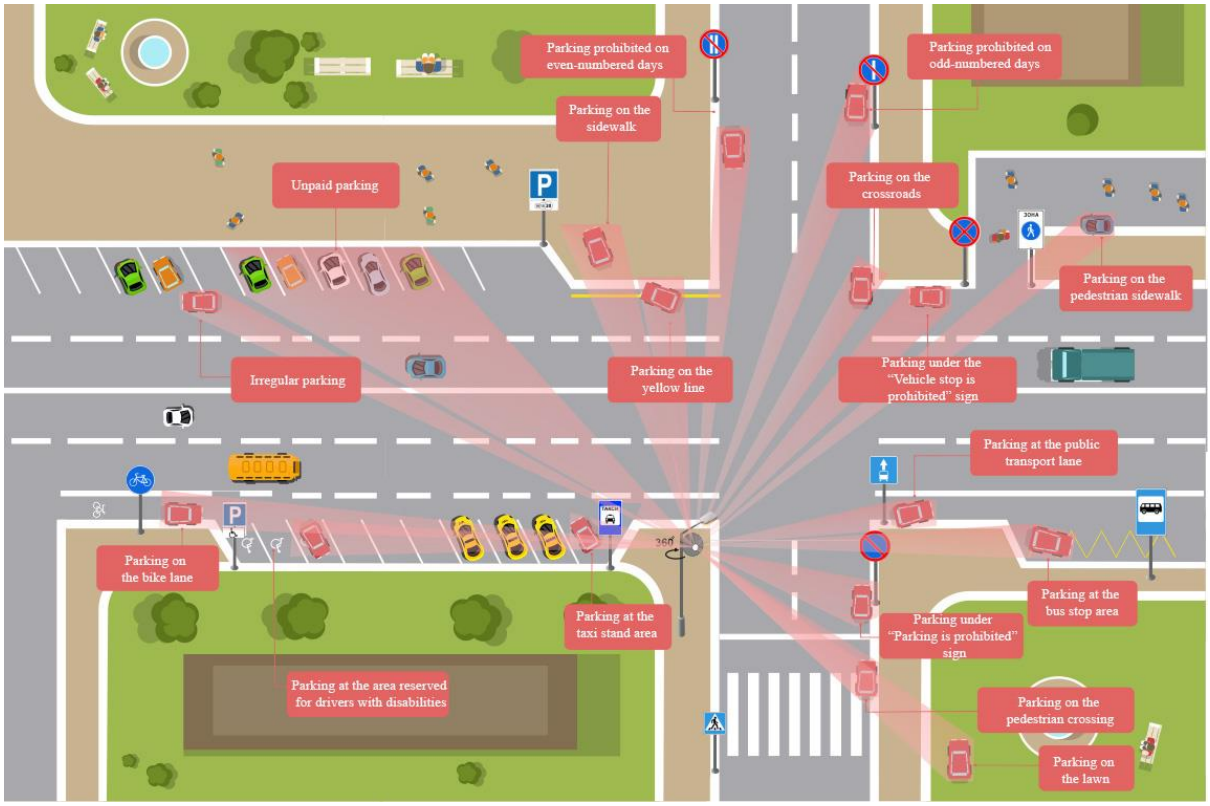
Ticket issued	Tue Nov 18 2014 00:08:08
Time Zone	EST
Violation Type	Parking not paid
Grace Period	2 min
License Plate	**ADL4681**
Location	319 Third Ave, NYC

Data	Description/Explanation
Date	Date the image was captured (month/day/year)
Time	Time the image was captured in a 24 hour clock format (hour:minute:seconds)
Elapsed time	Time since the first image was captured (hour:minute:seconds)

Picture 41. Parking violation ticket example

The system will also analyse and detect parking violations and signal these violations to the authorities automatically. It is important to monitor all major violation types in real time, as even a single vehicle parked incorrectly can cause a traffic jam. Furthermore, vehicles parked in violation with the municipality rules and regulations contribute to insecure environment not only for other vehicle drivers, but also pedestrians.

Figure 16. Traffic violation monitoring



3) Mobile application

The vehicle driver application will provide the standard functions to ensure seamless and efficient parking experience in GKMA. Drivers will be able to locate empty parking spots and use the navigation function to get there using the fastest route available. After the parking process is completed, drivers will be able to pay for their parking either by registering their bank card or through mobile payment.

In the future, an additional function for owners of private car parks can be added, which will allow them to register their car parks in the system and open them for vehicle drivers looking for vacant spaces in the city. This will promote inclusion of private parking in the city and help alleviate congestion by providing additional parking spaces.

5.2. Expected benefits

The proposed Intelligent CCTV Parking model is expected to ideally meet the needs of KCCA, Kampala vehicle drivers as well as city residents and visitors. By analyzing the data received

from the cameras on parking availability, usage and trends, the KCCA officials will be able to determine best where more parking spots are needed and which direction can the parking facilities expand. In the long-run, the proposed system is expected to offer the following benefits:

1. Reduce the investment necessary for hardware installation and maintenance (no need for sensors and costly parking meters);
2. Reduce the amount of time to find parking by providing efficient mobile parking application services and installing parking location availability signs;
3. Improve customer experience by facilitating more efficient, faster and easier parking process;
4. Increase city revenue by providing automated billing and collection processes (work toward providing dynamic pricing to maximize parking revenues and subsequently reduce congestion);
5. Enforce parking fee payment through efficient monitoring of vehicle license plates and issuance of violation tickets including the snapshots of the parked vehicle and related parking information;
6. Enforce public parking safety by monitoring the entire public parking environment through installed CCTV cameras;
7. Contribute to the greenhouse gas emission decrease by reducing the time spent driving around in search of a vacant parking place.

6. PILOT PROJECT IMPLEMENTATION

6.1. Project rationale

The goal of implementing this pilot project was to assess the KCCA and Kampala's readiness to transition to a large-scale Smart Parking project for public parking facilities in Kampala as envisioned by the To-Be model. The As-Is analysis introduced the overall parking environment in Kampala and identified that even though off-street parking facilities in the city require innovation to solve their parking problems, the most urgent and pressing issue is on-street parking management.

As a result, a small-scale off-street project was advised, as on-street parking in Kampala covers a very large area that is managed by a single operator making it not suitable for a small-scale project implementation. Introducing a pilot project for just one segment of the on-street parking would have only created confusion among vehicle drivers looking to park on the streets of Kampala. The FS team concluded that starting with a small project off-street is usually the best approach for Smart Parking beginners as it reduces the risk of irreversible mistakes. Building upon a pilot project by growing it step-by-step will ensure a sustainable Smart Parking infrastructure in the future.

The proposed Intelligent CCTV Parking Monitoring System meets all requirements of a small-scale off-street Smart Parking pilot project due to the following factors:

1. *Easy to deploy* as cameras avoid all unnecessary construction efforts (i.e. installation of sensors onto the parking ground surface);
2. *Cost efficient* (considering project budget) as a single camera can cover up to 250 parking spots depending on its installation height and view angle;
3. *Flexible* as the system can adapt to any changes in the environment and is compatible with any other AI enhancement modules Smart Parking algorithms like LPR;
4. *Increases security* as the officials can use the video feed to observe uncommon behaviour in the parking lots (i.e. illegal gatherings at night, suspicious behaviour next to a car, illegal parking).

KCCA Headquarters off-street parking grounds were selected for the pilot project implementation due to their proximity to KCCA itself, as this allowed for a simpler hardware

installation process under direct supervision from KCCA officials. Moreover, the proximity also ensures efficient system operation, monitoring and maintenance.

6.2. Project site analysis

The following table summarizes the results from the environment analysis of KCCA Headquarters off-street parking grounds.

Table 23. Pilot project site analysis

Factor	KCCA Headquarters off-street parking grounds
Location	Kampala Capital City Authority Headquarters
Ownership	KCCA
Parking structure	Visually divided into 3 areas
Parking ground	Asphalt, relatively good shape
Parking lines	Available, marked with yellow paint
Parking angle	90°
Parking space size	Approx. 5m x 2.5m
Parking capacity	Approx. 60 in front of the KCCA main building; Approx. 70 in front and behind of the KCCA Physical Planning and Land Transactions Client Care Centre
Entrance/exit	One (combined), security personnel present
Parking hardware	N/A (no parking barrier, steel gate at the entrance/exit point)
Parking facilities	Parking spaces for executives have shades
Parking fees	N/A
Parking demand	Does not meet supply at peak times
Peak time	Daytime (exact time cannot be identified due to lack of statistical data)
Environment	Abundant vegetation (mostly high-rise trees), several parking shades for designated parking spaces

The parking grounds can be visually divided into two separate areas – area 1 and area 2 – as seen from the following picture. The FS team selected area 1 for parking environment monitoring as this area is relatively well-visible from above and there are not many objects obstructing the view of the pilot project CCTV camera (the project originally envisioned installation of one camera). KCCA Library & Information Centre building was selected for the CCTV camera installation as it offers best visibility over the parking spaces in area 1. In addition to that, the camera installation site is visible from KCCA Traffic Control Centre. Furthermore, Area 2 was avoided during the selection as KCCA allocated it for the construction of a new building that will be used by the relocated Traffic Control Centre.

Picture 42. Satellite view of KCCA Headquarters off-street parking grounds

Picture 43. KCCA parking area 1 view from KCCA Library & Information Centre building

6.3. System hardware

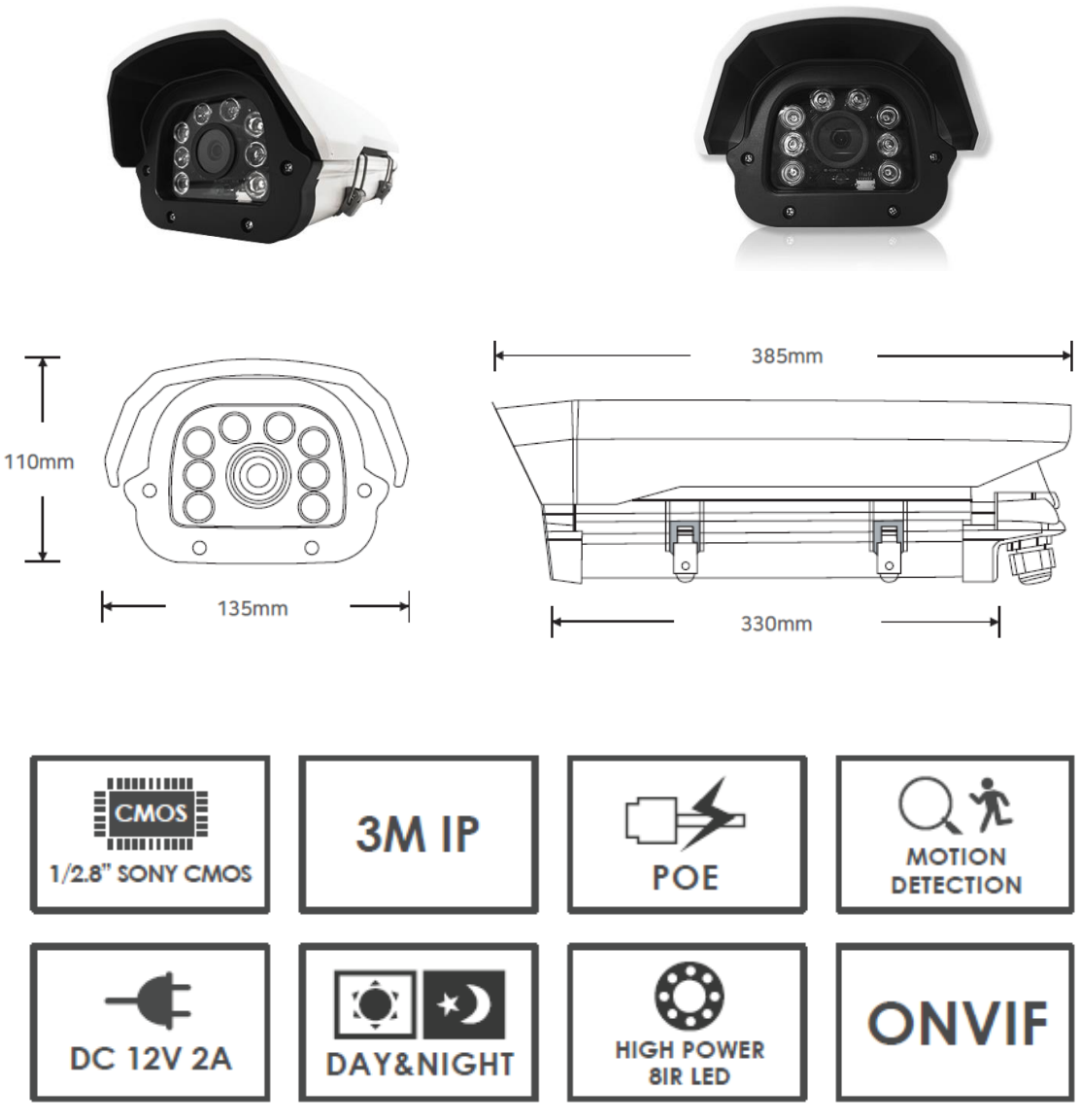
The following Intelligent CCTV Parking Monitoring System hardware was installed at two locations: KCCA Traffic Control Centre and KCCA Library & Information Centre.

Table 24. List of pilot project hardware

No	Item	Qty	Installation site	Image
1.	CCTV (IP camera)	1	KCCA Library & Information Centre	
2.	Server	1	KCCA Traffic Control Centre	 (default picture, actual photo N/A)
3.	Monitor (24 inches)	1	KCCA Traffic Control Centre	
4.	Keyboard & mouse	1 & 1	KCCA Traffic Control Centre	Typical keyboard & mouse (actual photos N/A)
5.	DVR (Digital Video Recorder)	1	KCCA Traffic Control Centre	
6.	PoE (Power of Ethernet)	1	KCCA Library & Information Centre	 (default picture, actual photo N/A)
7.		1	KCCA Traffic Control Centre	
8.	WAP or Wireless AP (Wireless Access Point)	1	KCCA Library & Information Centre	
9.		1	KCCA Traffic Control Centre	
10.	Control box	1	KCCA Library & Information Centre	

The most important item in the hardware list is the CCTV camera. The model used for this pilot project is JMotive CCTV; JMT-P300H-8B28. This is a high-resolution camera that can cover a relatively wide area without losing the image quality both day or night. Full technical description of all pilot project hardware will be included in the System User Manual and submitted to the beneficiary government during the trial period.

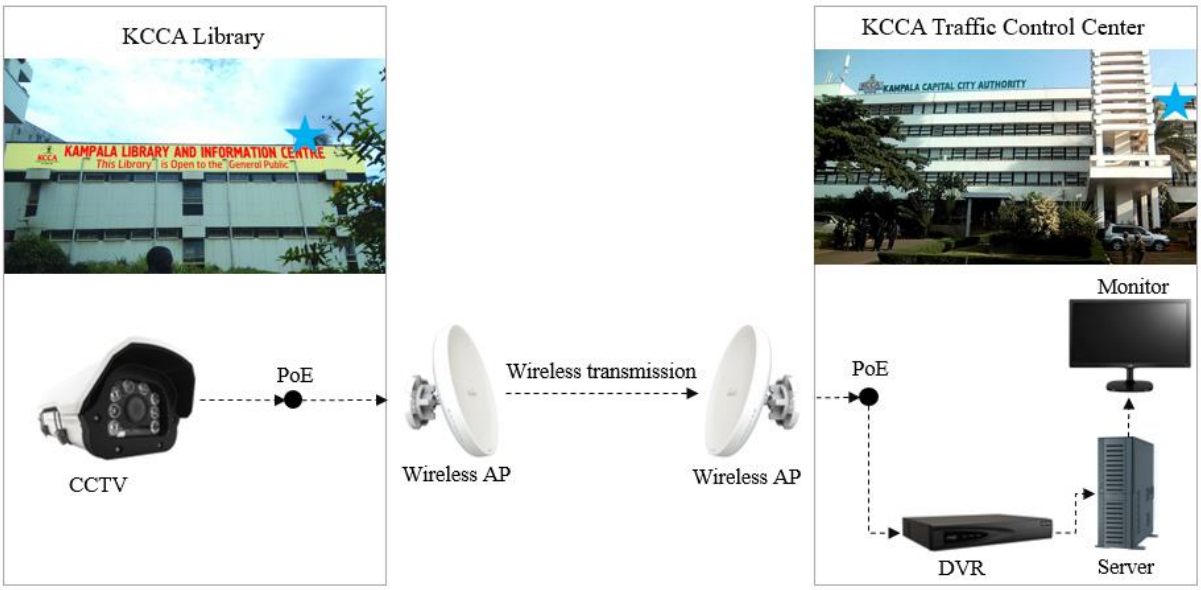
Figure 17. CCTV camera characteristics overview



There are power generators installed on the KCCA premises that will provide necessary power in emergency cases, so the power outage is not considered a serious problem for the hardware and software functioning.

The following figure is the hardware installation scheme visually outlining the hardware installation location and data stream direction.

Figure 18. System workflow



The parking lot image data received from the camera is transferred via wireless access point (WAP) installed at the KCCA Library & Information Centre to the digital video recorder (DVR) via wireless access point (WAP) installed at the KCCA Traffic Control Centre. The WAP accomodates heavy traffic, facilitates ability to access real-time information services and is ideal for hard-to-wire and frequently changed environments such as Kampala. The DVR facilitates centralized management of the CCTV camera, including configuration, information import/export, real-time information display, two-way audio, upgrades and more. It allows for instant playback for assigned channel during multi-channel display mode, smart search for the selected area in the video; and smart playback to improve the playback efficiency.

The following pictures illustrate the hardware installation process at both locations. System hardware was installed during the 2nd official visitation under supervision of KCCA Engineering and Technical Services Team who actively participated in the process.

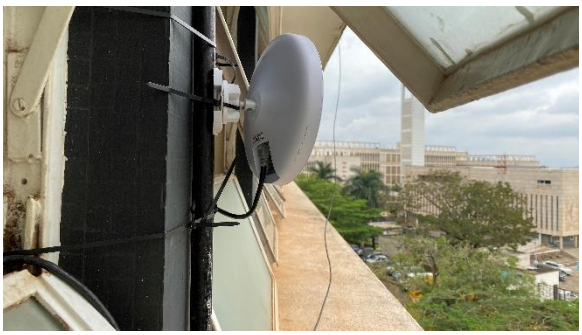
Picture 44. Installation of hardware at KCCA Library & Information Centre

Picture 45. Control box (KCCA Library & Information Centre)

Picture 46. Finished installation of hardware at KCCA Library & Information Centre

Picture 47. Installed hardware as seen from the KCCA Traffic Control Centre

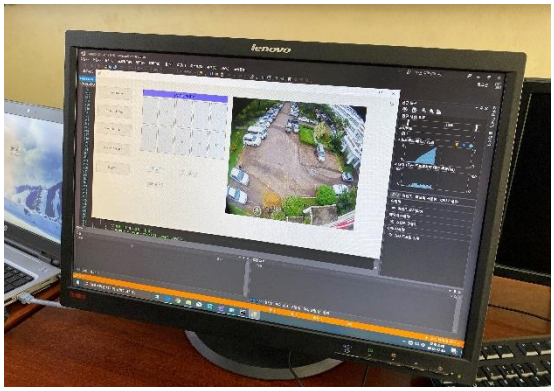
Picture 48. In the process of installing hardware at KCCA Traffic Control Center



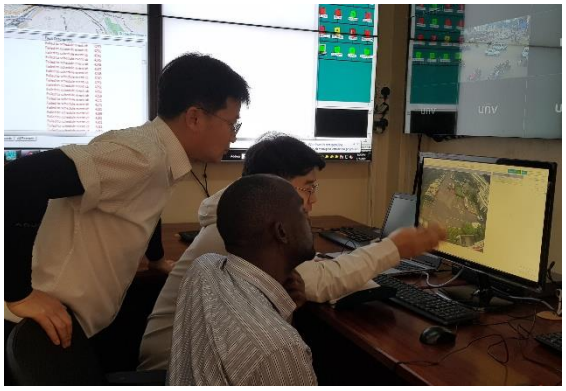
Picture 49. Wireless AP at the KCCA Traffic Control Center

6.4. System software

The system software development and installation were completed during the 3rd visitation based on the image data collected during the 2nd official visitation.

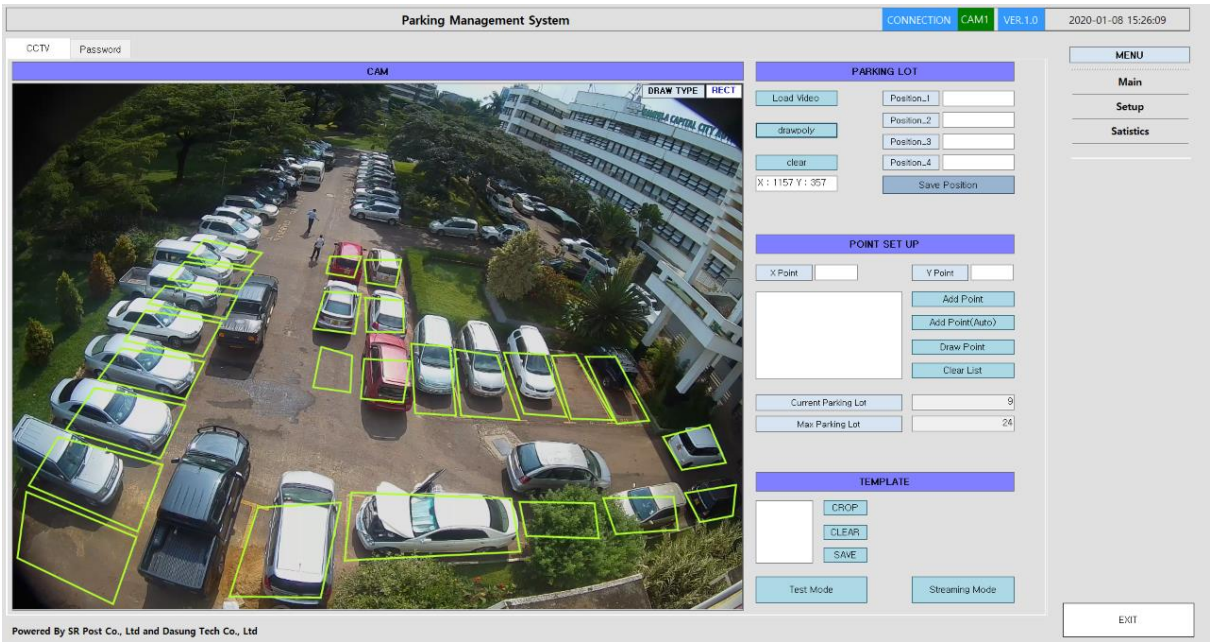


Picture 50. Installation of system software



Picture 51. The FS team at work

There are two important system setup modes. The first mode is where the system administrator can define parking spaces on the image itself by joining four corner points of the parking space. The image below illustrates the parking setup page with the finished outline of parking spaces in the system. Currently, the administrator cannot modify a single parking space (all must be selected from start again) after the parking space allocation and selection process is completed.



Picture 52. Defining of the parking spaces in the system

The following screenshot illustrates the "image preprocessing" mode. This is the actual image that is processed to analyze the parking occupancy. The parking spaces are viewed as

preselected values that are displayed as boxes on the screen. Boxes with red contours stand for spaces that are recognized as vacant. The image below is a test-run screenshot and depicts several recognition errors, as it was taken during the system test-run.

Picture 53. Parking image preprocessing mode

The system source code is the intellectual property of the FS implementation team and cannot be disclosed to the beneficiary government.

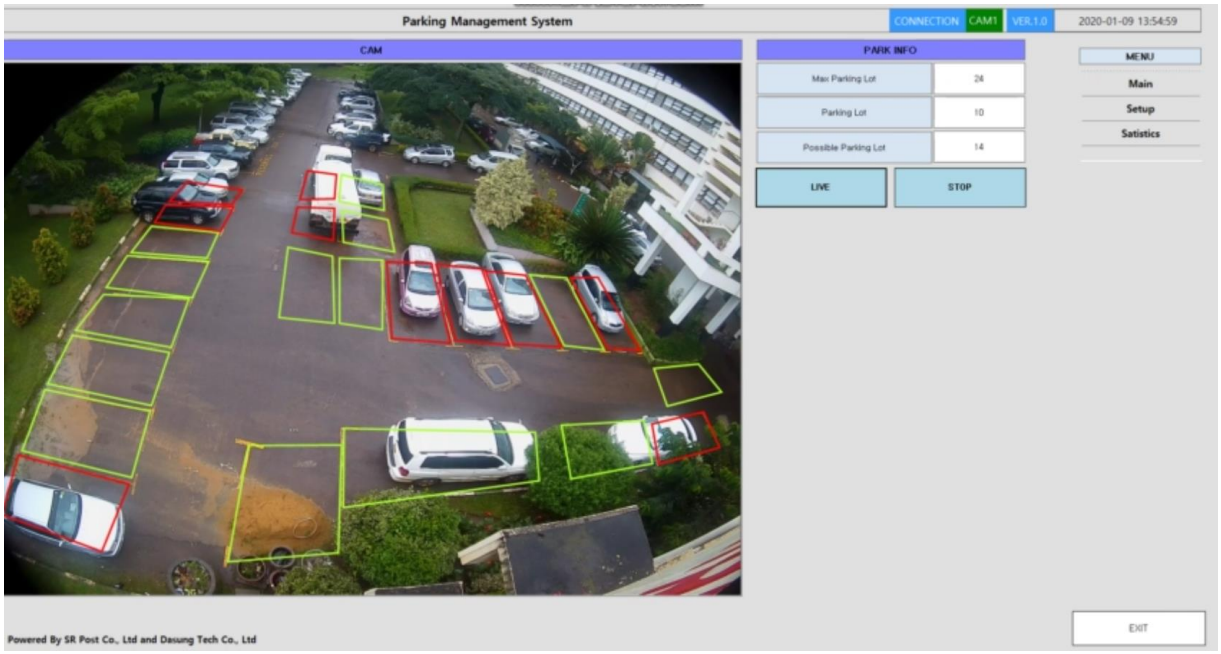
6.5. Project test-run

Currently, the installed camera can successfully monitor up to 30 parking spaces as it is installed right in front of the parking area at a very low building. In order for the camera to monitor all parking spaces in Area 1, it has to be installed much higher and no objects (in present conditions trees obstruct the vision) should block the view. As long as the camera is installed at a distance, high enough to oversee the entire grounds and receives a clear image, it will successfully recognize whether the parking spaces are occupied or vacant.

The image below illustrates the running system – the parking spaces marked with bright green lines indicate empty parking lots, the parking marked with red lines indicate occupied parking lots. The test-run system analyses occupancy of 24 parking spaces. The results of the occupancy are showed on the right: during the first test run the system recognizes that 15 out of 24 spaces

are occupied and 9 are vacant. Some recognition error is due to absence of clear parking lines on the parking lot, thus cars do not necessarily park within the lines set up in the program.

Picture 54. System test run (1)



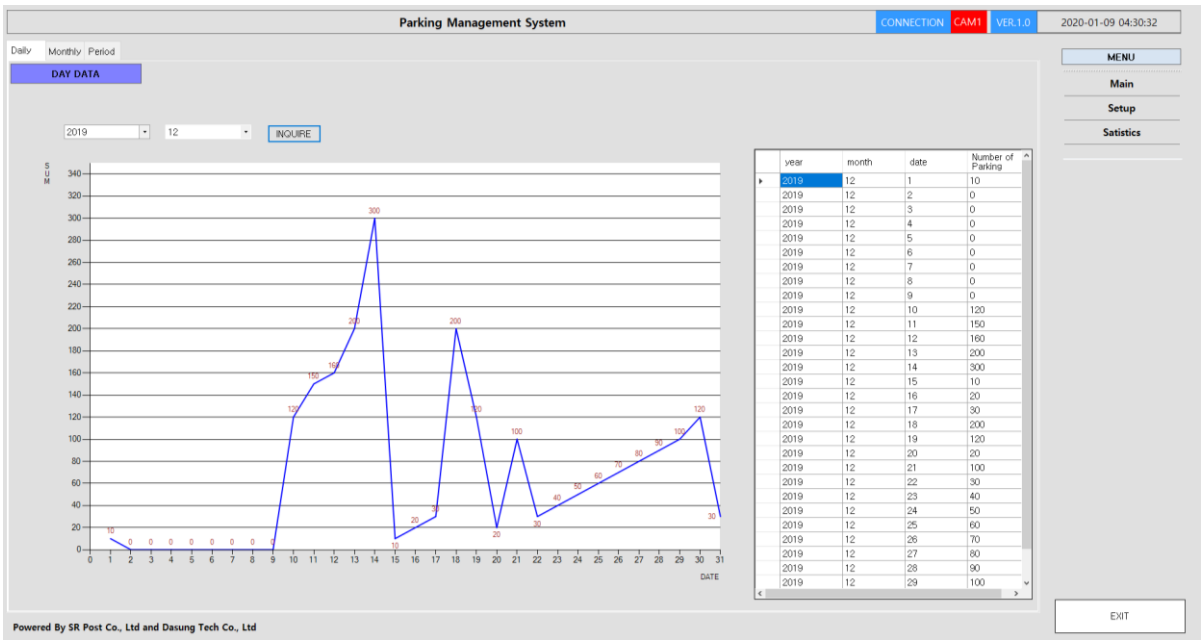
Picture 55. System test run (2)

The parking occupancy results for the second test run are as follows: 10 out 24 parking spaces are occupied and 14 are vacant. Here we can witness another type of the recognition difficulty:

a huge truck in the top of the screen occupies 2 parking spaces. Thus, parking occupancy does not necessarily equal the number of vehicles.

The FS team concluded that at the moment the camera can cover up and successfully recognize approximately 30 parking spaces with minimum recognition error. The camera cover area depends on the height of installation (the KCCA Libarry building is relatively low) and presence/absense of objects obstructing the vision. Shall the camera be installed higher, it will be able to cover more parking area.

The system generates statistics on overall parking count (total parked vehicle count per given timeframe) per day, month or preselected period of time. The screenshot below illustrates the parking lot occupancy graphs for each day of December, 2019. Additional statistics generation is subject to request, negotiations and possibility of implementation within the FS funding.



Picture 56. Generation of daily parking data

6.6. Functions

The installed Intelligent CCTV Parking Monitoring System analyzes KCCA Area 1 parking occupancy in real time, displays total count of parked vehicles and vacant spaces and provides overall parking lot occupation statistics for a preselected period of time. The addition of LPR to the pilot project was not envisioned due to funding constraints.

During the training session, KCCA Engineering and Technical Services Team submitted several system function enhancements requests that will be reviewed and enacted during the system trial period. The requested functions include:

1. Function 1: allocation of name to a specific parking space;
2. Function 2: statistics per single parking space;
3. Function 3: modification / addition of a single parking space.

6.7. Trial period

The Intelligent CCTV Parking Monitoring System will analyze the parking occupancy in real time for the preselected parking spaces in Area 1 – how many vehicles currently are parked and how many parking lots are vacant – and provide overall parking lot occupation statistics for a preselected period of time. During the maintenance year, the FS team will focus on understanding:

1. The fitness of use and or satisfaction of the requirements of end-users (KCCA);
2. The best way of adding additional parking lot marking features, i.e. assign names to the predefined parking lots;
3. What additional statistics can be added for the administrator, i.e. parking lot occupancy for per slot, duration;
4. The best angles for CCTV to capture more parking spaces (as the installed camera can cover a much wider area if installed higher and if vegetation obstructing its vision can be removed);
5. The configurability of the system (understand what additional AI algorithms can be added to enhance the existing system, i.e. license plate recognition algorithm);
6. The scalability (the ability to continue to function well when it is expanded in scope) and stability (or the ability to perform and function under load).

The FS team will be remotely monitoring the system's performance and parking statistics on a monthly basis from Korea. Group conference calls will also be held on a quarterly basis to follow up on the project performance and handle and resolve all issues, if any shall arise.

7. PROJECT DEVELOPMENT ROADMAP

7.1. Roadmap overview

Starting with a small-scale off-street project is usually the best approach for Smart Parking beginners as it reduces the risk of irreversible mistakes. Building upon a pilot project by growing it step-by-step will ensure a sustainable Smart Parking infrastructure in the future.

The core stages of growth from a small Smart Parking project to a comprehensive system implementation – the Smart Parking development roadmap – are explained in the following figure. KCCA took the first step into the right direction by starting the Smart Parking development with a feasibility study to identify issues that have to be resolved, study the environment and implementation of a Smart Parking pilot project on its premises.

Figure 19. Roadmap overview

Strategy & scope	Pilot project	Preparation to scale	Scale	Evolve
Analyze As-Is environment	Implement pilot project	Departmental reorganization	Scale to all public parking in Kampala	Monitor performance
Identify issues to be resolved	Refine processes	Regulatory reform	Introduce new public services	Adjust service parameter if needed
Define the To-Be model	Test network performance	ICT level strengthening	Integrate parking with city dashboard	Improve system maintenance
Define required outcomes	Understand installation needs	Increasing public awareness		Share leanings with other cities
Define stakeholders and project cost	Generate test data	Stakeholder engagement	Generate big data	Analyze big data

The next step – preparation of system to scale – is discussed in detail in the following subchapter. The third and fourth subchapters on the last two steps – scale and evolve – provide a more general overview.

7.2. Preparation to scale

7.2.1. Departmental reorganization

The F/S team concluded that KCCA has a successfully functioning government structure that would benefit from a small-scale departmental reorganization. KCCA should focus on establishing a Department (Directorate) of Transportation to centralize efficient maintenance and development of Kampala's transportation system and infrastructure as well as smooth transition to and efficient management of all future Smart Parking ecosystem aspects. The new Department of Transportation should take responsibility over the following aspects:

1. City public transportation system management;
2. City transportation infrastructure management (*parking facilities included*);
3. Development and enforcement of transportation laws, rules, regulations and policies;
4. Vehicle registration and driver licensing;
5. Strengthening of ICT level;
6. Development of robust financial ecosystem;
7. Provision of public access to all information related to city transportation.

The new Department of Transportation will be in charge of KCCA Traffic Control Centre. The Traffic Control system should ideally employ not only traffic control managers but also team up with Uganda National Police and Medical Emergency services, who would be responsible for law enforcing and emergency situations. In the long-term, KCCA Traffic Control Centre should monitor road traffic, public transport operation and public parking facilities in real-time 24/7/365, provide prompt response to emergency situations, solve traffic-related difficulties as well as forecast traffic using big data analysis.

The FS team proposes TOPIS (Seoul Transport Operation and Information Service) – an intelligent transportation system used by Seoul Metropolitan Government from 1998 – as the best case-study for KCCA. Over the years TOPIS proved to be extremely efficient in solving Seoul transportation problems, providing 24/7 transportation monitoring and managing of emergency situations.

7.2.2. Regulatory reform

1) Revision of parking rules and regulations

KCCA Department (Directorate) of Transportation is advised to envision a comprehensive parking rules and regulations act to facilitate the transition of parking services to Smart Parking. The FS team proposes to implement a new parking fare system that would consider the following three categories:

1. Parking type: very short time (up to 30 minutes), short-term (1h-2h), medium-term (2h-4h), long-term (8h+), subscription (parking pass);
2. Vehicle type: motorcycle, car, large vehicle, public transport, etc.;
3. Discount eligibility: no eligibility (regular fees), drivers with disabilities, women, economy cars, low-emission vehicles (LEV), shopping receipts/event receipts from adjacent shops/places, etc.

The new parking fare system should also clearly outline parking regulations for all public parking spaces, since specific regulations can increase/decrease parking of certain vehicle groups, i.e.:

1. Specify all vehicle types that are allowed to park (i.e., no trucks are allowed);
2. Specify minimum and maximum parking duration (i.e. minimum 1h parking to avoid short-term vehicles such as deliveries);
3. Specify parking opening hours (i.e. no parking before 9 am and after 9 pm as all adjacent shops/places work between 9 am - 8 pm);
4. Specify employee parking spaces;
5. Specify special restrictions (i.e. parking is closed first Sunday each month for maintenance and cleaning);
6. Specify clear rules regarding removal of inoperable or abandoned vehicles, vehicles without a parking pass/parking ticket, etc.;

The Department should envision an act describing in detail the rules and regulations for developing on- and off-street parking facilities in Kampala. The following aspects are advised to be taken into consideration:

1. *Parking lot design*: Optimize the parking area space and define a clear perimeter. The FS team recommends using rectangular areas and making the long sides of parking areas parallel. Design the parking so that parking spaces are located along the lot's perimeter. It is also recommended to pay special attention to the flow of vehicles in and out of the parking lot.

2. *Parking ground construction preparations*: Prepare the implementation site with minimum damage to city's green environment.
3. *Parking ground base construction*: The FS team recommends an asphalt concrete base as it will greatly reduce the potential for problems related to water strength and stability. It is also recommended to focus on drainage provision as it should be carefully designed and installed early in the construction process.
4. *Parking angle and parking space dimensions*: The FS team recommends a 90° angle, as it provides the most parking spaces for a given area. The parking space dimensions shall vary according to vehicle type.
5. *Parking lot markings*: Markings are a crucial element of a good Smart Parking lot. The parking area should be clearly marked to designate parking spaces. Traffic flow markings should also be marked for directing the vehicle movement. The markings will last longer on asphalt concrete base.

The Department is also advised to to install additional CCTV cameras at public on- and off-street parking facilities and connect them to the KCCA Traffic Control Centre. This will facilities procuring of the information on accidents and crimes, vehicle speeds and adherence to parking rules, which will in turn provide a safe parking experience in the city.

The FS team also proposes Seoul CCTV Integrated Control Center – a control center monitoring Seoul city public spaces – as the best case-study for KCCA. Among other functions, Seoul CCTV Integrated Control Center plays a crucial role in enforcing parking rules and regulations. The center monitors illegal parking activities by recognizing the illegal parking event, detecting and recognizing the vehicle number plate and then taking a snapshot to redirect to the authorities, who later issue a parking fine to the vehicle owner. Seoul Metropolitan Government operates the Integrated Control Center under close cooperation with the district offices, police and fire departments.

2) Vehicle registration and driver licensing

Currently, there are no comprehensive guidelines or explanations on vehicle registration, driver licensing or vehicle number plate types available for public use or study purposes in Uganda. The FS team concluded that a comprehensive research on vehicle number plates in use in Uganda is necessary in order for the future LPR cameras to operate smoothly.

It is also necessary to understand whether the Government of Uganda is considering to change vehicle number plate format to a unified new security embossed number plate format as this will simplify the LPR technology introduction in Uganda.

7.2.3. ICT level strengthening

KCCA is expanding rapidly and as city population increases, the pressure on the city's infrastructure increases. In order to create a successful Smart Parking infrastructure in the future, it is necessary to strengthen the city's ICT level.

First, KCCA is recommended to focus on development on talent and skills, necessary for implementing an efficient Smart Parking ecosystem. Possible ways of fostering such talent might include investing in transportation related education, training of municipality officials by sending them overseas to visit best Smart Parking examples, providing ICT literacy training to municipality officials.

Furthermore, the Government of Uganda should consider fostering talent that would carry out research in subjects related to Smart Parking. As vehicle number plate recognition is one of the most crucial elements of Smart Parking, it is important to support work on developing an effective automatic number plate recognition for Ugandan transportation vehicles.

The FS also recommends for KCCA to take leadership in driving 5G adoption in Kampala to facilitate faster and more convenient Smart Parking experience in the future. Good internet connection is vital as Smart Parking solutions provide parking availability status to vehicle owners through an app. Typical solution require users to update their requirements at any given time on the app following which the system will reflect the current occupancy status of the parking spaces. The system can also update the user about the prevalent parking rates at the designated spot, and allow them to reserve the parking using mobile payment.

7.2.4. Increasing public awareness

It is important that all transportation-related policies, laws, rules and regulations, real-time information be clearly indicated to Kampala citizens. In case of Smart Parking, by providing timely information, KCCA will improve vehicle owner experience and service quality by providing comprehensive information on all public parking lots, related parking rules and regulations.

In future, it is recommended to create an official mobile app for the KCCA Department (Directorate) of Transportation that will not only provide information on public parking, but also lay down details of various public transport modes including taxi and buses in the city. Ideally, the future app will provide information on the various routes, connecting key locations, availability/frequency/transport schedule, time estimates, and fare details.

Moreover, it is also recommended to create a separate page for the future Department on the KCCA official website where citizens of Kampala could check all the relevant information. In addition, the municipality should focus on marketing and introducing Smart Parking system to the citizens beforehand to familiarize them with the concept.

7.2.5. Stakeholder engagement

Smart Parking ecosystem development requires not only talent, but significant funding and investment, which the local government cannot provide alone. It is recommended for KCCA to keep up the good job they are doing now by promoting entrepreneurship, encouraging private sector participation and attracting foreign investment. Possible actions that KCCA can undertake might include promoting digital payments for parking, promoting local public-private partnerships (tendering and encouraging participation by providing incentives and relaxing entry).

KCCA is also encouraged to look into foreign investment opportunities, i.e. participate in intragovernmental programs (e.g. WeGO Smart City Feasibility Study), create international partnerships with private Korean companies and apply for Korean government funding schemes (e.g. SRPOST and Kampala Capital City Authority, Uganda's cooperation on implementation of an integrated Civic Participation System), tracking various ODA and FDI application opportunities. It is important to continue fostering the cooperation between KCCA and the World Bank in Uganda, as WB representatives are increasingly interested in exploring Smart Parking development opportunities.

In addition to that, KCCA is also recommended to learn more about Seoul's transportation policies, energy policies, water supply policies, urban planning policies and urban safety policies, as they all are directly or indirectly connected to Smart Parking planning. For example, as Smart Parking is a parking strategy that combines technology and human innovation in an effort to use as few resources as possible – less fuel, time and space – it is necessary to develop policies for environmental protection (promote green transport).

Seoul Metropolitan Government launched "Seoul's Policy Sharing Initiative" with aim to provide capacity building programs, policy consulting and knowledge sharing. This initiative is closely monitored by WeGO, and KCCA officials are encouraged to participate.

7.3. Scaling up

7.3.1. Scale up

Scaling up the pilot project means launching live, integrated smart parking services in Kampala that will cover all public on-street parking currently managed by Multiplex. The actual system will be infinitely scalable, enabling to expand the public parking to all the streets of Kampala.

7.3.2. Integration with city dashboard

As the main goal of Smart Parking system is to improve the operation efficiency of public parking, which is achieved through the collection of constant and accurate data on parking occupancy, the collected data has to be analyzed and provided to the KCCA parking management officials through suitable dashboards. In the long-run, it is important to integrate all public parking data with other city data to create a comprehensive smart city monitoring dashboard for the KCCA executives to enable better urban management.

7.3.3. Introduction of new public services

Not only is it necessary to educate the public if Kampala in the new Smart Parking services by providing timely information on how to use the system and its importance, but it is also necessary to think about expanding public services related to public smart parking in the city. For example, KCCA might utilize the city parking application and create push notifications about various city events, new parking spaces created, etc.

7.4. Evolving

7.4.1. Performance monitoring

In order to monitor the Smart Parking system performance, KCCA should make an effort to regularly receive and provide feedback to all involved stakeholders, document parking successes and gains as well as losses if such arise, put in place clear accountability and governance structures. Furthermore, KCCA should obtain feedback from the service users –

the vehicle drivers in Kampala – to understand public sentiments toward the new public Smart Parking services. All this information will help KCCA understand system constraints for future modeling and scaling up.

7.4.2. Adjustment of service parameters

The process of evolving Smart Parking services in Kampala will also involve service adjustment, which should be based on the feedback provided by system users and statistical data provided by the parking management system. For example, parking prices can be readjusted depending on the statistical data on parking lot occupancy. Another example service adjustment is adding of additional parking app functions upon public request.

7.4.3. Improving maintenance

One of the final steps toward seamless Smart Parking system operation in Kampala should be KCCA's efforts toward improving system maintenance. The system performance should be closely monitored, all hardware condition routinely checked and all relevant system documentation updated in a timely manner.

7.4.4. Share learnings

KCCA is encouraged to share their process of transitioning to Smart Parking with other cities and countries. The willingness to share data and experience will promote intragovernmental and intradepartmental collaboration and knowledge-sharing between organizations on Smart City topics as well as promote the progress of Smart Parking technologies. Ultimately, by sharing and comparing their smart city experiences, cities can learn from each other and improve the quality of life of their citizens.

7.4.5. Big data analytics

When the Smart Parking system scale up process is completed in Kampala, the system will start generating a massive volume of data as there will be a large number of devices communicating with each other. It is necessary to aggregate all this big data, as it would play a vital role in the improvement of public parking environment in Kampala and betterment of all public services provided by KCCA.

8. FEASIBILITY ANALYSIS

8.1. Feasibility analysis overview

Chapter 8 assesses the feasibility of implementing a comprehensive on-street Smart Parking system in Kampala by overviewing the quantitative and qualitative aspects of parking on street, estimating the project implementation cost and assessing its feasibility based on the TELOS methodology, and, based on the estimated cost, recommend possible project funding options. The FS envisions a five-year Smart Parking project implementation for Kampala public on-street parking facilities to avoid any irreversible mistakes.

Figure 20. Five-year Smart Parking system implementation plan for Kampala

Year	Stage	Task
Year 1	Master Plan	Smart Parking system planning
		Smart Parking system analysis
		Smart Parking system conceptual design
		Smart Parking system detailed design
	Business process re-engineering (BPR)	Analysis and design of workflows and business processes within KCCA
Year 2	System development	Smart Parking system software development for KCCA Traffic Control Centre and Smart Parking app for vehicle drivers
	Hardware system installation	Kampala on-street parking facilities and KCCA Traffic Control Room
	System run start	Implementation of the Smart Parking system
Year 3	System maintenance	Smart Parking system maintenance, preparation of documentation and manuals
Year 4	System maintenance	Smart Parking system maintenance
Year 5	System maintenance	Smart Parking system maintenance

8.2. TELOS feasibility assessment

The feasibility assessment of Smart Parking project implementation in Kampala is based on the TELOS methodology of project assessment.[76] TESOL covers the following aspects:

6. *Technical*: Is the project technically possible?
7. *Economic*: Can the project be afforded?
8. *Legal*: Is the project legal? What are the legal determinants / are there any conflicts?
9. *Operational*: How will the current operations support the change? What is the organizational framework? Can adequate procedural changes be made, sufficient personnel retrained and new skills obtained?
10. *Scheduling*: Can the project be done in time? Estimating how long the system will take to develop. Schedule feasibility is a measure of how reasonable the project timetable is (i.e. a project will fail if it takes too long to be completed before it is useful).

Table 25. Kampala Smart Parking project TELOS assessment

	Area	Assessment
T	Technical	Smart Parking system for monitoring and managing the on-street parking facilities in Kampala can be developed under existing technologies on the market. From an availability point, technical feasibility for Kampala and KCCA is not considered an issue. The real issue is KCCA's desire and ability to apply the Smart Parking technology. KCCA proved their readiness and desire to apply the technology, however, fostering talent that would carry out research in subjects related to Smart Parking and manage the newly installed system is necessary.
E	Economic	Economic feasibility of the project is subject to funds available to KCCA to complete the installation of the Smart Parking system and all the necessary hardware. The FS provides an estimated cost analysis and proposes funding possibilities; however, the actual capital consideration must be carried out by KCCA.
L	Legal	KCCA must clearly identify whether there are any legal conflicts to implementing the Smart Parking system in Kampala. As far as the FS is concerned, the proposed Smart Parking system falls inside all legal boundaries of the Republic of Uganda.
O	Operational	The FS concluded that minor departmental reorganization within KCCA is necessary for smooth implementation and operation of a new Smart Parking system. KCCA should focus on establishing a Department (Directorate) of Transportation to centralize efficient

[76] Hall, James A. *Information Technology Auditing*. Cengage Learning Asia Pte Ltd, 2016.

		maintenance and development of Kampala's transportation system and infrastructure as well as smooth transition to and efficient management of all future Smart Parking ecosystem aspects.
S	Scheduling	KCCA envisions the future Smart Parking system to be fully implemented within a relatively short timeframe (1-2 years). The FS concluded that the short timeframe will impact the scope of the project and whether it will be a ready-to-use solution or one carefully customized to KCCA's environment and requirements. The FS thus proposes to schedule the project implementation for a time period of five years.

8.3. Estimated cost

A comprehensive identification of implementation costs of a comprehensive Smart Parking system for on-street parking management in Kampala should ideally be divided into, analysed by and calculated by two categories – one-time costs and recurring costs.

Table 26. Factors of identifying Smart Parking project implementation costs

Costs	Example	Details
One-time costs	Hardware purchase	Cost of all hardware Smart Parking hardware necessary for on-site parking facilities (Kampala public on-street parking) and off-site management facilities (KCCA Traffic Control Centre).
	Installation site preparation	Hardware installation process, installation site environment modifications (i.e. some city vegetation might need relocation), freight charges. These charges are subject to hardware vendor.
	Software acquisition	These costs apply to all software envisioned for the Smart Parking system.
	Systems design	These costs are those incurred by the professionals performing the project planning, analysis and design functions for the envisioned Smart Parking project.
	Programming and testing	These costs are those incurred by the Smart Parking system development team and are typically estimates of the personnel hours required to write and modify programs for the proposed system.
	Data conversion from old system to new system	The costs arising from transferring of parking data from one storage medium to another. All existing records for Multiplex parking – on paper or computer-based – must be prepared for transfer to the new Smart Parking system. This is a significant task and must be handled professionally.
	Personnel training	These costs include training of KCCA Traffic Control Centre team and other officials involved in the operation of the Smart Parking system.

Recurring costs	Hardware maintenance	These costs include the Smart Parking hardware upgrade as well as preventive maintenance and repairs. KCCA is advised to enter into maintenance contract with the Smart Parking system project provider.
	Software maintenance	These costs include upgrading and debugging the Smart Parking system. KCCA is advised to enter into maintenance contract with the Smart Parking system project provider.
	Insurance	This cost covers such hazards and disasters as fire, hardware failure, vandalism and destruction by disgruntled employees. Considering Kampala environment, KCCA is advised to look into insurance opportunities and not take this step lightly.
	Supplies	These costs are typically incurring through routine consumption of necessary office supplies for KCCA.
	Personnel	These costs are salaries of all personnel who are involved in the Smart Parking system management in KCCA – KCCA Traffic Control Centre officials and any other involved officials.

The following table provides an estimation of the envisioned five-year Smart Parking project implementation (one-time costs only) for Kampala public on-street parking facilities.

Table 27. Estimated cost of Smart Parking system implementation in Kampala (USD)

Category	Amount	Remarks
Consulting (Master Plan)	475,431	Year 1
System implementation	1,585,776	Year 2
System maintenance cost	570,879	Years 3 - 5
Total Amount	**2,632,086**	

The FS envisions a five-year Smart Parking implementation plan. The FS recommends to use the first year for work on the Smart Parking Master Plan for Kampala Capital City that will provide a clear map for all future project development decisions on the project. A comprehensive Master Plan will save a lot of costs in the long run and help avoid any irreversible mistakes. Master Planning will build visibility and credibility for the Smart Parking project in Kampala. Master Planned projects traditionally have a higher rate of completion that non-planned projects. The following table provides an estimation of costs required for Master Plan consultation and includes calculation of estimated labor costs and travel expenses that will be incurred by the project team when travelling to Kampala from Korea for project implementation.

Table 28. Estimated cost of Smart Parking Master Plan implementation

Category		Product / Description	M/M	Unit Price (USD)	Total (USD)
Project Management	Consult	Project Manager	9	11,207	100,862
Master Plan	Consulting	Project Leader / Planning	9	8,621	77,586
	Research Assistant	Consultant / Analysis	9	6,034	54,310
	Assistant	Consultant / Conceptual design	6	4,310	25,862
	Assistant	Consultant / Detailed Design	6	4,310	25,862
BPR (Business Process Reengineering)	Consulting	Consultant / BPR	9	8,621	77,586
	Assistant	Consultant / BPR	6	4,310	25,862
Subtotal			54	-	**387,931**
Labour Cost Total				-	**387,931**

Category	Product / Description	QTY.	Unit Price (USD)	Total (USD)
Direct expenses	Travel expenses	25	3,448	86,207
	Meeting expenses	5	86	431
	Printing expenses	1	862	862
Subtotal		-	-	**87,500**
Travel Cost Total			-	**87,500**

Total		-	**475,431**

The following table provides an estimation of costs required for Smart Parking software development and hardware purchase. The construction costs and the electrical wiring costs are not included in the calculation, as they require a thorough assessment of all Kampala on-street parking facilities on each street. The hardware delivery fee is included in the construction costs. All system infrastructure is open source.

Table 29. Smart Parking software development and hardware installation cost

Category		Product / Description	M/M	Unit Price (USD)	Total (USD)
Project Management	Expert Technician	Project Manager	12	13,793	165,517
Parking Management System	Expert Technician	Project Leader / Architecture Design & Dev.	12	13,793	165,517
	Advanced Technician	Engineer / Development	12	11,207	134,483
	Intermediate Technician	Engineer / Development	9	9,483	85,345
	Intermediate Technician	Engineer / Development	9	9,483	85,345
	Assistant	Engineer / Development	9	4,310	38,793
	Assistant	Engineer / Development	9	4,310	38,793
Mobile Application (for drivers)	Advanced Technician	Engineer / Development	12	11,207	134,483
	Advanced Technician	Engineer / Development	9	11,207	100,862
	Advanced Technician	Engineer / Development	9	11,207	100,862
UI Development	Advanced Technician	Engineer / UI Design & Publishing	3	11,207	33,621
	Intermediate Technician	Engineer / UI Design & Publishing	3	9,483	28,448
Interface (Payment…)	Advanced Technician	Engineer / System Link	6	11,207	67,241
Translation	Intermediate Technician	Interpretation / Translation	6	9,483	56,897
		Subtotal	**120**	-	1,236,207
		Labour Cost Total		-	**1,236,207**

Category	Product / Description	QTY.	Unit Price (USD)	Total (USD)
Direct expenses	Travel expenses	25	3,448	86,207
	Meeting expenses	5	86	431
	Printing expenses	1	862	862
	Subtotal	**-**	-	87,500
	Travel Cost Total		-	**87,500**

Category		Product / Description	QTY.	Unit Price (USD)	Total (USD)
Development & Construction Sys.	Web Server	2.0Ghz(8Core)/RAM 8GB/HDD 1TB	2	8,621	17,241
	Web Application Server	2.0Ghz(8Core)/RAM 16GB/HDD 2TB	2	10,345	20,690
	Database Server	2.0Ghz(8Core)/RAM 16GB/HDD 2TB	1	10,345	10,345
	Development Server	2.0Ghz(8Core)/RAM 8GB/HDD 1TB	1	8,621	8,621
	Monitor	24Inch	1	431	431
Intelligent CCTV Parking Management Sys.	CCTV Camera		600	172	103,448
	LRP Camera		150	345	51,724
	DVR	HDD 2TB	50	345	17,241
	LED sign		150	216	32,328
Subtotal			**-**	-	262,069
Hardware Cost Total				-	**262,069**

Category		Product / Description	QTY.	Unit Price (USD)	Total (USD)
Development & Construction Sys.	WEB	Apache	2	-	-
	WAS	Tomcat	2	-	-
	DBMS	Maria DB	1	-	-
Subtotal			-	-	-
Software Cost Total				-	-

Total	-	**1,585,776**

The estimated cost of system maintenance per year is calculated at 12% of the system implementation cost.

Category	Price/1 year	Total (USD)
System maintenance cost (years 3 – 5)	190,293	570,879
Total		**570,879**

8.4. Quantitative benefit analysis

The economic benefit analysis was calculated on the basis of the current parking revenue estimate that KCCA would receive directly from the operational on-street parking during the course of 1 year. The parking revenue was calculated on the premise that on-street parking is occupied 80% of the time on average during workdays, excluding weekends and public holidays when parking is free.

Table 30. Current revenue estimate of KCCA on-street parking

Item	Value
ⓐ Overall number of parking spaces	5,782 units
ⓑ Maximum operational hours per day	10 hours
ⓒ Overall parking occupancy [arbitrary percentage (defined by the city representative during the interview: workdays 90%, Saturday 70%, Sunday 35%)]	80%
ⓓ Daily parking count (ⓐxⓑxⓒ)	46,256 vehicles
ⓔ Maximum operating days per year (excluding weekends and public holidays)	313 days
ⓕ Annual parking count (ⓓxⓔ)	14,478,128 vehicles
ⓖ Parking fee per hour	UGX 1,000.00
ⓗ Total annual parking fees (ⓖxⓗ)	UGX 14,478,128,000.00
ⓘ Exchange rate (UGX → US$)	UGX 3,800.00
ⓙTotal annual parking fees (US$)	USD 3,810,033.68

KCCA collects a fixed amount of parking revenue through Multiplex - USD 92,105.26 per month - which is USD 1,105,263.16 per year. After transitioning to the Smart Parking system, KCCA will be able to collect 100% of the parking revenue directly without an intermediate.

Table 31. Revenue calculation for the next 5 years (USD)

Year	Before system deployment (Multiplex)	After system deployment	Cumulative
Year 1	1,105,263.16		1,105,263.16
Year 2	1,105,263.16		2,210,526.32
Year 3		3,810,033.68	6,020,560.00
Year 4		3,810,033.68	9,830,593.68
Year 5		3,810,033.68	13,640,627.37

The following table is a summary of the previous subchapter and outlines the expenses estimate born by KCCA in the process of development and deployment of the Smart Parking ecosystem.

Table 32. Expenses estimate for the next 5 years (USD)

Year	Consulting	System development	System maintenance	Cumulative
Year 1	475,431.00			-475,431.00
Year 2		1,585,776.00		-2,061,207.00
Year 3			190,293.12	-2,251,500.12
Year 4			190,293.12	-2,441,793.24
Year 5			190,293.12	**-2,632,086.36**

The following table provides an estimate of profit from parking revenue collection following the change of parking operator to Smart Parking system. Starting from the 3rd year, KCCA is expected to see a rise in annual profit from USD 1,105,263 to USD 3,619,741 which is an increase of approximately 328%.

Table 33. Profit estimate for the next 5 years (USD)

Year	Revenue	Expenses	Annual profit	Cumulative profit
Year 1	1,105,263.16	-475,431.00	629,832.16	629,832.16
Year 2	1,105,263.16	-1,585,776.00	-480,512.84	149,319.32
Year 3	3,810,033.68	-190,293.12	3,619,740.56	3,769,059.88
Year 4	3,810,033.68	-190,293.12	3,619,740.56	7,388,800.44
Year 5	3,810,033.68	-190,293.12	3,619,740.56	**11,008,541.01**

The reasons behind the dramatic increase in the parking revenue collection by the KCCA are outlined in the form of tangible benefits in the table below.

Table 34. Tangible benefits of implementing Smart Parking in Kampala

Example	Details
Increased revenue: increased parking revenue collection for KCCA	Smart Parking system will increase revenue collection due to transparency in all parking-related operations. Smart Parking system will also facilitate the parking fee payment compliance rate, which will also result in the increase of revenue for KCCA.
Increased revenue: expansion into other markets in Africa	In the future, KCCA can pioneer Smart Parking practices in its region and promote and expand their system to other markets in Africa that are technologically ready to adopt this technology.

Cost reduction: Labor cost reduction	Smart Parking system will eliminate the need to employ parking fee collectors and parking fee managers on the streets of Kampala (i.e. Multiplex managers).
Cost reduction: Operating cost reduction	Operation of an automated Smart Parking system can be easily carried out by a small team at KCCA Traffic Control Centre.
Cost reduction: Less expensive equipment	Smart Parking cameras are cheaper than parking meters and easier to install.
Cost reduction: Reduced equipment maintenance	Smart Parking cameras are ideal for hard-to-wire and frequently changed outdoor environments, and facilitate ability to access real-time information.

8.5. Qualitative benefit analysis

During the course of five years, the system is expected to provide the following qualitative benefits for KCCA, citizens of Kampala and overall environment in Kampala city.

Table 35. Intangible benefits of implementing Smart Parking in Kampala

Example	Details
Increased customer satisfaction	Overall vehicle driver satisfaction with on-street parking experience in Kampala will increase due to reduced traffic which is increased by vehicles looking for a parking space and due to simplified and more transparent parking process. Ultimately, drivers will save both money and time during parking on-street, which will result in a better parking experience in the busy Kampala city center.
Improved employee satisfaction	Smart Parking will increase KCCA parking management and KCCA Traffic Control Centre teams' satisfaction through intuitive system interface.
Efficient operations: more current information	Smart Parking in Kampala will aggregate real-time parking data and will greatly contribute to understanding of drivers' behaviors and observe their reactions to changes to parking rules.
Efficient operations: improved decision making and faster response	KCCA will be able to quickly make informed decisions regarding parking rules and regulations based on the data analytics functions of the Smart Parking system.
Efficient operations: better internal and external communications	Automated processes will provide for better communication between the KCCA parking management teams, KCCA Traffic Control Centre and system/parking users.
Improved environment: improved planning	Smart Parking system will facilitate urban planning and planning of the on-street parking facilities expansion in Kampala.
Improved environment:	Smart Parking system can greatly contribute to curbing air and noise pollution levels, saving time and energy in Kampala. Typically, 30%

reduced traffic and pollution	of traffic is generated by motorists looking for a space and Smart Parking can greatly contribute to reducing traffic problem in Kampala. Typically, 10 minutes of finding a parking space equal 1,3 kg of CO2, thus Smart Parking can also greatly contribute to bringing the air and noise pollution down in Kampala.

As the project is envisioned for five years, some of the expected benefits can be quantified as follows. The performance values and target values are estimates based on research of existing Smart Parking ecosystems.

Table 36. Estimated measurement of benefits of Smart Parking system implementation

Benefit	Year	Performance value	Target value
Master Plan development	Year 1	-	1
	Year 2	-	-
	Year 3	-	-
	Year 4	-	-
	Year 5	-	-
License Plate Recognition accuracy for Ugandan vehicles	Year 1	-	-
	Year 2	-	75%
	Year 3	75%	80%
	Year 4	80%	85%
	Year 5	85%	90%
On-street parking occupancy rate accuracy (calculation of the average parking occupancy recognition performed by the installed CCTV cameras)	Year 1	-	-
	Year 2	-	70%
	Year 3	70%	75%
	Year 4	75%	80%
	Year 5	80%	85%
Parking fees consistency check (automatic calculation of the exact fare based on the parking time)	Year 1	-	-
	Year 2	-	85%
	Year 3	85%	90%
	Year 4	90%	95%
	Year 5	95%	99.9%
Reduced traffic congestion degree in the surrounding areas (measurement of the vehicle speed at the parking lot surrounding areas with a speed gun)	Year 1	-	-
	Year 2	-	-10%
	Year 3	-10%	-20%
	Year 4	-20%	-30%
	Year 5	-30%	-40%
Reduced air pollution degree in the surrounding areas (Measurement of the dust density & CO2 emissions rate of the surrounding area)	Year 1	-	-
	Year 2	-	-5%
	Year 3	-5%	-10%
	Year 4	-10%	-15%
	Year 5	-15%	-20%
Reduced vehicle theft and vandalism rate (based on parking-related crime rate analysis)	Year 1	-	-
	Year 2	-	-5%

	Year 3	-5%	-10%
	Year 4	-10%	-15%
	Year 5	-15%	-20%
Increase in ICT talent in Uganda	Year 1	-	30%
	Year 2	30%	40%
	Year 3	40%	50%
	Year 4	50%	60%
	Year 5	60%	70%
Annual income growth rate for the Smart Parking project participants	Year 1	-	-
	Year 2	-	10%
	Year 3	10%	20%
	Year 4	20%	30%
	Year 5	30%	40%
Employment growth rate in the parking industry in Uganda (JV and partner companies, affiliated companies, etc.)	Year 1	-	-
	Year 2	-	10%
	Year 3	10%	20%
	Year 4	20%	30%
	Year 5	30%	40%
Number of partnership agreements (portal, PG, credit card companies, equipment and materials companies, car washing facilities, vehicle service centers, etc.)	Year 1	-	1
	Year 2	1	3
	Year 3	3	10
	Year 4	10	25
	Year 5	25	50
Annual sales growth rate of partner companies	Year 1	-	-
	Year 2	-	10%
	Year 3	10%	20%
	Year 4	20%	30%
	Year 5	30%	40%
Cumulative growth rate of Smart Parking mobile app users (number of drivers, parking lot workers, managers of sensitive parking lots, and staff members of affiliated parking lots)	Year 1	-	-
	Year 2	-	10%
	Year 3	10%	20%
	Year 4	20%	30%
	Year 5	30%	40%
Increase in the Smart Parking services reliability rate (based on the user ratings)	Year 1	-	-
	Year 2	-	80%
	Year 3	80%	85%
	Year 4	85%	90%
	Year 5	90%	95%
Annually accumulated number of Smart Parking technology-related patent applications in Uganda	Year 1	-	1
	Year 2	1	2
	Year 3	2	3
	Year 4	3	4
	Year 5	4	5

8.6. Funding options

The funding options of smart parking system implementation in Kampala were evaluated based on the information gathered on various international funding programs. Based on the source of generation, funding is classified as internal and external, wherein former covers those means which are generated within the government. Governments look for funding internally when the project fund requirement is quite low. All possible funding opportunities and their possibility of procurement are outlined in the table below.

Table 37. Project funding options

Type	Detailed type	Funding example	Possibility
Internal	Government funding	The Government of Uganda internal funding	Average
		KCCA internal funding	
	PPP	PPP between the local and central government and local private businesses in Uganda	Low
External	Grants (GPPP)	Korea: KOICA	Average to low
		International: EU, UNDP, international ODA funding opportunities, etc.	Average to high
	Loans	Korea: EDCF	High
		International: the WB, AfDB, EADB, etc.	High

Loans provided by the international financial institutions like the Economic Development Cooperation Fund in Korea, World Bank, African Development Bank and East African Development Bank seem to be most viable funding options for KCCA to implement the Smart Parking system in Kampala.

Government funding in Uganda and international funding from EU, UNDP and various ODA organizations seems to be the next possible option, however, procurement of such funding depends on the list of priority project subjects set by these organizations.

In case of KOICA, funding procurement for a Smart Parking project implementation in Kampala might prove a difficult task, as this organization focuses on BOP-driven market and business approaches to solve poverty and social problems. As Smart Parking does not directly address the issue of poorest of the economic human pyramid, the funding application might need extra consideration.

CONCLUSION

As metropolitan areas around the world grow, they begin facing growing traffic congestion that typically results in uncertainty in or insufficient supply of parking availability. As cities stand to face the challenge, they often face such problems as uncertain parking payment regulations, problems with observing traffic laws, corruption in revenue collection and poor infrastructure. Kampala in Uganda is one of such cities, working hard to improve the traffic situation in the city and improve the on- and off-street public parking facilities for its citizens.

As cities are turning to Smart Parking – a parking strategy that combines technology and human innovation in an effort to use less fuel, save time and space to achieve faster, easier and denser parking of vehicles for the majority of time they remain idle – KCCA makes every effort to learn more about this parking strategy and use it to solve the parking problems in Kampala.

Smart Parking technology is an integral part of smart cities which in turn heavily rely on the use of ICT to implement their strategies and to collect and deliver information to all users. The FS has confirmed that the Government of Uganda recognizes ICT as the most critical sector to the delivery of its national Vision 2040. Since 2017 Ugandan economy's growth was driven largely by growth in information and communication technology (ICT) services, the FS concluded that implementation of a comprehensive Smart Parking system for Kampala's on-street parking facilities will motivate the ICT sector development in Uganda and facilitate the digitalization of parking experience as well as promote trust of Kampala citizens toward KCCA.

KCCA's first important step toward Smart Parking implementation is this 2019 WeGO Smart Sustainable City Feasibility Study that defines the roadmap for developing an on-street Smart Parking system in the city and addresses the most pressing challenges in Kampala needed for its transformation into a smarter and more sustainable city. Furthermore, KCCA took the right step by agreeing upon starting with a small-scale off-street Smart Parking pilot project – an Intelligent CCTV Parking system for KCCA off-street parking facilities. The pilot project provided valuable insights into scaling up strategies that will ensure a sustainable Smart Parking infrastructure in Kampala in the future with minimum hardware installation costs.

APPENDICES

NEW VISION, Friday, January 10, 2020 9

KCCA to decongest Kampala with smart parking system

By Juliet Waiswa and Diana Babirye

Kampala Capital City Authority (KCCA) has partnered with the World Smart Sustainable Cities Organisation (WeGO) to reduce traffic jam in the city and enable motorists to save fuel.

KCCA acting deputy executive director, Samuel Sserukuuma, said the system will be rolled out in the central business district, which is most affected by lack of enough parking space.

How the system works

Speaking yesterday at the roll out of the smart parking system in Kampala, Sserukuuma said motorists will be required to download an application on smartphones to obtain information about which streets have free parking space.

Drivers will also be able to pay for parking fees using mobile money.

The first five minutes of parking will be free.

Sserukuuma said the companies currently managing street parking, such as Multiplex, will compete with others for the tender.

"As of now, KCCA is going to acquire space where vehicles will park as they pilot the system," he added.

Anastassia Brehhunova, one of the innovators of the system, said a study was carried out three months ago.

Brehhunova said a CCTV camera will be installed at the entrance of the parking slots to ensure safety of vehicles.

Parks around Kampala such as Namayiba Bus Terminal, New and Old taxi parks and Usafi Park were visited in order to design a better system.

Some road users, however, say KCCA should first get rid of bodaboda cyclists because they take up parking slots.

Kampala is estimated to have a day population of 2.5 million people and 1.5 million at night. This means that one million people enter Kampala during the day and leave in the evening daily using over 12,500 taxis.

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