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Electric Moto-Taxis Innovation in Low Income Countries: A Rider's Perspective in Kampala

Monday morning in Kampala promised a busy day as school started after a long lockdown from the COVID-19 pandemic. Every family was preparing to send their children to school, and the traffic jams in Uganda's capital would be monstrous. Sammy Kalunji, working as a boda rider (motorcycle taxi operator) for the last 10 years, was getting ready to start his day. He was operating from Matugga, a small peripheral town near Kampala, where he lived with his wife and four children.

Kalunji previously worked as a street vendor. An attack by thieves who stole his merchandise led him to start working as a boda operator by leasing a motorcycle from a friend. Later, he acquired a loan to purchase his own P-boda (or Petrol-boda). He operated the motorcycle for eight years until 2019, when he switched to an electric boda (or E-boda), with lower operating costs, in a bid to gain an advantage over other boda riders.

Since his decision to sell his petrol motorcycle and acquire an electric one, Kalunji was confronted with multiple urgent and related dilemmas he had to negotiate creatively and innovatively to harness opportunities and survive as a low-income self-employed transport entrepreneur in Kampala. He had to think about how to overcome the pandemic collapse of his business and retrieve the path of a decent livelihood both in the short run and over the long term. Amid technological, economic, and social disruptions, Kalunji represented a test case for efficiently harnessing the opportunities presented by a new low-carbon urban transportation solution and contributing to the transition to green urban mobility in Kampala.

The question for individuals such as Sammy Kalunji was how to make a good living amid the transition.

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Figure 1

Taxi Motorcycles in Kampala

Source: Jean Grébert, 2019.

Micro-Enterprise Background

Before he switched from a P-boda, Kalunji came across Zembo (Zero Emission Boda), a company showcasing its electric motorcycle. One reason he was interested was that Kampala had some of the most polluted air in Africa. The Ugandan capital ranked among the world's most polluted cities, and around 28,000 people died each year in the country as a result of air pollution.[1]

French and German interests founded Zembo in Kampala in 2018 at a time when the costs of operating P-bodas had increased and the public image of P-boda riders was not good.[2] After Zembo's successful piloting and scaling up of its grid-based charging infrastructure, around 250 pioneer E-boda riders, including Kalunji, enrolled as taxi providers.

After learning more about the technology, Kalunji negotiated a lease-to-own financing package. He sold his Bajaj P-boda, made a down payment on the Zembo Storm model, and became the second rider to acquire one. He was to pay weekly installments to Zembo for two years, but the COVID-19 pandemic broke out in February 2020. Country-wide lockdowns were imposed with far-reaching impacts on him and his family: Transport services of boda operators were suspended for prolonged periods of time.[3] Not able to work during that period, he defaulted on his payments for about five months. With other riders, he negotiated with Zembo to halt the payments until the situation normalized.

Yet possibilities opened up. The limitations placed on passenger transport triggered demand for delivery of goods. Kalunji signed up with one of the new online delivery firms. Then, when the lockdown lifted and after completing his deliveries, he shifted to carrying passengers. Also, with his wife, he opened a kiosk in his neighborhood that offered mobile money transfer services, in order to diversify their income given the highly volatile economic environment in which he operated (see **Table 1**).

Each workday, Kalunji drove over 18 kilometers from his home to a Zembo charging station in Kampala that provided swappable batteries. By 2023, the company was running 27 stations in the Kampala region and a few in towns further away.[4] To recharge batteries, Zembo relied on local hydroelectricity sources for most of its swapping stations, except a few pilot ones harnessing the potential of solar energy. Zembo competitor, Bodawerk, had only seven swapping stations.

Table 1

Sammy Kalunji's Socio-demographic Profile

Age	36
Rural origin	Busoga region, eastern Uganda
Residence	Mattuga (24 km from Kampala city center)
Household size	6 (himself, his wife and 4 children)
Past employment/work	Street vendor
Experience as boda rider	10+ years
Net income / day (average)	USD 4.48 = 16,576 UGX (one USD = 3,700 UGX - Uganda shillings)
Other source of income	Kiosk (with his wife) offering mobile money transfer services. His wife is also a self-employed tailor.
Availability of assets	Owns a piece of village land where he would like to grow coffee

Source: Created by the case authors.

Kalunji found that a fully charged battery would enable him to travel 60-70 kilometers, depending on the weight of the load. His energy and maintenance costs were lower than with a P-boda, but E-boda riders had to turn down more trips because of the small number of swapping stations in key commercial and administrative areas and the limited distance capacity of the battery. Another constraint they faced was the shortage of E-boda repair shops.

Transportation in Uganda

Uganda is a landlocked country (see **Figure 2**) categorized as a low and middle income country (LMIC) with a population over 46 million. (For comparative facts about Uganda see **Exhibit 1** and for more on Kampala see **Exhibit 2**.)

Figure 2
Uganda

Source: "Uganda-map." *The Network for Natural Gums & Resins in Africa*. https://ngara.org/uganda/attachment/uganda-map/.

As the capital city and economic hub of Uganda, Kampala spawned the Greater Kampala Metropolitan Area (GKMA), with a population of about seven million and growing at about 5.2 percent annually, according to the Uganda Bureau of Statistics (2019).[5] Its traffic had increased considerably, outpacing investments in road upgrading and expansion. Daily traffic gridlock (see **Figure 3**) exacerbated already poor levels of connectivity and mobility constraints, in turn eroding labor productivity.

Motorcycle taxis cumulatively were one of the largest informal urban mobility providers in Africa. They were called boda-boda in Uganda and elsewhere in East Africa, moto-taxis in the Democratic Republic of Congo and other French-influenced countries, okada in Nigeria, and taxi mota in Mozambique.[6] In Kampala, people had the choice, in ascending order of cost, to use buses (30-60 seats), minibuses (14 seats), bodas (1-2 seats), and cab cars (3-4 seats). Mobility in Kampala was the most important daily expense for poor residents, ahead of fuel and food.[7]

Figure 3
Kampala Traffic

Source: Jean Grébert, 2019.

In 2023, it was estimated that more than 400,000 boda riders were operating in the city alone, creating a high level of competition. It provided substantial freelance employment and brought mobility to the majority who lacked a superior alternative public transportation system.[8] The emergence of the boda-boda industry also enlarged new service niches such as goods deliveries (see **Figure 4**) and had multiplier effects including ride-sharing, spare-part vendors, mechanics, and food sellers. About 25 percent of the city's population depended on this urban transport system.

With the city authorities accelerating plans for mass urban electric mobility, numerous opportunities were on the horizon for E-boda providers like Zembo to engage and gain from the urban economy. The plans aimed for more bottom-up, innovative, and sustainable solutions,[9] which would create more sustainable

livelihood opportunities for low-skilled entrepreneurs such as Kalunji and more socially inclusive, just, and environmentally sustainable urban futures in African cities. Kampala already had the most extensive network of swapping stations for charging batteries in East African cities.[10] Transport providers have shown that potentially transformative bottom-up measures brought employment while also offering mobility solutions (see **Figure 4**).[11]

Figure 4

Boda Delivery of Goods and Passengers

Source: Tom Courtright, 2022.

Boda Financials

Kalunji had sold his Bajaj P-boda for about 2,500,000 UGX (USD 675), to buy the Zembo E-boda for 4,500,000 UGX. To acquire a Zembo, a rider agreed to pay an amount between 300,000 to 500,000 UGX upfront and then weekly payments until the full amount of the vehicle was covered—on average in two years. Kalunji was paying 65,820 UGX per week (more than 16 USD). Zembo guaranteed two years of after-sale services in maintenance and parts. Default could cause Zembo to impound the motorcycle or negotiate. Riders had Zembo operating cards that could be deactivated if they failed to meet their loan payments. These cards also facilitated the swapping of batteries.

The battery swap model (see **Figure 5**) had important implications for E-boda riders. A single charge cost Kalunji an average of 4,000 UGX (slightly more than one USD).

Figure 5

Battery Charging and Swapping Station

Source: Jean Grébert, 2021.

Field research on E-boda riders—by the Urban Action Lab of Makerere University in Kampala and the Management Research Center of Ecole Polytechnique in France—illuminated their financial situation. The survey found that, on average, an E-boda rider grossed 255,950 UGX. If the main costs concerned the battery swap (71,095 UGX) and the weekly vehicle payment (65,820 UGX), and minor costs of maintenance (1,358 UGX), the weekly profit was 117,677 UGX. For an operator such as Kalunji, it meant that until he had paid enough to own the motorcycle, he was covering only the family's food expenses and the house rent. But he was netting 54% more than when driving a gasoline-powered motorcycle.

Sammy Kalunji's Business

Kalunji had two categories of customers: companies (business-to-business market, B2B) and individuals (business-to-consumer market, B2C). As a self-employed transport provider, his fares, schedules and routes varied. He offered flexible, affordable, quickly accessible, efficient services, carrying passengers, delivering goods, circulating information, and even serving as an ambulance. He could penetrate traffic jams and find access through narrow, muddy, and overcrowded roads. His clients were about half women, half men, and mainly from disadvantaged groups.

Kalunji's daily income was not sufficient for making a decent livelihood, and he thought a lot about how to increase his profit. All boda transportation in Kampala was the same, and so, like other operators, Kalunji served a very broad base of people and needs: regular and occasional clients, varied purposes of trip (commercial areas, work, medical, friends), a variety of cargo, nature of client (corporate employees, traders, etc.), length of the ride (very short, short, long, very long), income level of the client (middle, low, very low), and time of day. Getting customers was not so difficult during peak hours (6-8 a.m. and 4-6 p.m.), but during off-peak hours the competition among bodas was quite challenging, and included potentially unsafe behavior.[12]

He would have liked to drive in more remote areas but the limited extent of swapping battery service from Zembo did not enable him to travel long distances.

Kalunji listed his choices:

- Focus on existing clients and their needs. These included goods delivery for companies, transportation of employees during peak periods to the city center once they left their cars parked at the periphery, goods delivery for households, and transportation of individuals for any kind of urban mobility need—commercial, health, recreative, education, and more.
- Target existing clients with new services. For example, many traders (wholesalers and retailers) had moved away from the city center since the COVID-19 pandemic began and needed courier service from more remote distances.
- Some companies might want to develop their own boda fleets; Kalunji could become an employee of one of those companies.
- Some individuals might want to book in advance for weeks at a time. He could develop his own network of regular customers.
- He could target new clients to be served with existing, modified, or even new services.

To be able to harness these opportunities, Kalunji could not continue running his business as he had to date. Several issues were impacting his capacity to make money with his low-carbon vehicle and, as a result, to effectively support sustainable transition for green mobility services in Kampala. Kalunji needed to make innovative entrepreneurial decisions related to his financial, operational, commercial, and organizational practices while using the E-boda.

a) Financial arrangements

Under his lease-to-own financial model, Kalunji made a down payment of 500,000 UGX and had to make two years of weekly payments of 60,000 UGX until the completion of the full payment for the motorcycle. Once the payments were completed, he would acquire full ownership of his E-boda. However, Zembo retained battery ownership rights.

According to Kalunji, flexibility with the weekly payments was crucial. Some weeks he was able to pay more than required. This helped him greatly during the COVID-19 pandemic when he lost his income due to the government-imposed lockdowns. With Zembo, he negotiated a suspension of the weekly installments until the economy opened up. For E-boda operators, flexibility in the financial terms was important because of the irregularity of their income. It helped negotiations with Zembo if the operator had assets such as savings or land ownership.

b) Operational conditions

Clearly, Kalunji's business depended on maximized use of his E-boda, and that depended on charged battery access. He wondered about alternative operations models that could improve localization of future swapping stations and autonomy of the battery.

In a stroke of good fortune, Kalunji became acquainted with two research assistants in charge of a field survey on E-boda operators.[i] He became one of 200 interviewees for that research and therefore, had access to the results. The survey provided insights for improving the infrastructure service provision for E-boda operators. In addition to his decade of boda experience, Kalunji absorbed from the survey a comprehensive bird's-eye view of each part of the city. He noted the

[i] The survey was executed during September-November 2021 by the Urban Action Lab of Makerere University in coordination with a team of researchers at the Management Research Center of the Ecole Polytechnique (i3-CRG), France.

insufficient numbers of swapping stations in the central business district and city center of Kampala (see **Exhibits 3** and **4**).

The survey recorded boda operators' preferred locations of future swapping stations and additional options to develop for improved battery service. The most-preferred locations were near markets, fuel stations, and bus stops or stages[ii] for last-mile connectivity. Operators said there should be a swapping station every 10 kilometers. Kalunji, as part of a WhatsApp group linking Zembo to riders, wondered if advising the company about better locating swapping stations based on the survey's results could help him and his fellow operators.

Kalunji, who was among the operators expressing support for more battery swapping stations, spoke from personal experience. He had planned to start a coffee farm in his village, but couldn't rely on his E-boda to make the required longer trips outside Kampala, and had to abandon that potential family-supporting project.

He also thought about seeking short-term improvements at Zembo, especially because the swapping stations sometimes provided less-than-fully-charged batteries. For example, could boda operators buy or rent an extra fully charged battery to carry with them? His thoughts led to the three options shown in **Table 2**.

Table 2

Options Without Going Back to the Swapping Station

OPTIONS	BENEFITS AND COSTS
Option 1	Buy a second battery and carry it on the E-boda. This could cost about 2 million UGX.
Option 2	Rent a fully charged second battery. E-boda operators could pay 5,500 UGX instead of 4,000 UGX for swapping just one extra battery.
Option 3	Pay an extra 2,000 UGX to receive a fully charged battery on the road within 20 minutes.

Source: E-boda riders survey, Urban Action Lab of Makerere University and i3-CRG at Ecole Polytechnique, 2021.

Kalunji's regular interactions with fellow E-boda operators were of mutual benefit. They shared views on the development of E-bodas and the bottlenecks they faced in the swapping infrastructure. He gained insights on how to advise the company in overcoming challenges with regard to swapping stations and battery capacity. He felt that upgrading the battery technology was absolutely required to keep up with the rapid changes in the industry. The company needed to provide the latest battery technologies, as he was already using the fifth generation of battery.

c) Commercial challenges

In operating his business, Kalunji, like the vast majority of boda riders, shared information mostly via text messages and word-of-mouth (plus WhatsApp for those with smartphones). Most often the topics were: (1) finding locations; (2) where the police were; (3) traffic information during peak hours and getting customers; and (4) setting prices for customers.

In addition to his regular mobile phone, Kalunji acquired a smartphone for getting new types of clients (such as retailers asking him to deliver goods to households) but also individual passengers.

[ii] A stage is a gathering point on the roadsides or on small plazas, at street intersections and in commercial zones, where riders can park and wait for passengers. Riders register on an annual basis to have a stage membership (based on a monthly fee) so they can pick up passengers from a designated stage. However, 30-40 percent of riders in Kampala City are not registered with a stage.

Weighing against frequent app use were the costs associated with continuous access to the internet and the commissions taken by ride hailing and delivery platforms (such as Safe Boda, Glovo, Bolt, and Uber).

Following the pandemic, in a context of high and diversified demand, but also intense competition among bodas, Kalunji wondered if he should stick to the total opportunism strategy that he had developed so far to increase his revenues, or rethink his distribution model to benefit from society's rapid digitalization.

d) The social organization model

Several organization models were available in Kampala to elevate entrepreneurs like Kalunji. They could work independently or, for example, affiliate with a collaborative of five to fifteen operators patronizing specific locations where they park and wait to pick up or drop off passengers. These spots included busy commercial areas (shopping, hotels, markets, etc.), intersections near major institutions such as schools and hospitals, and densely populated residential areas. At these "stages," as they were called, operators would share business, build solidarity and camaraderie, create social support safety nets among themselves, and expand clientele networks through cooperation.[13]

Each stage had a leadership committee to represent the collective interests of its members. Membership fees built a treasury to be used in times of personal crises (such as hospital bills when members were involved in accidents, bailing out detained colleagues from police custody, and defending themselves when involved in altercations with other road users). Such organizations generally were locally accepted despite their presence and legitimacy being contested by the city government.

A third mode of organization was affiliation with larger boda boda associations that combined membership from several stages. These associations could have membership ranging from 50 to 1,000 riders or more, and were characterized by more sophisticated organizational politics with powerful patronage links and connections to political elites up through members of parliament, the police, military officials, and the president.

Four Decisions

That evening, Sammy Kalunji found the 24 kilometres back to home in Mattuga seemingly endless after an exhausting day. He had managed to change his battery twice very quickly as the stations were on his routes. He felt proud of working with a motorcycle serving so many urban mobility needs that was no longer producing smoke pollution. Considering the difficulties of breathing while driving due to the massive air pollution caused by the continuous flow of P-bodas and other modes of petroleum-fueled transportation, he was deeply convinced that the future of urban mobility in African metropolitan areas like Kampala must be emission-free.

He reflected upon how several components of his business model could be changed to increase his income while taking part in low-carbon transportation service as a sustainable innovation. It could be a win from the environmental perspective and also on the social front, by providing decent livelihoods. To keep participating, Kalunji faced four decisions:

1. How to improve the financial arrangements with Zembo, which kept ownership of the battery after the E-boda was paid for.

a. Would it be better to negotiate paying off the vehicle with his own resources?

b. Or, would a loan (from a bank, microfinance institution, friends, or family) enable more profit-making?

2. How to overcome the limits of battery range. With Zembo having too few swapping stations, reaching them was often time-consuming. He was thinking of advising the company about more and better-located swapping stations. Meanwhile, he could:

   a. Buy a second battery.

   b. Rent fully-charged batteries.

   c. Propose to receive batteries while on the road.

3. How to increase his revenues. While he couldn't charge higher prices than other boda operators, marketing distribution decisions could be improved.

   a. Should he continue traditionally, according to opportunism, SMS, and word of mouth?

   b. Or, should he collaborate with fast-growing ride hailing and delivery platforms, along with the rapid digitalization of society?

4. Whether to associate. What organizational model would offer the best trade-offs between benefits and costs? Should he:

   a. Join a large territorial-based association with extensive reach?

   b. Join a stage-based association with local reach?

   c. Remain an independent low-carbon transport entrepreneur?

This moment was critical because the costs of mistakes in low-income groups are proportionally higher compared to high-income groups. Sammy Kalunji promised himself to take time this evening with his wife to analyze the pros and cons of the four decisions and their links with each other. He hoped to make money on E-boda while helping to sustain a low-carbon mobility innovation in Kampala.

Exhibits

Exhibit 1

Uganda Compared to Other Low Income Countries*

Indicators	LIC	Uganda
Social		
Poverty headcount ratio at 2.15% a day (2017 PPP) (% of pop.) (2020)	43.9	42.2
Life expectancy at birth (years) (2019)	63	63
Population, total (2021)	718,255,072	45,853,778
Population growth (annual %) (2021)	2.7	3.2
Economic		
GDP (current USD) (2021)	783.8	883.9
GDP growth (annual %) (2021)	2.6	3.5
Unemployment, total (% of total labor force) (2021)	5.5	4.3
Inflation, consumer prices (annual %) (2021)	6.6	2.2
Personal remittances received (% of GDP) (2021)	4.2	2.7
Environment		
CO_2 emissions (metric tons per capita) (2019)	0.3	0.1
Access to electricity (% of population) (2020)	41.4	42.1
Individuals using the internet (% of population) (2020)	19	6
Pop. using safely managed sanitation services (% of population)	-	18
Other		
Smartphones registered	-	10 million (2020)

* Low income countries, according to the World Bank in 2023, were: Afghanistan, Burkina Faso, Burundi, Central African Republic, Chad, Congo Dem. Rep., Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Korea Dem. People's Rep., Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Sudan, Syrian Arab Republic, Togo, Uganda, Yemen Rep., Zambia.

Sources: "Data for Uganda, Low Income." *The World Bank*. https://data.worldbank.org/?locations=UG-XM; Laricchia, Federica. "Number of smartphones registered in Uganda from 1st quarter 2018 to 1st quarter 2022." *Statista*, 20 Oct. 2022. https://www.statista.com/statistics/1082286/number-of-smartphones-registered-in-uganda/.

Exhibits (cont.)

Exhibit 2

Greater Kampala Metropolitan Area - Quick Facts

Uganda's capital city region is well-positioned to be the engine to drive positive structural transformation. A World Bank report, "From Regulators to Enablers: Role of City Governments in Economic Development of Greater Kampala," aims to provide Ugandan policymakers with economic analyses on the region's role in achieving Uganda's economic goals outlined in Vision 2040, and the actions needed to unlock the area's economic potential.

Here are a few facts from the report:

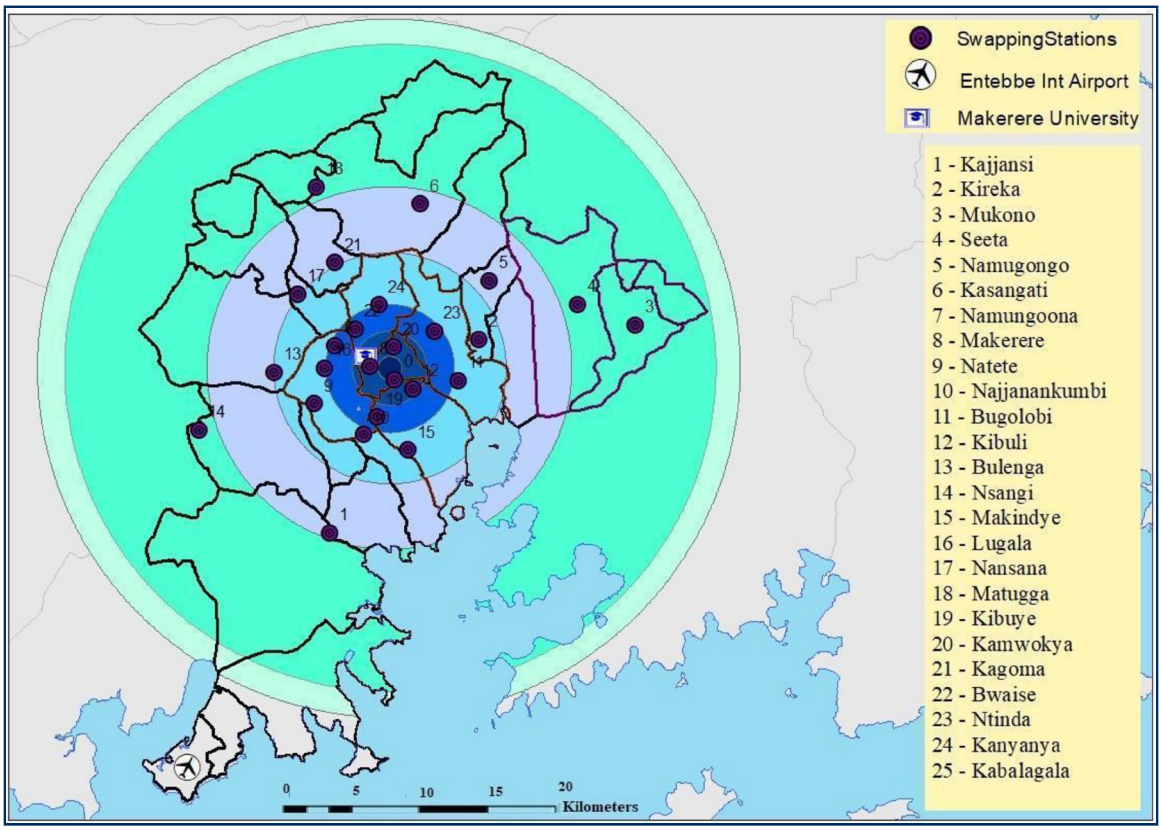
- The GKMA has been earmarked in Vision 2040 as an economic and administrative hub, and a major investment destination for Uganda.
- 10% of Uganda's population resides in Greater Kampala.
- 10% of people residing in the GKMA are unemployed.
- Kampala is the most industrialized city in Uganda, with 70% of Uganda's manufacturing plants.
- Greater Kampala contributes a third of Uganda's overall gross domestic product.
- 23% of the GKMA's labor force are underemployed either in terms of the number of hours or wages.
- The informal sector in Kampala provides essential livelihoods for the city's poorest in the absence of more formal jobs.
- 97% of informal businesses employ five or fewer people; 59% are one-person enterprises.
- 93% of micro-enterprises earned income below the poverty line of $1.90/day.
- 24% of informal sector enterprises started their business because they could not find other employment.
- 69% of the informal firms generate less than UGX 10 million annually, hence are not taxable.
- Only 18% of informal firms have the potential to grow and create more jobs.
- 84% of informal businesses sell to customers within a 30-minute walk.
- 35% of informal businesses say their biggest constraint is a lack of customers or lack of profitability of their business model.
- The number of vehicles on the roads in Greater Kampala is increasing faster than infrastructure investment can keep up.
- Improved transport infrastructure can decrease the cost of motorized transport in Kampala, which would reduce costs for business.
- Increasing paved roads in the city can better connect where people live and where they work.
- A majority of formal firms rated access to finance and tax administration as major constraints.

Sources: "From Regulators to Enablers: Role of City Governments in Economic Development of Greater Kampala." *The World Bank,* Sept. 2017. https://openknowledge.worldbank.org/server/api/core/bitstreams/1fdff54c-dff9-51b8-b66a-f10e434ab4f9/content; "Greater Kampala Area – Quick Facts." *The World Bank*. https://thedocs.worldbank.org/en/doc/595971521054661269-0010022018/original/GreatKampalaMetropolitanAreaQuickFacts.pdf.

Exhibits (cont.)

Exhibit 3

Existing Battery Charging and Swapping Station Infrastructure for the Kampala City Region

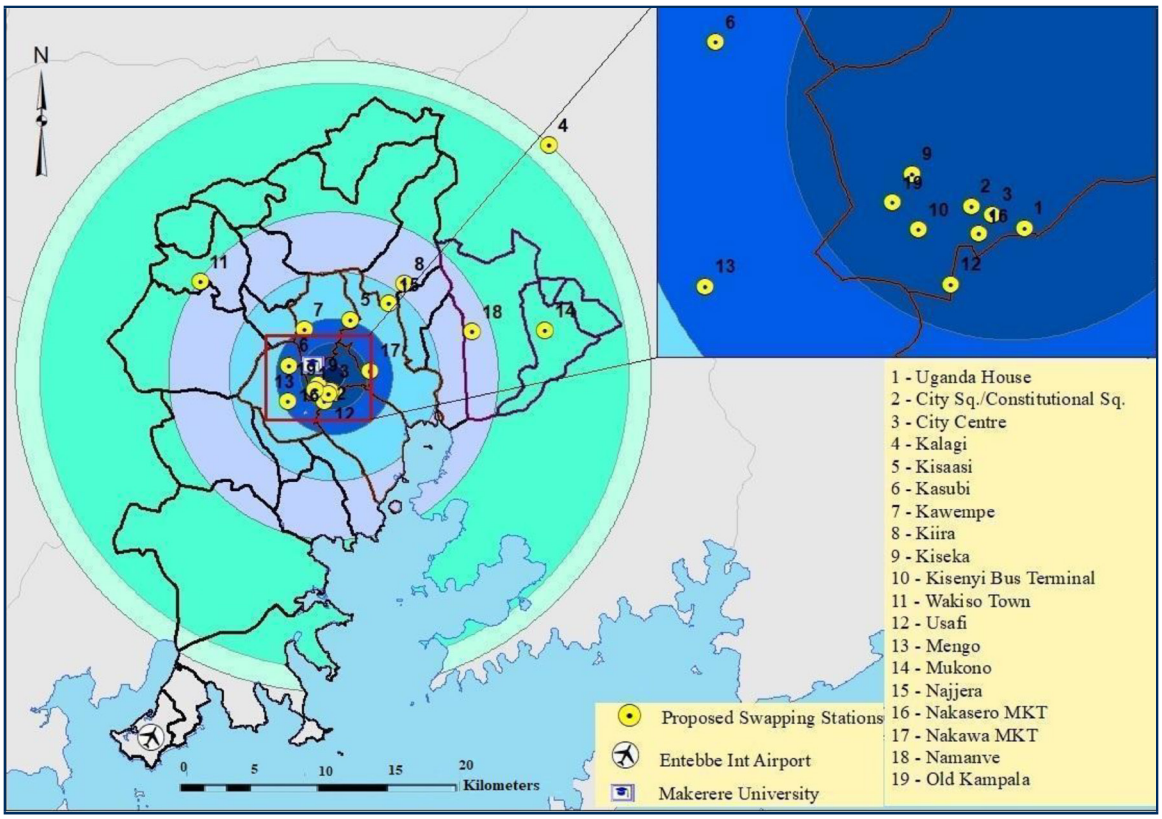


Source: E-boda drivers survey, Urban Action Lab at Makerere University and i3-CRG at Ecole Polytechnique, 2021.

Exhibits (cont.)

Exhibit 4

Proposed Battery Charging and Swapping Station Infrastructure for the Kampala City Region



Source: E-boda drivers survey, Urban Action Lab at Makerere University and i3-CRG at Ecole Polytechnique, 2021.

Acknowledgments

This case study is based on primary data collection in Kampala that followed a two-phase methodology: a quantitative survey with 200 boda riders (130 E-boda, 70 P-boda) from September to December 2021, followed by a series of qualitative interviews with 20 E-boda riders concluding in February 2022.

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Notes

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