"You are asking me to pay for my legs": Exploring the Experiences, Perceptions, and Aspirations of Informal Public Transportation Users in Kampala and Kigali

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ABSTRACT

Smart technologies have recently come under scrutiny for automating inequality. Given the current push towards developing and implementing smart cities policies that affect transportation systems in places like Kampala and Kigali, it is important to examine how the different modes of transportation meet the needs of diverse passengers and identify opportunities for technology to address any inequities. Prior studies have focused on the impact of informal public transportation on government policy and examined drivers' perspectives, but they largely overlooked the experiences of passengers and other industry stakeholders. In this study, we conducted interviews and surveys with public transportation riders with different disabilities as well as other stakeholders, including transport and financial technology creators. Our findings illuminate inequities in the transportation system surrounding discrimination and harassment, influence of ability on preferred transportation modes despite inaccessible interfaces, and influence of perceived social hierarchical structures on innovation. We present insights into how passengers appropriate technology to overcome challenges, and we uncover opportunities for technology to fill additional gaps. Lastly, we discuss how these findings support emergent frameworks such as aspiration-based design, and we present potential envisioned futures of technology for informal public transportation.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Field studies**; *Empirical studies in HCI*.

KEYWORDS

Informal Mobilities; Global South; Public Transit; Mobile Computing; Qualitative Research

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1 INTRODUCTION

"Sister, sister, ogenda?" shouts a man with half his body hanging out of a vehicle window. He is the conductor and his hand is raised in an effort to get the attention of a woman as his minibus drives by on a city street. In cities across East Africa, infrastructures such as marked bus stops are often unavailable and the above example is a popular way for transportation providers to attract passengers. It is taken from the streets of Kampala, Uganda, and the conductor is asking a female pedestrian whether she is heading in their direction.

Across East Africa, informal public transportation (IPT) is the lifeblood of cities and towns, with vehicle options such as the boda boda (a motorcycle taxi), the tuk-tuk (a three-wheeled vehicle), bicycles (with a perch for passengers), taxis (14-seat minibuses), large buses, and cars (similar to cabs). These forms of transportation are owned and managed privately and/or by community groups rather than by the government. Thus, the creation and enforcement of government regulation is limited, giving these entities free rein over schedules and the ability to change pricing. While there has been extensive literature focused on understanding the perspectives of the operators (i.e., drivers and boda riders) of IPT [37, 53, 61, 62, 70], there is little work focusing on the perspectives of passengers and local technology creators. These perspectives are necessary because they serve both as direct users of IPT systems (who have first-hand experience of any inequities in the systems), and also influence the direction in which technology will impact IPT. Therefore, there is a need to engage a diverse group of passengers and technology creators in order to reveal and discuss existing inequalities faced by different segments of the population.

According to national statistics, people with disabilities comprise 20% and 5% of the population for Uganda [59, p. 18] and Rwanda [60], respectively. They are viewed as among the most vulnerable people to transportation inequity; however, it is not clear how they navigate transportation and whether access to technology improves their mobility. Understanding the influence of technology on mobility is important because Kampala and Kigali are cities that are poised to see new transportation technologies: the former was chosen as the designated lead for the smart city initiative in Africa [44] and the latter because Rwanda is known as the regional leader in innovation [29]. Relatedly, these cities have seen the introduction of ride-share services – both international (e.g., Uber, Taxify, and VW Move Ride) and local variants (e.g., SafeBoda, SafeMoto, YegoMoto, etc.). Though technology can benefit users and enable

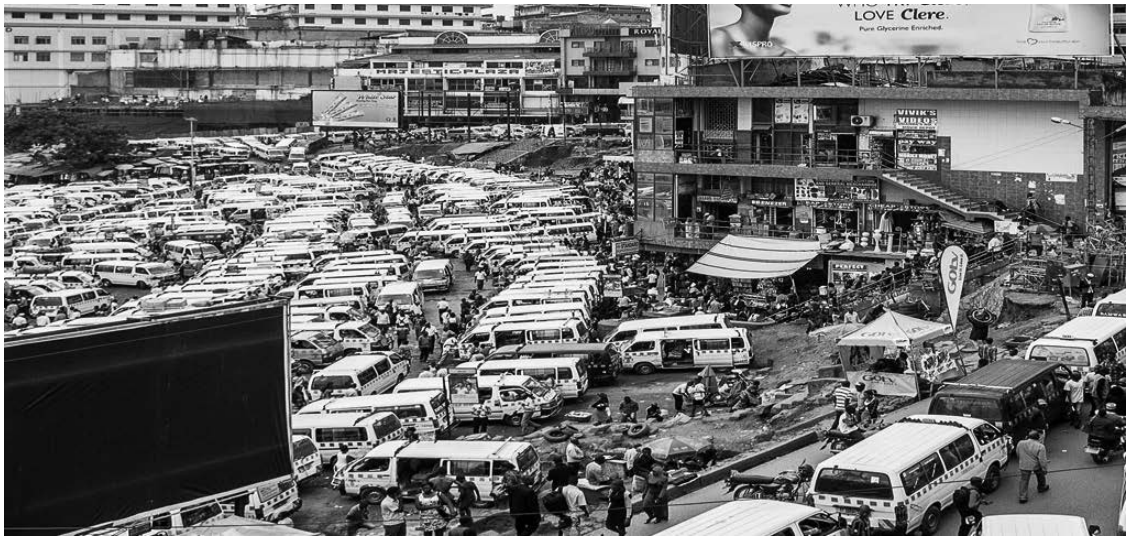

Figure 1: Photo showing two pedestrian entrances of the Old Taxi Park in Kampala. One entrance is a staircase close to the shopping arcade building while the other is a dilapidated staircase behind the Yellow GoTV Kiosk. Both limit persons with mobility and visual impairments from accessing the vehicles. Image courtesy Andrew Pacutho.

new and positive interactions among people and systems [14, 33], it also can have unexpected effects when applied to mismatched contexts [46] and even fail completely.

The fast-evolving nature of technology necessitates the need to examine the ecology of potential user communities (e.g., [9, 27]) in order not to risk automating existing inequalities and robbing agency from users [23]. Therefore, this work contributes a deeper understanding of the experiences, perspectives, and aspirations of passengers and industry stakeholders with the goal of informing future technologies. In our study, we administered surveys to passengers who use IPT in Kampala and Kigali and supplemented this data with in-depth interviews with key informants in the disability community and local technology ecosystem. We present 5 high-level themes, including the influence of ability on preferred mode of transportation and technology appropriation, patterns surrounding local commutes, discrimination and harassment faced by riders, and the influence of perceived social hierarchies. Motivated by the findings, we discuss areas where technology can and cannot mitigate existing inequities. We also look at how the findings support emergent frameworks, such as aspiration-based design, and we present potential envisioned future technologies for IPT.

2 RELATED WORK

In this section, we explore previous research emphasizing the importance of context in creating technology in general. Context is inextricably intertwined with technology design and adoption. Additionally, a holistic understanding of the context in which individuals are situated often complements their needs, perceptions and aspirations in informing design. We also examine prior work on transportation in developing countries.

2.1 Transportation in urban African cities

Transportation research in Africa has not been a popular domain for human-computer interaction (HCI) or intervention-related research [81]. In an analysis on HCI for development, Dell and Kumar [19] noted that the most prevalent domains were education, access (referring to the provision of technology, such as internet access or offline browsing experiences), and health. This finding supported previous work that noted that health and education technology interventions dominated development-focused research [13].

The vast majority of research on transportation in developing countries has a strong focus on policy. Examples include explorations on how capacity-building of operators could inform the public transport reform process [75]; the progress, process, and risks of engaging operators for public transport reform in Cape Town, South Africa [76]; policy challenges in developing countries on hybrid urban transport systems caused by the complexities and constraints of old, existing systems [25]; the organization and improved services of inner-city Matatu (taxis) and the potential for their transferability [8]; and the structuring of a user satisfaction model based on observed and unobserved variables from commuters in Nairobi, Kenya [30]. We also encountered literature on the role played by motorcycle taxis in providing IPT: they contribute to increased employment opportunities [62], improve access and last mile distribution [32], increase women ridership in urban areas [71], and potentially expand urban transportation systems [21].

2.2 Navigating public transportation with disabilities

Public transportation in cities in the global south has been described as chaotic and a nightmare [4, 35] especially for riders with disabilities. This ranges from overcrowded bus stations in India with little to no access to audio announcements [35] to bus parks in

East Africa with no accessible infrastructure (as shown in Figure 1). Pedestrian walkways are littered with obstacles such as hawkers and cyclists [54]. This lack of accessible infrastructure greatly limits the mobility of persons with disabilities. The idea of equitable mobility advocates that transportation services should be accessible to all. Crucial to that is the understanding of the needs and aspirations of riders with disabilities in these cities.

Disability research specific to Kampala or Kigali has explored the intersection of gender and accessibility [68]; and focused on the clinical disability model that is rooted in medical interventions [4, 15, 51, 83]. Studying access to transportation by people with disabilities and the influence (or lack thereof) of technology has yet to be addressed.

2.3 Transportation technology in developing contexts

As in other domains, technology has a critical role to play in enabling the collection of transportation information [72, 73] as well as improved access to vehicles. Kasera et al. [39] presented an example of this when proposing a ride-sharing system in Namibia that was optimized to support driver agency and the concept of *tempo*, referring to the pace of the driver's day. They emphasized the need for interventions to fit into the existing pace of the community. Similarly, Ahmed et al. [3] made recommendations for the redesign of Ola, a peer-to-peer technology to better serve the auto-rickshaw drivers in Bengaluru, India. Their insights found that while the drivers adopted new technology, they did not prioritize it over their traditional passengers (i.e., regulars who called them or those who hailed them from the roadside). They also pointed out that Ola did little to mitigate the uncertainty that existed in the drivers' days. In Nairobi, Klopp and colleagues [45] used information from the General Transit Feed Specification to record the complexities of the Matatu system (i.e., typical routes, stops, schedules, and fares). This type of real-time information is important for local transit applications. We also see examples of technology enabling access in rural areas through an SMS-based system that was used to solve last-mile challenges of connecting boda boda riders to customers [26]. Lastly, there is one example of a smartphone-based application that had a positive impact on women's empowerment and mobility in Kampala [55].

Studies with persons with disabilities outside of Kampala and Kigali have explored the effectiveness of interaction techniques [24] as well as the appropriateness of assistive technologies [49, 64–67]. We have also seen one example of the impact of ride-share services among persons with visual impairments in India. In their qualitative study, Kameswaran et al. [35] found that ride-share services had a positive impact on notions of independence. However, more research is still needed to illuminate the transit experiences of persons with disabilities in developing contexts.

2.4 The importance of context in technology adoption

Ethics and the appropriateness of a solution are important considerations when working with technology solutions, especially in the Global South. For example, Ssozi et al. [77] discussed how seemingly innocent terminology can cause discomfort when used in different regions, such as using the term "in the wild" in Africa. Researchers that are visitors to countries where their research is conducted are often concerned with the novelty effect their presences bring [56], which is known to result in response biases [20]. Therefore, researchers must carefully consider how they introduce and explain their research and whom to include in their research teams in order to obtain the best possible data.

Beyond linguistic or ethical differences, researchers must consider how access to certain technologies affects whether potential solutions are practical or even relevant. Discussions of context inevitably lead to the topic of generalizability. While technology has had positive impacts in some contexts, there are other notable examples of technology solution failure [46]. Bell and Dourish challenged ubiquitous computing researchers to expand their vision of the research setting beyond the laboratory and envision a future that considers the "cultural, social and political contexts within which technologies have transpired, and the contexts in which they have been deployed, consumed and resisted" [10, p. 139]. As one example, mobile payment methods that are not as popular in developed countries have proliferated in developing nations. Morawczynski and Misciones [50] unpacked the popularity surrounding mobile payment methods in Kenya. They found that it arose from the culture of dispersed families, rural-urban migration, and poor physical security. Understanding cultural differences like these can lead to insights on how people make decisions on technology use and adoption [12].

Motivated by this, we conducted a mixed-methods study with passengers of IPT and industry informants (with and without disabilities) to uncover transportation inequities and identify technology opportunities in Kampala and Kigali. We also were interested in identifying how embedded contexts (as seen in daily routines, challenges, envisioned futures and aspirations) might impact technology adoption (i.e., top-down or bottom-up approaches to innovation, design, and adoption).

3 BACKGROUND: SITUATING CONTEXT

In this study, we focused on two capital cities in East Africa: Kampala, Uganda, and Kigali, Rwanda. In this section, we present profiles of both cities and colloquial terms that are used within the context of IPT in order to provide an overview of the two transportation systems. While they are similar, we note that there are some important contextual differences.

3.1 Kampala, Uganda (KLA)

Kampala, the capital of Uganda, has a resident population of 1.5 million people [42] and a daytime population of more than 2 million people [22]. Kampala has various forms of public transportation, ranging from Taxis to Boda bodas, Special Hires, bicycles (with a passenger perch), and large buses [36].

The 14-seat minibuses are locally referred to as *Taxis*. Taxis can be considered a form of shared transportation because they provide rides to multiple unacquainted passengers at the same time. They are operated by a driver and a conductor who collects money from passengers as they leave the vehicle.

The motorcycle form of transportation is called *Boda Boda*. Boda bodas are ideally not shared by multiple passengers due to the

physical constraint of seating on the motorcycle; they typically seat a driver and a single customer. However, the size constraint often does not stop additional riders. Motorcycles have a notorious reputation among the locals for driving as if they are exempt from traffic laws and are often seen breaking regulations, even in front of law enforcement.

Kampalans use another form of transportation called *Special Hires*. These are vehicles that are rented by individuals to get them to specific destinations, which might range from a shopping trip to a funeral. While the cars in this category can be any size, it is most common for them to be approximately the size and the shape of an early 2000s Toyota Corolla. Another type of transportation in Kampala is the larger, 60-person bus that can travel both long and short distances.

Hailing these modes of transportation is slightly different. Outside the city center, taxis and boda bodas can be hailed from the side of the road, while within the city center, taxis are strongly encouraged to collect passengers from designated stages (stops). For taxis, a conductor will often ask bystanders if they are interested in boarding by announcing the vehicle's destination (e.g., Kampala, Ntinda, etc.). The reverse happens when hailing a boda boda: the passenger informs the driver of their destination. Sometimes, passengers will keep the contact information of a boda boda driver and call them when they need to travel. It is also common for passengers to haggle before boarding any of the mentioned modes.

IPT recently evolved (as of initial data collection) to include ride-share services, including SafeBoda, Uber and Taxify (now Bolt). Uber and Taxify both started with only cars in their operations, but later expanded to include boda bodas. We postulate that this is due to the observed preference of passengers in Kampala for the boda boda because of convenience. Ride-share services are hailed by using the application or, in the case of the boda bodas, walking up to riders and scanning the rider's QR code to initiate the ride.

Individuals can board or disembark from a vehicle from multiple places, including a *Taxi Park, Stage,* and along the *Roadside*. A taxi park is a designated location where multiple taxis to different locations might park. Fares from this location only fluctuate in rare circumstances (e.g., rain, operator strikes, riots). That isn't the case for taxis that are boarded along the road that credit fare inconsistency to "jam" (traffic). A stage is a locally known spot where taxis drop off and pick up riders; in contrast, a boda boda stage is a location where a cluster of bodas park and wait for passengers.

3.2 Kigali, Rwanda (KGL)

Though Kigali is 500 km from Kampala, the cities have similar modes of transportation but differing patterns, laws and regulations. Kigali is the capital of Rwanda and boasts a population of over 1.3 million [57]. It has multiple IPT options that are similar to those in Kampala, including minibuses, large buses, motorcycle taxis, and cars [2]. The 14-seat minibuses, locally referred to as *Taxis*, are currently being phased out in favor of buses that can carry 30 to 51 passengers. Here, motorcycles are called *Motos*. Similar to Kampala, taxis and buses are a form of shared transportation. In Kigali, motos usually do not exceed their intended rider capacity.

Kigali has begun to implement new, more organized, bus stops in different parts of the city. Also, it is required for anyone using a motorcycle in Rwanda to use a helmet; as such, moto drivers often carry an extra helmet for their passengers. As in Kampala, motos can be hailed from the side of the road or from a designated stage in a neighborhood. Kigali's version of the special hires are called *Taxi Voiture*. Unlike motos that might drive along the road looking for passengers, taxi voitures usually only depart from specific locations and will only solicit business from people who approach their vehicles or glance in their direction from across the road. In Kigali, transportation has also recently evolved (as of initial data collection) to include ride-share services such as SafeMoto, YegoMoto and Move (Volkswagen's ride-hailing service).

4 METHODOLOGY

4.1 Study design and data collection

Our design was guided by our motivation to uncover passenger experiences with IPT in Kampala and Kigali and understand nuances that affect how technology can influence and possibly improve transportation for riders with different abilities. To this end, we administered surveys with passengers of IPT to understand influences around usage and adoption and followed up with in-depth, semi-structured interviews with passengers and other key informants (e.g., start-up workers, regulatory agencies and disability activists) in the local technology ecosystems. The interviews were conducted either in person or online with stakeholders who were physically unavailable. This research was approved by our university's Institutional Review Board as well as university faculty and staff in Kampala and Kigali.

We recruited participants through social media, a technology co-working space, and local university noticeboards because populations that frequented these spaces were determined to be frequent users of IPT. We required that participants were above 18 years of age, had resided in Kampala and Kigali for at least a year, and used public transportation. We used one-on-one semi-structured interviews, in-person surveys, and online meetings (audio and video). In total, we conducted 46 surveys over a 2-week period and 12 key informant interviews (5 in person and 7 online) over a period of 2 months. Our participants lived in areas outside the city and commuted to town for work or school.

4.1.1 Passenger patterns survey. Our survey focused on preferences in public transportation. We invited participants to hour-long sessions where survey forms were physically distributed. We conducted 7 survey sessions in Kampala attended by 25 participants and 15 sessions in Kigali attended by 21 participants. Each session started with an overview of the research topic, the informed consent process, and a high-level briefing on the survey. Participants did not receive any monetary compensation for filling out the surveys and participated due to their interest in improving IPT. Although the surveys were administered in person, we only collected demographic identifiers, such as participant gender and age. No personally identifiable information was collected.

The 9-page survey was used to collect information on eight key topics: Frequency of Use, Morning Commute, Evening Commute, Familiar Strangers, Perception of Safety, Harassment in Public Transit Spaces, Passengers with Disabilities, and Future Impact of Technology. However, only Morning Commute and Evening Commute

were labeled explicitly, in order to prevent response bias. Inspired by prior work [69], we included questions on "familiar strangers", who are the people that passengers observe, but do not interact with, at a boarding location or along a commute. These questions explored if participants often boarded with the same people and would intervene on their behalf in the event of any issues.

The 25 participants in Kampala (9 female and 16 male) were almost evenly distributed in age (with 7 participants between 18-24, 10 participants between 25-31, and 8 between 32-38). The majority of the participants indicated that they lived in areas in the northern part of Kampala. Of the 21 participants in Kigali (6 female and 15 male), 18 indicated that they were in the 25-31 age range, with the rest falling in the 18-24 age bracket. Again, most of the participants lived in areas north of the city.

4.1.2 Key informant interviews. We interviewed different stakeholders, including riders with disabilities, individuals in or associated with transportation in the start-up community, members of regulatory agencies, and individuals who work with persons with disabilities.

The in-person interviews were conducted in the interviewee's office or another convenient location (2 interviews in Kampala and 3 in Kigali). These 8 participants (2 companies opted to have group interviews) included persons who either worked for regulatory agencies or worked for organisations associated with transportation in the startup community. In-person interviewees did not receive any monetary compensation.

Our seven online interviews were conducted on Skype with participants in the disability community. These interviews lasted 1.5 hours. We modified the type of streaming (video vs. audio) based on both participant preference and whether they were using Wi-Fi or mobile data. Four participants used Wi-Fi and 3 used mobile data. Online interview participants were compensated to cover their data costs using mobile money transfer. The compensation rate was based on the average monthly rate of mobile data packages sourced from local telecommunication providers. We conducted 6 Skype interviews for participants in Kampala and 1 for a participant in Kigali. Five of our participants who work with persons with disabilities self-identified as having a disability (i.e., Physical: 3; Deaf/Hearing Loss: 1; Albinism with Visual Impairment: 1). These participants shared their insights from working with persons with disabilities and their own personal experiences using public transportation.

The interviews covered topics that included the current state of IPT, access to different modes by people with disabilities, and potential challenges and opportunities for technology. All interviews were audio recorded for transcription and further analysis. Researchers also maintained a daily activity log and recorded their observations and insights after every interview.

All data was transcribed by a researcher with experience living and interacting in Kampala or Kigali. This was useful in the event of colloquial expressions that have local contextual meanings and have been integrated into English speech but do not make sense to English speakers elsewhere (e.g., ...don't *disturb* people to *look for me* data...).

4.2 Data analysis

We used descriptive statistics to analyse our quantitative survey results and thematic analysis for the survey's free text responses and interviews [11]. Our initial analysis revealed 9 high-level themes that we later condensed to 5 themes. These include the influence of ability on preferred mode of transportation and technology appropriation, local commutes, discrimination and harassment, perceived social hierarchical structures, and technology interventions.

While reliability is a debatable notion in qualitative studies due to changes in human behavior, we attempted to ensure our results were consistent with our data using a combination of an audit trail and triangulation (i.e., using multiple sources and including observations, reflections, and decisions made during data collection).

4.3 Self disclosure

Data collection was conducted by the first author, who grew up and worked in Kampala and has also lived in Kigali. Her experience using and navigating IPT in both cities motivated this study. The other authors are from the United States and have research experience working within human factors, accessibility, and developing countries. All authors have experience with information technologies and were intentional not to inflate the potential of technology to participants.

5 FINDINGS

Here, we present themes that emerged from our survey and interviews data. All names have been changed for anonymity. For the sake of clarity, all boda bodas and motos will be referred to as motorcycles, special hires and taxi voiture will be referred to as cabs, large buses will be referred to as buses, and taxis will be referred to as minibuses.

5.1 Local commutes: connections, detours, and safety

AI systems within the transportation domain (e.g., time to leave suggestions) are built off of routine rider patterns. Thus, we sought to understand whether survey participants had regular travel routines. We asked whether they left at the same time each day. A majority in both cities (18 in Kampala and 16 in Kigali) said that they leave home within a specific time window rather than at a specific time. For example, saying that one leaves home every day at 9 AM signifies leaving at any point in the 9 o'clock hour. In Kampala, participants typically said that they board at a popular stop to use a minibus or motorcycle. In Kigali, participants typically start their commute with a motorcycle hailed outside their homes.

In general, participants reported that their commutes did not have any formal transfers or connection structures, especially for those with final destinations in the city. Most of the transit options offered direct trips from the suburbs to the city. For those whose commute included connections, Kampalans noted that they often use another minibus or motorcycle, while Kigali participants mentioned using buses. For most trips to the city, there are main roads that are the most direct and obvious routes. However, during morning rush hour, drivers often use secondary routes. As a result, riders will get to their final destination but cannot predict the route or its duration, which is especially important for morning commutes.

Operators will sometimes announce the reason for the route change, and participants in both cities agreed that these were typically traffic on the main road and declarations that the secondary route was a shortcut. Other reasons include construction and roadblocks. Participants in Kampala noted that these routes are in fact normally busier and longer than the main route. Participants in Kigali agreed that the length of the route is usually longer but noted that it is normally less busy.

Participants indicated that their evening commute was similar to the above, except for some in Kampala using Uber (car mode) late at night. In both cities, participants said that operators gave the same reasons for opting for a secondary route: traffic and "shortcut". One participant account highlighted the randomness of this process - to avoid traffic, their minibus simply followed another minibus in front of them without knowledge of its final destination (KLA). Participants also noted that the secondary route was often busier and longer than the main route in the evening as well. Participants did not state if their plans were more negatively affected by these changes in the morning compared to the evening or vice versa. They also did not suggest any potential solutions.

In both cities, participants said they would change the amount of traffic they had to endure during commutes. These are growing cities, so this is not a surprising finding. However, sharing local knowledge of gridlock-prone routes is important and would be useful when moving between suburbs. Other pain points were the uncertainty of fare prices (KLA) and irregular bus schedules (KGL). In Kampala, participants particularly reported price uncertainty during poor weather.

As a result of the above challenges, participants in Kampala expressed interest in information on traffic congestion, user ratings for their motorcycle operators, alternative routes, and route fares. Participants in Kigali mentioned similar information needs and added minibus arrival time predictions. These suggestions were complemented by ideas from our industry informants, who envisioned solutions that include implementing price-based systems that took into consideration distance and elevation changes for motorcycle operators, displays that offered bus arrival times to passengers, and implementation of a bus rapid transit (BRT) system (Shema and Ntwari (KGL)).

In Kigali, participants' safety concerns included vehicle condition and speed. One participant noted they had no choice in the route, but they implicitly trusted the driver. Participants in Kampala noted that they did not feel safe when their transportation chose an unfamiliar secondary route, due to minibus muggings coordinated by operators [40]. For persons with disabilities in Kampala, security of assistive devices was a key issue; they feared their devices would fall from the vehicle. Most participants in both cities said they would ask a fellow rider about route safety. This strategy could provide useful information, assuming that rider was not also a thief.

We also asked about factors that influenced perceptions of safety in the morning and evening commutes. While each city presented unique factors, the factors were consistent across the commutes. In Kampala, the number of passengers in the vehicle, time of day, and gender of passengers who occupied the minibus had the biggest influence on passengers' perception of safety. Both male and female participants noted that they felt safer with women in the minibuses compared to men, for example:

> "*Who else is in the [minibus], I feel too many young men no ladies is a problem*" - Ssebaana (KLA), Male.

Several concerns noted by participants in Kampala have value to policy makers by identifying achievable interventions, such as an improved road network and street lighting. These requests are related to the increase in incidences of kidnappings, muggings, and murders [6].

In Kigali, the concerns for safety during morning and evening commute regarded the vehicle's condition and speed.

5.2 The influence of ability on preferred mode and technology appropriation

Participants without disabilities in Kampala selected minibuses as their preferred mode, with motorcycles and Uber (car mode) following closely behind. These choices make sense because minibuses are considered the cheapest mode of transport covering long distances. In Kigali, however, motorcycles were the preferred mode, with buses second. Participants in both cities noted that, of all of the options, the agile motorcycles were always immediately available.

Participants who worked with people with disabilities reported that public transportation was a huge part of their stakeholders' lives. Different modes of transportation best suit different abilities, which was reflected in how passengers chose to travel.

> "*Deaf persons can use all [the available modes]. Blind people move better in buses and maybe [minibus]. Physically challenged people can use [motorcycles] preferably.*" - Wasswa, Mobility impairment.

> "*For a person with physical disability will [use a] [motorcycle] because it will take him to the final destination or the door step unlike the [minibus] for which you have to walk a distance [...]*" - Mutebi, Mobility impairment.

The motorcycle mode was considered a favorite for passengers with some disabilities because of its flexibility and ease of access compared to minibuses. This door-to-door convenience is likely amplified by the use of app-based motorcycle services, such as SafeBoda and UberBoda. Data from the survey participants supported these findings, i.e., participants in Kampala reported observing people with mobility impairments frequently using the motorcycles; however, a preference for buses was observed in Kigali. Participants with assistive devices noted that the devices were either tied to the back of the motorcycles or held by the driver. However, the consequence of having the current transportation options is that blind people cannot easily find transportation in areas that only motorcycles travel (e.g., streets with bad roads), and people with mobility impairments can only travel short distances easily because motorcycles do not travel as far as minibuses do (without becoming excessively expensive).

The preference for motorcycles by participants with disabilities is also reflected in the appropriation of technology solutions targeted at IPT. When asked about technologies that they use related to transportation, give of our online interview participants mentioned motorcycle applications (e.g. SafeBoda, UberBoda, Taxify). Mutebi (KLA), a participant with a physical disability, specifically cited the independence he felt when using these applications,

"I can order for Uber or SafeBoda. It is easy for me, I do not disturb anyone to go and look for me a [motorcycle]."

However, participants with disabilities also pointed out the shortcomings of these applications. It is common for these ride share drivers to call their passengers as they approach the pickup point, but answering these calls is particularly difficult for passengers who are deaf. Egwang (KLA), a participant who is deaf, noted that to use these applications, he needs to have someone else on hand to answer the calls. He described an incident where he tried to get help from a nearby shop; however, the shop owners were alarmed by his gestures and did not understand what he was trying to communicate and thus refused to help. Asiimwe (KLA), a participant who works with people with disabilities in internally displaced camps, also noted that while persons with disabilities are using these applications, she had yet to see in-app accessibility features, such as vehicle options that were modified to cater for persons with physical disabilities. Lastly, both Mutebi and Asiimwe remarked on the exclusive nature of these solutions: users must have a smartphone and buy data to access to the Internet.

Government and transportation stakeholders are aware of these issues and some are actively working to improve transportation for disabled riders. The recent shift toward catering to the well-being and mobility of persons with disabilities has led to the introduction of accessible buses in Kigali. Ishimwe (KGL), a participant with a physical disability, noted that buses are the favored form of public transportation by riders with disabilities and that they have improved the mobility of public transit riders in wheelchairs. For riders with visual impairments, these buses are fitted with audio functionality that announces the approaching bus stations. However, he noted that there was still an opportunity for the inclusion of riders with hearing impairments, as they were not yet supported.

5.3 Discrimination & harassment of transportation riders

The interview data provided an interesting emphasis on the role of other passengers with disabled riders. Our interviews in Kampala revealed harassment of persons with disabilities around denial of access and unfair fares. Participants reported instances where some minibuses would not stop to pick them up or operators would first inquire whether the rider would be taking their assistive device (e.g., wheelchair or crutches) with them, and then potentially drive off depending on their answer. They reported two instances of passenger intervention. In both instances, the transport operators were attempting to deny a passenger using a wheelchair entry into minibus unless they paid extra (often another full fare) for their wheelchair. In both instances, the passengers in the vehicle came to the aid of the person with disability, ensuring that they boarded and also arrived at their destination without further harassment.

"*I was traveling a long distance [...] the guy was like I should pay for my wheelchair and I was refusing saying no I cannot do that saying this is my legs and he said, but it is occupying my space you have to pay and the amount that they sometimes charge is equivalent to what an individual is paying. So someone said that unless you tell everyone in this bus to pay for their legs, he is not going to pay. And then others also joined in. And then when we reached the stage, they carried my wheelchair out and said you go - let us see him following you [...].*" - Mutebi (KLA)

An overwhelming majority of our survey participants did not observe or board with the same people daily, however, they were more likely to intervene on behalf of strangers over issues (shown in Table 1). Some participants seemed surprised at the notion of talking to strangers at the stop; for those that interacted, it was mainly in greeting form.

Table 1: Distribution for recognition of familiar strangers.

	Kampala		Kigali	
	Yes	No	Yes	No
Observe the same people	5	20	1	20
Board with same people	4	21	0	21
Intervene for stranger	6	17	6	13

Passenger intervention, however, was not always the norm during trips for riders with disabilities. Our discussion with our participants with disabilities revealed that other passengers remarked that a person with disability would take too long to board the vehicle or outright refuse to sit next to them because of their state of dress and body odour. An unintended result of these experiences with negative attitudes left passengers with disabilities feeling like second-class citizens.

A similar sentiment and experience was reflected in interview data from the participant in Kigali. Ishimwe (KGL) blamed the existing stigma on a lack of awareness and naming conventions for persons with disabilities that are rooted in cultural origins.

Among riders without obvious disabilities, responses concerning harassment presented a dichotomy between the two cities. In Kampala, most survey participants said they had been heckled more than once in an IPT setting. In Kigali, more than half of survey participants said they had never been heckled in these settings. When distinguishing between verbal harassment and physical gestures of groping, in Kampala, all of the female and more than half of the male participants reported having encountered both forms of harassment. Notably, the definition of harassment varied between by location. Hissing is viewed as harassment in Kampala but not Kigali.

5.4 The influence of perceived social hierarchical structures

In Kampala, participants noted that there was a need to understand the invisible reach that culture and norms have over adoption and perceptions regarding technology. Bugembe (KLA) noted that he rides his bicycle to work every day, but bicycles are at the bottom of the transportation hierarchy, so there is a general lack of respect toward him on the road. His explanation for using a bicycle was that with the population shift from rural areas to urban city centers, there is a need to adopt clean and affordable transportation solutions. However, this mode of transportation poses an additional safety risk as there are no laws protecting bicycle riders and motorists believe that they have right of way over bicycles and do not even account for the presence of bicycles when switching lanes.

Participants hinted that the choice whether to drive a private vehicle or take a minibus was directly related to a person's socioeconomic status. A common viewpoint is that people who drive cars have simply achieved enough success to not take minibuses any more. Abaho (KLA) noted, "In a city where 1 in 4 cars has a parking spot, technology offers opportunities to find the closest parking lot or structure (several blocks away), then hop onto a [minibus] to work. However, when you propose it to Kampalans, they would rather spend another 20 minutes driving around looking for a parking spot than [be seen taking] a short [minibus] ride". Participants from Kigali did not seem to share the same status association with boarding minibuses. However, people preferred to take cabs over minibuses for comfort (minibuses in Kigali seat more people than those in Kampala).

5.5 Technology: (un)successful interventions

In Kampala, experiences with implementing technology solutions in the existing public transportation ecosystem highlighted negative sentiments. Abaho (KLA) noted that operators were interested in testing cashless payment, but they encountered barriers when interacting with various informal structures that characterized their day. Examples of such structures included making payments to route touts (individuals who collect "membership" dues from minibus operators) and cabals (routes that only allow drivers who have paid said dues), fuel pump attendants, and minibus owners. These findings provide evidence of a mismatch between technology solutions and their appropriateness for use in different context.

In Kigali, however, Ntwari noted that there have been successful tech-based changes due to favorable government policy, including: (i) implementations of cashless payment solutions in public buses—"Intercity buses use tap-and-go payment while buses that go outside of the city use tickets"; and (ii) an online dashboard monitoring the deployment of buses as well as enforcing speed limit regulation and providing reward incentives to drivers who adhere to regulations. Habimana (KGL), whose start-up works with motorcycle riders, noted an uptick in technology literacy among riders. Riders who previously had limited or no technology access were now becoming adept at reading maps and troubleshooting device errors.

Some participants (KLA) noted that technology can be used to improve passenger safety within vehicles, improve access to the different options, and determine trip cost. Other participants (KGL) envisioned technology being used for bus arrival predictions and scheduling, as well as improved payment systems (e.g., contactless payments). The latter was an idea expressed by our industry informants Mugisha (KGL), Keza (KGL), and Gara (KGL), who work at the intersection of IPT and financial technologies. Their imagined that the future of IPT technology includes allowed seamless payment transitions between different modes of transportation and diversification of the current payment systems across multiple domains (e.g., transportation and healthcare). They believe that technology offers a unique opportunity to add value to both passengers (e.g., manage bus fares where uncertainty exists or promote financial budgeting) and government entities (e.g., transparency through identification of revenue leakages).

6 DISCUSSION

We gain a rich understanding of the local context in regions like Kampala and Kigali by identifying transportation patterns (even those that are mundane, such as daily commute habits), examining desired aspirations through envisioned futures in transportation, and exploring perceptions related to transit, technology and the space between. This reinforces the ICTD and HCI for development communities' commitment to obtaining a holistic understanding of local settings. Identifying these factors can inform technology design and interaction.

6.1 Aspirations through Envisioned Futures

Exploratory studies like ours are a good source of findings relevant to technology design and implementation. We position these results within frameworks, such as aspiration-based design, and discuss future research directions and their implications.

6.1.1 Opportunities for technology. The preference for specific modes of transportation based on users' abilities should be taken into consideration when implementing functionality. For example, this could include enabling speech recognition for users with amputated limbs who are unable to use interfaces built with traditional gestural interaction. In addition, applications targeted at cabs and minibuses should take into account the requirements of users with visual impairments as these are their preferred modes of transportation. For instance, they should promote the use of digital payments (like mobile money) in Kigali, which has digital systems in place. These types of payments help avoid instances of cheating that might happen with cash payments. These requirements should also prioritise the safety of passengers (especially those with visual impairments) by providing audio updates when alternative/unfamiliar routes are taken and thereby giving them agency regarding route choice. Another opportunity to enhance agency for passengers with and without disabilities is through implementing a crowd-sourced route safety tool. This tool can provide passengers with information before they start their trip or while their trip takes an unplanned detour. An aggregated mapping might also show evidence of crime hot spots that would be useful to law enforcement. This tool could have multiple use cases outside of safety: 1) technology hubs can use this feature to educate passengers about engaging with drivers on the challenges of secondary routes, and 2) citizens who commute using bicycles can use the application to find bike-friendly routes and times.

6.1.2 The influence of aspirations on adoption. Prior work has argued for the importance of understanding the aspirations of potential technology stakeholders [47, 80] because these aspirations then influence adoption. In this study, we find further evidence that supports these assertions, especially among experiences shared by passengers with disabilities. We discuss this support based on the three main qualities of aspirations: embedded (aspirations are rooted in past experiences and local context), temporal (aspirations can be satisfied within an unspecified period of time), and mutable (aspirations have the capacity to change).

Embedded aspirations can be clearly seen in the adoption of rideshare services by persons with disabilities. Participants described

situations where they felt like second-class citizens when using traditional methods to utilize IPT. Their technology adoption results in additional freedom from traditional social and physical accessibility barriers. The temporal boundaries within the aspirations that we found were connected to the day-to-day and long-term activities and patterns of users of IPT. The day-to-day activities that could be affected by technology include interactive bus terminal data for bus arrival and departure information (KGL) and efficient and context-dependent pricing systems (KGL, KLA). The long-term aspirations include the ability to implement integrated single-source payment systems across multiple domains (e.g., linked health and transportation systems) to increase convenience.

The fact that aspirations can change over time is reflected in their mutability. We posit that shifts will be seen as more solutions are implemented that satisfy passenger aspirations, including policy and infrastructure improvements. As needs and priorities change, so might transportation and technology preferences. For example, bicycles are currently disregarded as modes of transportation in these two East African cities, as they are the least expensive option. However, as these countries develop, it is possible that the ecological and health concerns that motivate bicycle usage in other cultures will change the impressions of bicycles in East Africa.

6.1.3 The nuance of engaging ability. Within the disability research community, there have been longstanding efforts to focus on user ability when designing technology [28, 82]. Our work presents some evidence of tension when integrating the notion of ability. Our findings show that taking ability into consideration goes beyond understanding a passengers' mobility. This is made evident in passengers (both without and with disabilities) preferring the boda boda mode of IPT. For the former group, the preference was rooted in efficiency (i.e., reaching the destination as fast as possible). For the latter group, participants liked how motorcycles get them from their origin point to the doorstep of their destination and the lack of additional hassle of dealing with traditional operators. Interfaces that integrate transportation routes, modes, and schedules should adapt to factors like perceived efficiency, door-to-door service, and other personal preferences.

Conversely, we identified one failure case at the intersection of technology and ability that has implications for designers and researchers. Ride-share operators are not trained and applications are not designed to consider riders with different physical disabilities. As with boda boda and special hire operators in Kampala, ride-share drivers will often call passengers to confirm that they are en route or at the gate. However, riders who are deaf had difficulty with this use case. This has recently been solved through the addition of an in-app texting platform (as seen in the Uber app), but it is unclear whether this will work across the board due to the wide variety in literacy levels for users and drivers. This reveals an opportunity for new interaction and experience designs that support lower literacy levels (e.g., read-aloud options with local options).

We also found evidence that supports prior work on the importance of offline connectivity [5, 74]. Participant responses extended the notion of ability to include connectivity. To address this, designers of mobility interfaces should be intentional about internet connectivity and consider interfaces that adapt to offline functionality when data is expensive.

6.1.4 The influence and appropriation of technology. Researchers have disagreed at times about the influences that ride-share technologies can have on a population as a whole [18]. Our work provides evidence that these technologies are being used to alleviate some of the social pressures that characterize users' lives, especially for those with disabilities. As previously stated, riders with disabilities characterize their appropriation of these technologies using terms that relate to the promotion of agency and independence. The idea of technology contributing to agency and independence is not new to researchers in the disability domain [78]. The appropriation of transportation apps by persons with disabilities in developing countries is especially noteworthy given that they are considered some of the world's most vulnerable populations [48].

We also see the influence of local contexts on technology development and dissemination, such as Uber offering boda boda ride-share options in their local application. This speaks to the context for this particular form of transportation in the region: even though some ride-share companies offer cheaper car rides, users still choose the boda boda option because they find it more efficient and convenient. Both Kampala and Kigali also have local ride-share applications solely for the boda boda form of transportation.

The notion of smart mobility eventually evokes the idea of *AI for transit*. From a user's standpoint, these systems often rely upon the concept of regularity: predictable numbers and types of vehicles on the road, schedules, etc. However, our work indicates that, in these cities, users report regularity in general terms (e.g., early morning or late at night) and IPT modes follow flexible schedules, if any. This raises the question of whether AI could, and should, be used to nudge user schedules (e.g., waiting out surge pricing especially during the rainy season) as is the norm in cultures with specific time-based routines. Perhaps the adoption of these AI technologies will be increased if they are designed to adapt to the scheduling norms of these cities.

Lastly, pursuit of equitable mobility proposes that individuals should have equal access to transportation and travel. Our findings support prior work from different regions that found that transportation is often not equitable for riders with disabilities [34, 63]. In some societies, media-related campaigns (e.g., television, radio programs and advertisements) have been used to target behavior change [52]. Technology such as persuasive design and game development can be another effective method to impact behavior change [16, 31, 41], especially among operators who discriminate and harass persons with disabilities.

6.1.5 Gendered ridership. Around the world, women have lived in societies with deeply rooted histories of patriarchy [1, 79], including having little to no representation in political and social spheres and specifically being targeted for abuse (even while aboard public vehicles). Yet a surprising and novel finding from this work indicated that both women and men reported feeling safer boarding vehicles that were already carrying women. This presents the opportunity to investigate gendered computing at the intersection of public transportation. Drawing from backgrounds such as feminist HCI [7] and feminist theory [17], we can position our research into understanding whether this finding indicates a shift in power dynamics while aboard these vehicles and whether this perception is shared by women riders. Similarly, these perceptions may carry

over to other aspects of citizens' daily interactions, such as feeling more trust when working with female researchers or health practitioners.

6.2 Exploring context & adoption

It is undeniable that for cities like Kampala and Kigali, local social influences are unique and impact the lives of citizens. Our comparisons are not meant to elevate one city over the other, but rather to explore how regions that may appear quite similar from the outside may have different factors that impact technology adoption.

While both cities have been known to celebrate innovation, it is apparent from our discussions with different key informants in the two ecosystems that the nature of each system is fundamentally different. Kampala is characterized by a grassroots approach to technological innovation: individuals come together to implement systems that might end up influencing policy. The culture fosters a communal effort towards problem solving and solution creation, and therefore it may benefit from the use of crowd-based technologies and participatory design approaches that allow for continuous public initiative and contribution to the creation of a system and its content. Having users provide real-time information about road closures, construction and incidents of theft, harassment, less-than-optimal transportation routes, etc., might be especially successful as they fit into existing community-based practices. Top-down, policy-driven initiatives such as those for cashless payment systems struggled due to the need for cash payments by operators to different players (e.g., fees, fuel, payoffs, etc.). In spite of Kampalans' interest in a cashless system similar to one in Kigali, financial technology solutions also struggle when they create obstacles to existing forms of livelihood. Because of how context can make or break adoption, new technology service models must consider the nature of the ecosystem and purposefully balance aspects to obtain buy-in from cash-based stakeholders while providing the ease of use desired by passengers.

In contrast, Kigali has an approach similar to a policy-driven model: government policies are put in place to foster and direct an ecosystem of innovation (as noted in our findings). This policy-driven approach that characterises Kigali's growing ecosystem is primed for local ready-to-go technology solutions. Consider cashless payments, which can take the form of domain-specific smart cards, debit card transactions, and mobile money payments. Due to supportive technology policies and implemented infrastructure, Kigali has been able to design and employ cashless payment solutions within the sphere of IPT. Policies like these impact potential widespread adoption, especially within urban cities with technology-friendly populations, by creating a single, unified system that can be adopted simultaneously by all stakeholders.

Furthermore, in both cities, there is an opportunity to explore whether these policy narratives engage with the lived experiences of persons with disabilities. These narratives provide opportunity on which disability advocates and technology enthusiasts can engage with persons with disabilities and their allies.

6.3 Limitations

Our research with key informants who worked with persons with disabilities was conducted online rather than in person. While these informants were able to give us a wealth of knowledge, we acknowledge that this prevented interviews with people lacking access to online meeting tools. Similarly, while English is one of the official languages of both countries, we acknowledge that there is a diversity of other spoken languages in both countries. One of the authors speaks some of the local languages, but we limited our interactions to English in order to maintain consistency. This choice also limited the breadth of participants who were able to participate in our surveys.

7 CONCLUSION

In summary, this study revealed new knowledge about technology for the informal ecosystem of public transportation in two cities in East Africa. From our data, we identify high-level themes, including the influence of perceived social hierarchical structures, local heuristics around harassment within vehicles, and the appropriation of existing technology solutions to promote feelings of safety and reduce social stigma for passengers with disabilities. We discuss the different opportunities for technology to address existing inequities. We believe that this work is a complementary step to efforts in these cities to implement smart city technology as they expand beyond their colonial seats of power [38, 43, 58].

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