

INTERROGATING THE LINKS BETWEEN ACCESSIBILITY AND SUSTAINABLE MOBILITY TRANSITIONS IN AFRICA: ANALYSIS OF FREETOWN, SIERRA LEONE

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Abstract

In the context of still-low-but-rising levels of motorization, economic growth and increasing social and spatial inequalities, the formulation and implementation of policies, practices and partnerships that can support an accelerated implementation of sustainable mobility policies is an urgent concern for rapidly developing cities. This paper seeks to contribute to rethinking some of the knowledge and methodologies produced in and about cities of Sub-Saharan Africa through a comprehensive assessment about mobility patterns and accessibility needs within a larger debate about mobility transitions and sustainable development. By deploying a mixed-methods approach that builds upon case-study focus groups and city-wide accessibility and mobility analysis in the city of Freetown, Sierra Leone's capital, the paper maps travel patterns and their links with structural factors such as urban form, poverty, informality and social identities at the macro, meso and micro level. The paper also raises relevant evidence from a variety of methods that illustrate the significance of accessibility-centred information and analysis for policy priorities of urban mobility and accessibility in the local, African and global contexts.

Keywords: Accessibility, Mobility, Transitions, Sustainability, Mixed methods, Africa

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1. Introduction

The Transitions to Sustainable Urban Mobility (<u>T-SUM</u>) project is an interdisciplinary and cross-sectoral collaborative project that aims to identify the conditions under which pathways to sustainable and inclusive transport and land use development can be developed and accelerated in growing cities in the Global South. It is grounded in the observation that, in the context of still-low-but-rising levels of urban motorization, economic growth and increasing social and spatial inequalities, the formulation and implementation of policies, practices and partnerships that can support an accelerated implementation of sustainable mobility policies is an urgent concern for rapidly developing cities. The T-SUM project focuses on Maputo, Mozambique, and Freetown, Sierra Leone, with the aim to challenge the traditionally assumed links between economic growth and car-based urban transport, to document the socioeconomic and spatial inequalities stemming from current urban transport systems and to collectively explore with local policy makers the potential benefits of adopting urban sustainable mobility and land use policies.

This paper will focus on Freetown, Sierra Leone, and seeks to contribute to rethinking some of the knowledge and methodologies produced in and about cities of Sub-Saharan Africa, drawing on a comprehensive assessment of accessibility patterns and needs in the city. The paper is framed within the context of issues surrounding mobility transitions and sustainable development, trying to understand the base conditions under which trajectories towards more sustainable mobility can be identified and what role accessibility plays in such trajectories. The study seeks to ultimately produce evidence-based knowledge for informing policy in Freetown and similar cities in Sub-Saharan Africa, expecting to contribute to accelerate sustainable and socially inclusive transport development at the macro, meso and micro scales.

Despite emerging research in the African context, there is limited evidence on the configuration and development patterns of urban transport in sub-Saharan African cities. There are considerable gaps in the documentation and understanding of urban mobility and accessibility. its links with realised and non-realised travel, and the role of walking and the built environment in supporting inclusive and sustainable urban development. By deploying a mixed-methods approach, that builds upon case-study focus groups and city-wide accessibility and mobility analysis, the paper maps travel patterns and their links with structural factors such as urban form, poverty and social identities at the macro, meso and micro levels. The paper also presents evidence of local livelihoods strategies to negotiate access across the urban environment, available formal and informal opportunities and modes of transport, and intersecting social identities that determine specific social positions. Acknowledging that there most approaches and methodologies have been developed in the context of industrialised societies, the paper reflects on the need for conceptual and methodological consensus around current understanding of accessibility in cities of the global south and their potential implications for decision-making and planning processes. Using Freetown as a case study, the paper is constructed with a view to developing and testing methods that could be replicated in similar cities across the Global South.

This paper sits within a larger research interest on the extent to which rapidly growing Sub-Saharan African cities can initiate sustainable urban mobility transitions. In the context of this paper, the concept of sustainable urban mobility transition refers to the capacity cities have to grow within a way that meets the needs of present and future urban citizens while effectively maintaining renewable resources and minimising impacts on non-renewable resources, alongside reducing impacts on global carbon 'sinks'. It is particularly focused on the correlation between GDP per capita and percentage of private motorised modal share (as illustrated in figure 1).



Figure 1. City-level relationships between GDP per capita and private motorised mode share

Source: Teoh (2016) building on data from UITP (1995)

Figure 1 shows city-level relationships, at one point in time (1995), between GDP per capita and the share of trips made by residents in private motorised modes (i.e. car and motorcycle drivers and passengers) in a range of large cities across different continents. From this we can see that there are two distinct trajectories associated with cities of increasing wealth. The upper line shows ever increasing use of motorise modes (up to 90%) with higher income levels, mainly to be found in North American cities; and a lower trajectory where the share of motorised modes peaks at around 55% with GDP per capita of US\$30,000 and then falls to 30% - 40% at higher income levels, most typically in European cities.

African cities such as Freetown are currently to the far left of this graph within the circle, with relatively low GDP and private motorised trips, but beginning to experience a rapid growth in car ownership levels. This means that these African cities are facing long-term choices that need to be made now (either implicitly or explicitly) about which of the trajectories they wish to follow - or, indeed, whether they seek to develop a unique trajectory, learning from the mistakes and successes other cities have experienced.

To help in informing this dialogue, the T-SUM partners have been collecting a wide variety of data about transport and land use. The project has deliberately decided to frame the analysis and debate in a broader accessibility context, in recognition that transport, and land use policies

together affect many of the components that go to make up a decent life - ease of access to jobs, education, health care, etc. Moreover, the Sustainable Development Goals (SDGs) agreed by the United Nations (2015) argue that access is a key part of the targets of human development of the following decade. Such an objective is explicit in goal 11 (Sustainable cities and communities), which includes in one of its targets an aim to "by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, ...with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UN, 2015, p.21). Such a target has an explicit dimension of accessibility, highlighting the role of transport in bridging disparities across social groups and socioeconomic conditions. Moreover, in the global agendas for sustainable urban development embodied by the New Urban Agenda, targets highlight the promotion of equitable access, with emphasis on lowincome and peripheral urban populations to sustainable transport that enables participation in both social and economic activities (UN-Habitat, 2016). Our research is built on the recognition that transport systems and land use patterns co-evolve over time (e.g. high levels of car use tend to promote suburbanisation) - and that policy and planning can intervene to contribute to more sustainable trajectories in this evolution.

We argue for a conceptual transition from mobility to accessibility. Since mobility in traditional transport planning has mainly focused on the fastest movement between two points, we argue that it is more meaningful to focus on accessibility, since accessibility implies the actual ability to reach destinations that are important to living a decent life. Mobility metrics are not very informative in this regard and unlike accessibility, they do not assist in the direct identification of inequality. For example, longer trips could equally signify a disbenefit (e.g. being located far from the nearest hospital) as a benefit (e.g. freedom to explore other parts of the country). Whereas, measures of accessibility are much less ambiguous.

2. Accessibility, equity and sustainable mobility

Accessibility can be understood as "the ease of reaching desired destinations given a number of available opportunities and intrinsic impedance to the resources used to travel from the origin to the destination" (Bocarejo & Oviedo, 2012:143). However, these opportunities and impedances are in a reciprocal relationship with the social position of transport users, and the spatial structure of and distribution of activities in cities (Levy, 2019). In this regard, "access is unequally distributed, but the structuring of this inequality depends inter alia on the economics of production and consumption of the objects relevant to mobility, the nature of civil society (...), the geographical distribution of people and activities, and the particular mobility-systems in play and their forms of interdependence". (Urry, 2007, pp: 17).

One of the main characteristics of transport approaches to sustainability developed in the wake of environmental awareness movements in the early 2000s is that the goal changed from moving vehicles to seeking to move as many people, rather than cars, as efficiently as possible. This is a positive goal as it places people and their mobility at the centre of transport planning. However, it still assumes that "an increase in travel mileage or speed benefits society" (Litman, 2003 p. 29), and although different modes are considered, placing public transport and high-occupancy vehicles (HOV) as feasible solutions, it still prioritises private motorised vehicles (Ibid).

Accessibility appears as a principle for pursuing equity, strongly related to the freedom to move. The accessibility paradigm places access as the goal, not just an element of the transport system; hence, mobility shifts from being an end, to be a means to access desirable opportunities. Therefore, access as a priority became a primary social good that predetermines the benefits of living in an urban area (Martens, 2012; van Wee & Geurs, 2011; Vargas et al., 2017) while mobility became an intermediate good. The analysis of accessibility enables multi-modal assessments that consider, motorised, non-motorized modes and substitutes of transportation, considering the most suitable according to user needs and capabilities. Additionally, land use is taken as fully integrated and with the same importance as transportation systems (Litman, 2003) and sustainability. The individual characteristics or social positions of transport users, such as their intersecting identities related to physical abilities, class, age, gender and ethnicity also emerges as critical to an understanding of accessibility (Jaramillo, Lizárraga, & Grindlay, 2012; Levy, 2013; Vasconcellos, 2014).

Within such a paradigm, (Handy & Niemeier, 1997) reframe accessibility as "the potential for interaction, both social and economic, the possibility of getting from home to a multitude of destinations offering a spectrum of opportunities for work and play", a conceptualisation supported by several authors (Dong, Ben-Akiva, Bowman, & Walker, 2006; JH Farrington, 2007; M.-P. Kwan & Weber, 2008; Oviedo, Levy, & Dávila, 2017; Vargas et al., 2017). Accessibility is determined by the spatial distribution of potential destinations, the magnitude, quality and character of the activities found there and the ease to reach them which is determined by the transportation system, individual characteristics and resources. In this sense, travel costs, travel 'choices' in terms of availability of destinations and modes are essential for determining accessibility. Hence, several authors focus on understanding of how population groups with different socio-economic characteristics, experience differently macro-accessibility (Currie, 2004; Gao, Wu, & Liu, 2010; Guzman, Oviedo, & Rivera, 2017; Halden, 2002; M. Kwan, 1999; Lovett, Haynes, Sünnenberg, & Gale, 2002; Páez, Scott, & Morency, 2012; Schönfelder & Axhausen, 2003; Ureta, 2008).

In policy, the UK Social Exclusion Unit (Social Exclusion Unit, 2012) uses accessibility for evaluating and designing social policy, acknowledging the strategic relationship between transport-related social exclusion and accessibility. Furthermore, building upon transport and equity relationship, an emergent strain relates to transport and social justice (John Farrington & Farrington, 2005; Levy & Dávila, 2017; Martens, 2012). Here the relation between transport disadvantage and poverty is examined, focusing on the transport governance, political ideals and power that define transport trajectories (Titheridge, Christie, Mackett, Oviedo Hernández, & Ye, 2014)

The scales at which accessibility is approached has also evolved across the literature, changing from a focus on the "how", looking at inter-area movement patterns, to a thorough consideration the "who" or "what". As Halden et al. acknowledged, "People and opportunities have been considered within the planning of improved transport only to the extent that the characteristics of the people or the places affect mobility and the demand for travel." (Halden, Jones, & Wixey, 2005, p.3). Within the accessibility paradigm, two other scales of accessibility emerged, that of meso and micro-accessibility (Jones & Lucas, 2012). Meso focuses on the movement at a neighbourhood level, regarding local street network connectivity and permeability by different transport modes, and access by disability groups. The micro-scale focuses on sites relating to the physical(interior) design of vehicles and other transport-related objects, and to individual characteristics and possibilities (Jones & Lucas, 2012). The authors argue that high levels of

accessibility require good performance at all three scales. Building on such definitions, we argue that although 'Accessibility' has various meanings, these can be loosely grouped into three levels as shown in Figure 2.



Figure 2. Scales of accessibility

Source: Own elaboration

Access can be achieved in a variety of ways, such as by travelling from home to a destination, having the good or service delivered to/provided at the home, or in proximity, accomplishing the activity via the web (e.g. watching a film), or using pipes (e.g. water), wires (e.g. electricity) or air waves (e.g. radio) to link people and products. In this regard, we can differentiate between Accessibility and Access, the first being the potential of reachable opportunities and the second the realisation of such potential. Access has several dimensions, including the distance or time involved, the cost of access (both movement and consumption of the product), the availability at different times (of day, season, etc.) and restrictions due to gender, age, class, etc. Geurs and Van Wee (2004) identify four main components in the concept of accessibility: (i) land-use, which refers to the quantity, quality and distribution in space of opportunities such as jobs, shops, healthcare and, social and recreational facilities at destination locations, and the demand for opportunities at origin locations; (ii) transport, which accounts for the features of the transport system expressed in terms of the (dis)utility for an individual to travel between origins and destinations using a given mode of transport; (iii) time, which reflects time constraints

related to both availability of opportunities during the day, and the availability of time for individuals to make use of such opportunities; and, (iv) individual, which reflects the needs, abilities and opportunities of individuals that can influence levels of access to transport and their ability to participate in opportunities. According to these standard relations and components of accessibility, the interactions between the components outlined above produce differentiated levels of accessibility by mode, location, social groups and activity.



Figure 3. Components and relations of accessibility

Source: Own elaboration building on Geurs and Van Wee (2004)

Empirical and conceptual research in rapidly changing urban contexts suggest the need for an expanded definition that accounts for the diversity of experiences of urban mobility for individuals and social groups with different intersecting social identities that might be excluded by virtue of their social position e.g. class, gender, age, ethnicity etc, as well as the potential negative effects of accessibility relations for communities affected by the operation of an imperfect transport system. In this regard, to understand the role of accessibility in the development of specific trajectories for sustainable mobility, it is necessary also to account explicitly for the room for manoeuvre that informality, technology and dynamic relations of power may introduce into each of the components and relations suggested by Geurs and Van Wee (2004). Such expanded understanding and additional considerations are reflected in Figure 3, recognising the complexities associated with the analysis of accessibility in urban environments marked by weak governance and planning structures, and informality in the economy, housing and transport, as well as intersecting social relations and powerful interests that may influence the way in which each component of accessibility is developed and distributed across the city.



Figure 4. Framework linking accessibility and sustainable mobility

Source: Own elaboration

Challenges for cities at different stages of their urban development in relation to transitions to sustainable urban mobility are highly context-dependent and require the definition of a clear set of criteria that categorises cities according to their common features, while opening spaces for the detailed analysis of their unique challenges and features. Building on the main components of accessibility as identified in the literature (see Figure 3) and the conceptual and empirical relations between income and car dependency introduced in section 1, we propose an analytical framework that links sustainable mobility and accessibility as shown in Figure 4. The intention is that Figure 4 could frame collective discussions with policy makers, planners, and citizen representatives engaged with transport planning and provision in the city, to develop future policy and planning that would support the shift to more sustainable trajectories with low PMVU and high accessibility.

In Figure 4, private motorised vehicle use is proposed as a measurable proxy for unsustainable mobility (intensity), while accessibility is understood as the quantity and nature of reachable opportunities for the development and accumulation of social, human and financial capital. The framework enables the analysis at the different scales at which accessibility is manifested. At the local scale, it is possible to analyse neighbourhoods showing different mobility patterns and conditions for access. At the city scale, the framework also enables the positioning of cities with different starting conditions of motorisation and accessibility, using different measures depending on the local availability of data and resources. Furthermore, as transitions are long-term processes, the framework also identifies desirable and undesirable trajectories that can emerge over time at different stages of urban development, with a view to stimulating discussion about possible urban futures.

3. Freetown context

Freetown is the capital of Sierra Leone. This analysis of key trends in the city was drawn from the City Profile developed as part of the T-SUM project (Macarthy et al., *forthcoming*). It is located at 8.48 latitude and 13.23 longitude and is situated at elevation of 49 meters above sea level. Freetown is located on a mountainous peninsular, which is approximately 38 km long and 16km wide, with topographic relief rising to over 700m. The peninsula has a total land area of 357 square kilometres with a coastline of about 40km.



Figure 5. Sierra Leone, Freetown Peninsula

Source: Macarthy et al., forthcoming

3.1. Socio-demographics

With a population of about 1.1 million (approximately 21.1% of Sierra Leone's population), occupying an area size of 74km² which is less than 1 percent of the total land area of Sierra Leone, Freetown is densely settled with a population density of 12,878 persons per km² (Statistics Sierra Leone, 2017). It is expected to rise to 25,000 persons per km² by 2028 (MLCPE&FCC, 2014a). With an annual growth rate of 4.2%, the population of Freetown is projected to reach 2 million residents by 2028 (GoSL, 2014a), accounting for 65% of the total population living in the urban areas of Sierra Leone (Statistics Sierra Leone, 2017). Internal displacement during the civil war (1991-2002) and migration in search of employment opportunities has further contributed to the growth of the city's population (Macarthy et al., *forthcoming*).

Freetown has been unable to provide adequate housing, social infrastructure, and service provision to keep pace with population growth. In the 2015 census, the average number of people per household in Freetown was reported to be 10, compared to a national average of 9 people per household (SSL, 2016). With Freetown having the largest share of households (18.2 percent) in Sierra Leone, growth in the urban population already wields a heavy burden on service delivery in the city. The 2015 census lists 12% of dwellings as impoverished

homes/kiosks or unnamed etc representing the spatial expansion of low-income groups into marginal and vulnerable settlement areas (SSL, 2017).

3.2. Economy

Already, a large share (about 75 percent⁹) of Freetown's population live in informal settlements with the informal economy estimated to provide jobs for as much as 70% percent of the city's population (GoSL, 2015). The service sector accounted for about 33% of the labour force in 2014 (mostly in the capital Freetown), though its contribution to GDP declined from 30% in 2001 to 20% in 2015. More than half of the individuals aged between 15 and 35 participate in the labour force, and 91% percent of these are self-employed (SSL, 2016). Recent studies show that Freetown contributes 30 percent of the country's GDP despite housing only 21.1% percent of its population, indicating the economic potential of the capital city (World Bank, 2018) and has an average annual growth rate (2010-2020) of 4.22% ¹⁰. Table 4 summarises main demographic and economic features of the city.

Demography and economy	Indicators	Additional information
Population	1,055,964	Statistics Sierra Leone 2015
Population density (persons per sq.km)	12,878	Statistics Sierra Leone 2015
Population growth rate (%)	4	Statistics Sierra Leone 2015
Per capita (%)	1.25	World Bank 2018
Contribution to the country's GDP (%)	30	World Bank 2018
Annual growth rate (2010-2020)	4.22	MTNDP 2019
Gini Coefficient	0.32	ADB 2009 ¹¹
Poverty rate %	28.5	SSL, OPHDI and UNDP
		2019

Table 4: Demographic and Economic Indicators, Freetown

Source: ADB, 2009; SSL, OPHDI, &UNDP, 2019; MTNDP, 2019; World Bank, 2018; SSL, 2015

Freetown and other urban areas provide the majority (over 70%) of waged employment in Sierra Leone (MLCPE/FCC, 2014a). In Freetown, 87% of the jobs are in the tertiary sector. The transport sector is the second highest generator of jobs, although more than 85% of them are informal, which puts this group in a vulnerable position (World Bank, 2018). The Freetown Structure Plan (MLCPE/FCC, 2014a) suggest that although the construction sector provides employment for a significant proportion of Freetown's working population, most of these jobs are either informal (72%) or unpaid (8%). The Central Business District is the main commercial centre in Freetown including offices of consulting firms, financial offices, banks and insurance operations (Macarthy et al., *forthcoming*).

⁹ Also, about 25 percent of the Freetown population live in slums

¹⁰ World Urbanisation Prospects: The 2011 Revision, UNDESA, New York 2012

¹¹ African Development Bank, 2009. African Statistical Yearbook 2009. Addis Ababa. Economic Commission for Africa.

3.3. Development trends

Overall, Freetown has a Gini Coefficient of 0.32 based on 2002 data¹². Such degree of inequality can largely be attributed to the measured fall in prosperity in Freetown and by rural areas catching up with urban areas. Similarly, urban poverty in Freetown between 2003 and 2011 increased from x to 31% but has declined in 2019 to 28.5% (World Bank, 2013; SSL, OPHDI & UNDP, 2019:2). This increase was despite an overall decline in urban poverty for the overall country, from 47% to 31% over the same period (World Bank and Statistics Sierra Leone, 2013). The increase in poverty level is driven by economic migrants, moving to the capital city seeking employment, which reflects the low growth of the formal manufacturing and services sector (ibid). Similarly, it is reported that the intensity of poverty in Freetown accounts for the lowest percentage of deprivation among the poor (SSL, OPHDI & UNDP, 2019).

On the other hand, child mortality rates in Freetown is closely linked to poverty, with child malnutrition the main contributing factor of most deaths within the municipality. The prevalence of communicable diseases such as HIV/AIDS, tuberculosis, and malaria kill many people in the municipality. Access to education and health facilities differ significantly, and there remain pockets of low accessibility near the city Centre. Only 30% of households have access to improved sanitation compared to 40% regionally and around 19% of the population practice open defecation. 75% of Freetown inhabitants have access to an improved water source compared to more than 86% on average in sub-Saharan urban areas. Only 27% of the communities living in unplanned and informal development have access to proper waste collection services. The lack of efficient collection sources contributes significantly to flood risk, with discarded waste blocking channels. Poor health service delivery is indeed a very serious constraint in the City.

3.4. Transport features

Rapid population growth in Freetown has caused increasing pressure on the existing transport systems. Limited, poorly maintained roads, and the uncontrolled expansion of private and informal public transport, street trading, and inefficient traffic management, the city is experiencing high levels of congestion and poor conditions for basic access. Uncontrolled parking is a compounding issue, with formal passenger collection points either not observed (due to poor enforcement) or not clearly defined leading to circulation of problems at the main interchanges and terminals in the city. In addition, there is poor condition for pedestrians as a result of blocked walkways and damaged or non-exiting pavements.

The city is grappling with not only limited available land space for residential development, but also requires an increasing share of urban land for road infrastructure development as majority of inhabitants rely on motorized transport. Recent estimates suggest that only 5 percent of total land in Freetown is allocated to roads, of which only 24 percent are paved compared with regional benchmarks of 10 percent and 50 percent respectively (DFID, 2018). In the Western Area, road density per capita is about 165 meters of paved road per 1000 citizens in the Greater Freetown Area, which is around half of the average in low-income African countries (318m/1000 people) (AfDB, 2014 ; World Bank, 2018). The poor quality of the road network or narrow roads with large use of private cars, and a poor public transport service, considerably hinders accessibility within the city. Mobility is also impacted by lack of sidewalks, which if

¹² Gui, 2009. Global Urban Indicators – Selected Statistics Monitoring the Habitat Agenda and the Millennium Development Goals, Global Urban Observatory. November 2009.

they exist are usually occupied by parked vehicles or traders. This would not only bring about congestion of the roads but also traffic safety hazard. In the 2019 report, paved roads in Freetown have been modelled average replacement value of US\$341,700km, in contrast to the reported unpaved roads of US\$52800/km (World Bank, 2019). The report identifies three main routes of paved roads within Freetown: along the western coast of the peninsula through Hamilton, Goderich and up towards Aberdeen; through Hastings and through the centre of the peninsula through Charlotte and Regent; and along the eastern coastline of the peninsula from Hastings up through Congo Water II and towards Cline Bay (ibid). In Freetown, the paved road network becomes more intricate and is cross-cut by unpaved roads connecting roads.

The private sector is the major supplier of transport services in Freetown, accounting for almost 85% of the market share (World Bank, 2018). Limited institutional capacity for planning and delivery of public transport services has created gaps in the market that unregulated private transport service have filled. They are primarily provided by the informal sector, largely through a mix of a few full-sized buses, poda-podas (minibuses), shared taxis operating on fixed routes, kekeh (three-wheelers) and okadas (motorcycles). Though these services provide an essential means of mobility across the city, their low capacity and irregular stops mean that they contribute significantly to congestion. Furthermore, citizens with physical and cognitive disabilities are challenged in terms of basic mobility in and out of the street, with inaccessible infrastructure and a large share of buildings with no design consideration for such population groups.

4. Methods and Data

This paper seeks to build a critical examination of urban mobility, urban structure and land-use developments and related socio-economic, cultural and environmental issues at the city level and in selected localities with a focus on multi-factoral understanding of accessibility, as shown in Figure 4. The paper uses spatial and historical quantitative and qualitative analysis to assess the role past and contemporary transport and urban policy, planning and governance have influenced conditions for access across Freetown and their implications for sustainable mobility transitions. We build on various secondary data sources to conduct analysis of mobility, accessibility, urban structure and land-use. Moreover, we develop qualitative analysis of primary data produced by the T-SUM project, including semi-structured interviews with selected policy-makers and stakeholders and Focus Groups with residents in selected contrasting neighbourhoods using the criteria outlined in Figure 4, and policymakers to inform analysis of distributional impacts.

4.1. Interviews and Focus Groups

This paper draws on the thematic analysis of qualitative data. Between 30-04-2019 and 11-05-2019 semi-structured interviews were undertaken with key stakeholders in Freetown. In total, 26 participants were interviewed representing 21 organisations at the local, national and international level and across sectors. This included senior representatives of various national ministries (e.g. Ministry of Transport), the local authority, international donor organisations, Non-Governmental Associations, and private operators. The interviews aimed to assess accessibility, mobility and land-use issues in Freetown. Amongst other themes addressed, participants were asked to identify the biggest challenges in Freetown, linked with mobility and land-use.

In addition, focus groups involving a representative sample of residents were organised in 4 different neighbourhoods shown in Figure 6, involving a total of 57 participants. The four

neighbourhoods illustrated in the map below were selected based on the following accessibility criteria:

- 1. South Ridge: Mixed neighbourhood with different income, relatively high motorisation in the high-income segment
- 2. Brookfields: middle, middle-high income close to the city centre, larger-than-average motorisation
- 3. Moyiba: hilltop neighbourhood of very low-income, poor roads and challenging topography. Mostly informal housing development.
- 4. Cline Town: low middle-low income neighbourhood, closer to the city centre than (1) and (2)

The focus groups aimed to raise evidence on three areas of accessibility and mobility related to people's (i) behaviours and practices, (ii) rationales and motivations, and (iii) expectations and suggestions related to policy and practice.





Source: Own elaboration

4.2. Using WhatsApp to map Informal Transport

One innovation in our methodology is the use of *Small* and *Big Data* interdependently, defining the first as qualitative and targeted quantitative and spatial information that, despite not having a large sample size can shed light on issues not previously explored. Small Data, as used in this project, seeks to build seed information that can be later scaled up by local and global actors with larger resources. Additionally, we aim at defining collaborative approaches to the understanding of urban accessibility through the combination of Small Data and larger datasets from innovative sources.

Building on these ideas, we collected information from semi-structured interviews with stakeholders in local government and representatives from the Okada and Kekeh Associations in Freetown. Such qualitative interviews and information shared by the Associations was utilised as the basis for the co-production of maps of semi-formal transport modes presented in section 5. The team used the geo-location feature of the WhatsApp to create a protocol that could lead to map hubs of motorcycle taxis and rickshaws across Freetown with the participation of both researchers and residents trained as research scientists. The main features of the method are as follows.

- Co-Production approach: Participants as citizen scientists
- Initial locations of Kekeh and Okada hubs obtained from qualitative research
- Geolocation of hubs using WhatsApp with small groups of researchers and citizen scientists
- Definition of selection criteria of mapping points
- Collection of text, location and photographic registry of each point
- Developing an algorithm to automate location of WhatsApp in R
- Testing and confirmation of initial map with operators and Associations
- Joint definition with users and operators of pilot locations for affordability test
- Development of risk assessment and risk protocols
- Design of a data collection protocol with participants
- Collection of 120 WhatsApp-registered trips between 6 test locations
- Geographic and content analysis of data
- Construction of affordability indices and maps

4.3.Accessibility

We use available information for the city of Freetown to translate the main features of the framework in Figure 3 to the empirical reality of the city. We utilize a variety of data sources and proxies from open-source and planning data facilitated by project partners to capture to different degrees the different scales and factors driving accessibility. Below is a summary of main sources of information and forms of analysis applied through the paper.

- Land-use assessment open data: we build on data from Open Street Maps (OSM) and local assessment of opportunities by the Freetown City Council (FCC) and the World Bank to build a dataset of relevant opportunities that serve as a base for the accessibility analyses. We also use the most recent data of population from WorldPop (2019).
- Location-based accessibility to employment/main travel attractors: We build on information collected by the World Bank from a local phone operator to identify the main trip attractors across Freetown. The dataset includes over 50,000 data points collected across a month in 2018. Using this information in combination with Freetown's General Transit Feed Specification (GTFS) we apply the accessibility metric summarized in Equation 1 to estimate location-based accessibility within 15-minutes thresholds between 0 and 120 minutes (Brussel et al., 2019). The GTFS defines a common format for public transportation schedules and associated geographic information. GTFS "feeds" let public transit agencies publish their transit data and developers write applications that consume that data in an interoperable way (Google, 2019).
- Location-based accessibility metrics for health and education facilities: The team built on open datasets from (OSM) regarding administrative boundaries, the road network and some land-uses to build an initial accessibility model to opportunities of health and

education. OSM data was depurated and complemented using field-collected data from the World Bank and the FCC. Using such information, population and the GTFS, we apply Equation (1) to estimate accessibility within thresholds between fix travel time intervals.

$$\begin{split} A_{i\delta} &= \frac{\sum_{y} \varphi(t_{yi\delta})}{Y_{i\delta}} \\ & \varphi(t_{yi\delta}) \\ &= \begin{cases} 1 \; ; \; if \; T_l \leq t_{yi\delta} \leq T_u \\ 0 \; ; \; otherwise \end{cases} \\ \delta &= mode \; combination \qquad \text{Equation (1)} \end{split}$$

• Supply-based accessibility metrics for public transport stops and infrastructure: This metric builds on the same datasets as previous analysis and estimates the population within different distance thresholds from the routed public transport illustrated by the GTFS dataset.

4.4. Participatory policy workshops

In order to discuss future sustainable trajectories and supporting policy and planning, participatory workshops are planned in Freetown with the the guidance and support of a Steering Committee made up of central government and municipal officers, community representatives and university lecturers. The workshop content is built upon accessibility and mobility assessments, as well as conceptual developments in the T-|SUM. The first of these workshops was held in Freetown in December 2019. The aim is to gather a range of key government stakeholders and citizen representatives to discuss mobility issues and co-design solutions for each city, from the agreement of a vision for sustainable urban mobility, to the analysis of policy instruments and practical implementation. In this way, this policy-focused research seeks to provide collective spaces of reflection for the context-specific co-production of insights for decision-making and policy formulation.

5. Findings

5.1. Coverage and access to public transport



Figure 7. GTFS routes by modes

Source: Own elaboration

Conventional public transport modal share has been disrupted in the last few years by the exponential growth of okadas and kekehs. The growth is fuelled by high youth unemployment, low barriers of entry (low upfront cost) and time saving as vehicles are able to navigate through the traffic in congested areas. Furthermore, in the context of cities with a limited paved road network, okadas and kekehs offer the only motorized option for many citizens to access their home in unpaved hilly areas. These highly inaccessible areas can be identified in Figure 7, where a 500-meter radius is plotted around public transport stops (SLRTC, poda poda and shared taxis routes). Middle- and low-income household that do not have access to private vehicles in areas such as Goderich, Gbendembu, Tangbeth Town and area parallel to Bai Bureh Road, depend on okadas and kekehs as the only motorized option to access jobs and social services.



Figure 8. Highly inaccessible areas by fixed-route modes – SLRTC, poda poda and shared taxis

Source: Own elaboration

Although two and three-wheelers are the only motorized alternative for several areas in Freetown, low income households cannot afford them in many cases and opt for walking long distances or staying in limited areas within their neighbourhoods. It is estimated that the ratio of average cost per okada trip for a household with the minimum wage for commuting is 18% compared to modes with fixed routes (SLRTC, poda poda and shared taxis) where the ratio is 12%.

5.2. Accessibility by collective transport

Building on the analysis of coverage of routed public transport, we developed analysis of how accessibility levels to different opportunities for economic, social and human capital development and accumulation distribute across Freetown. We analysed patterns of attraction of trips using mobile phone data, as well as existing datasets for land use to estimate a cumulative accessibility index for different thresholds of time using routed public transport as reflected by the city's GTFS.

We examine accessibility first to motorised collective transport as potential inaccessibility in specific parts of the city can lead to double marginalisation: by exclusion and vulnerability and exposure to higher risks and externalities associated with the use of other forms or transport or over-reliance on walking for long distances to gain access to essential opportunities. Moreover,

accessibility analysis is relevant in a context such as Freetown as, in the face of limited technical and financial capacity, it may contribute to incremental planning and transitional actions.

These analyses are relevant to quantify and spatialise the distribution of access analysis needs across geographies and population groups, which are required to inform detailed assessment of distributional issues. The first analysis, shown in Figure 9 is the distribution of access to the main travel attractors in the city, which are a proxy for economic activity. The distribution of levels of accessibility to the monocentric distribution of trip attractors within a threshold of 15 and 60 minutes. As it can be observed, there is a minority of the population of Freetown that can secure access to the main areas of activity in 15 minutes of less. However, as shown in the bottom part of Figure 9, even within a threshold of 60 minutes, the limited supply of routed public transport services combined with a unidirectional pattern of travel towards a spatially concentrated centre of opportunities, makes a large share of the urban population in the peripheries and hilly parts of Freetown disconnected from the main travel attractors. Estimations of accessibility at 2.5 hours still leave nearly 8% of the population with no access to at least a fraction of trip attractors in the city, signalling high levels of disconnection in areas where routed public transport cannot operate.



Figure 9. Accessibility to main trip attractors in Freetown at 15 minutes (above) and 60 minutes (below)

Source: Own elaboration

Figure 10 shows the analysis of accessibility to opportunities for primary and secondary education, building on information from the Freetown City Council about public and private schools throughout the city. The recent education policy in Sierra Leone has led to an increase in investment in development and rehabilitation of school facilities across the city, which is reflected on the coverage of opportunities in most parts of the city. As shown in the upper side of Figure 10, around 50% of the population in Freetown has access to at least one school within 15 minutes by routed public transport and over 90% of the population can access at least one school within an hour. Although this speaks well about the coverage of opportunities, the map of the 60-minutes threshold still reflects inequalities in the distribution of access as well as areas of the city that remain disconnected. Moreover, considering that average income in Freetown is very low and most of the economy is informal, disposable resources to pay for motorised public transport are likely to be restricted to those in an economic activity, which may lead to many children not being able to access education despite a comparatively good coverage. In addition, the capacity of schools is limited in relation to the demand, which will lead to competition and increasing travel distance to access education that is not reflected by this accessibility metric.



Figure 10. Accessibility to School opportunities in Freetown at 15 minutes (above) and 60 minutes (below)

Source: Own elaboration

Figure 11 shows the analysis of accessibility to health facilities in the city. The distribution is similar to that observed for the main trip attractors in the city, reflecting a lower supply of

facilities in different parts of the city. Nonetheless, the availability of health facilities is sufficiently comprehensive for 90% of the population to access at least one opportunity within the 15-minutes threshold and to achieve that 100% of the population can access at least one facility within one hour by motorised routed public transport. These findings encapsulate the relevance of analysing transport in the context of the land use and population distribution of cities, highlighting the various isles of inaccessibility that can emerge in relation to different opportunities. As shown in Figures 9 to 11, peripheral settlements in Freetown, which also tend to be of low income and informal origin, are the most disadvantaged in relation to access to centres of economic activity, education and health, essential opportunities to overcome poverty and social disadvantage. In some cases, particularly in the eastern part of the city, disconnected areas from opportunities correspond to newly development land by higher-income groups that take advantage from available supply of infrastructure to gain access by car. This entails an implicit injustice as the socially vulnerable areas with low accessibility are forced to either not achieve access to essential opportunities or doing so at an unaffordable cost in terms of money. By the same token, given the distribution of road infrastructure connecting most areas of higher income as well as new developments, higher-income groups with access to private vehicles can overcome the potential inaccessibility left by the limited coverage of routed public transport through the use of private cars and motorbikes, which not only pose a larger social cost in terms of pollution and congestion but also represent a higher risk for pedestrians and cyclists, which tend to be mostly lower-income populations.



Figure 11. Accessibility to Health facilities in Freetown at 15 minutes (above) and 60 minutes (below)

Source: Own elaboration

5.3. Transport disadvantage and the semi-formal response

In the face of the potential disconnection and inaccessibility resulting from limited supply of routed public transport services, we developed the protocol described in section 4.2 to determine the coverage of non-routed public transport provided by Okadas (Motorcycle-taxis) and Kekehs (Three-wheelers). To this end, the team mapped all hubs of operation of these modes of transport using WhatsApp, finding 124 points across Freetown where these operators agglomerate to take and leave passengers. Figure 12 summarises the findings of the mapping exercise and the analysis of spatial coverage of the population in Freetown.



Figure 11. Coverage of Okadas and Kekeh: Distribution of hubs (left) and population coverage (right)

Source: Own elaboration

As shown in Figure 11, public transport services supplied by two and three-wheelers increase considerably access to motorised transport for the majority of the population in Freetown. 77% of the population can access an Okada or Kekeh hub within 1,000 m, which is still an acceptable walking distance, while at nearly 50% of the population can do so within 500 m. Even in areas characterised by disconnection and low degrees of accessibility by routed public transport, the evidence shows a good degree of availability of unrouted services. This suggests a much higher degree of flexibility and adaptability of these services to the challenges of the topography and infrastructure as well as a more rapid response to new land developments, which require some degree of public transport supply even in areas of higher income and high private motorisation. This is a very important finding for Freetown, as no spatial inventory of these services has been carried up to date.

5.3.1. What are the effects of Okada and Kekehs on affordability and social disadvantage?

The methodology for mapping hubs of Okadas and Kekehs was expanded to a small sample of trips conducted by citizen scientists between 6 pilot stations to test affordability assessments of unrouted paratransit modes. The team co-produced the evidence with participants from previous data collection exercises, obtaining information about origins and destinations, fares, travel times and negotiation approaches and outcomes at different times of the day and for users with different social identities of gender, age, etc.



Figure 12. Affordability curves for Kekeh: Charged price (above) and Paid price (below)

Source: Own elaboration

Figure 12 shows the findings for the 6 pilot stations of charged and paid prices in three-wheeler services to and from each selected point. The result are iso-cost curves for different parts of the city, which can go from 2,000 Le (USD\$0.21) up to 4,000 Le (USD\$0.41). For reference, the average cost of routed public transport is Le 1,500, which is considerably lower than the most expensive trip registered by three wheelers. Results in Figure 12 complement the findings in sections 5.1 and 5.2 as they reflect cheaper travel conditions to the city centre where a higher density of both supply and demand concentrates, while areas with lower coverage of both infrastructure and routed services tend to be more expensive. In addition, as shown in the bottom part of the figure, the ability of users to negotiate the price in these less-regulated services can contribute to the increase in affordability of certain trips and the homogenisation of travel cost for specific destinations. However, the ability to negotiate is determined by the social position of users, which translates into inequalities for specific social groups in the access to reduced price.



Figure 13. Affordability curves for Okada: Charged price (above) and Paid price (below)

Source: Own elaboration

Figure 13 summarises the findings of the analysis for Okada services. It reflects a similar trend to the one observed in Figure 12. However, as shown, there are less differences between charged and paid prices, which suggests less willingness to negotiate by operators and/or users. In addition, higher prices are observed in areas highlighted as less accessible in previous analysis, particularly in the south-east of the city.

This analysis responds to all drivers of accessibility in Figure 2 as it also considered seasonality of pricing driven by special conditions such as peak times and dry/rainy seasons. Findings from citizen scientists suggest strong gendered differences between amount charged and amount paid and the willingness to negotiate by operators, who tend to provide lower prices for men than women, particularly young women. Moreover, participants repot longer waiting times in specific periods to access a vehicle both in areas of high demand and areas with lower coverage during peak times, suggesting a negative effect of the demand-responsive pattern of operation

of such services. The changes in service conditions respond not only to the availability of other forms of public transport at origin and destination. Observations by participants suggest an observable influence of the state of infrastructure on pricing as drivers tend to charge more for areas they are aware the road is not paver or the topography is more challenging, adding an additional level of complexity to the affordability of unrouted paratransit.

This is compounded by lower availability of supply for specific destinations, as drivers tend to reject trips to areas where they perceive it will be more difficult to get a passenger on the way back. Regarding the temporal dimension of accessibility, other relevant factors to consider are the strong differences in price between morning and afternoon peak, with the first being more expensive.

5.4. How do people deal with their different alternatives to negotiate access?

Findings from the quantitative and spatial analysis of accessibility are confronted with insights distilled from one of the focus group discussions conducted as part of the project. We selected South Ridge, a mixed-income neighbourhood challenged by hilly topography and limited coverage of infrastructure and collective transport services. Such neighbourhood is interesting as it simultaneously shows increasing local traffic derived from growth in private motorisation in the neighbourhood's rising higher-income population. The focus group involved 10 participants between 17 and 63 years and with a gender proportion 6 to 4 Women-Men.

Among some of the main findings from the focus group are the awareness of distributional effects of transport and accessibility in the neighbourhood by residents. Participants identified lower accessibility for lower-income residents from the same neighbourhoods, as well as particular social groups that may become marginalised by lack of access to transport and opportunities. Some examples include breastfeeding women, elderly and children, who tend to remain in the neighbourhoods given lack of appropriate supply and limited disposable income to travel. More vulnerable groups and lower-income users tend to walk more and to make trade-offs between walking and Okadas and Kekehs at different times of the day.

Moreover, residents from South Ridge also highlighted that observed levels of accessibility come at a steep price for many residents in the form of higher exposure and risk to secure access at local and city-level to basic opportunities. In response to such risks, residents highlight the role of the informal sector in contributing to higher access to relevant goods and services. Such contribution is not only in terms of the increase in transport options, but also there is an active informal economic activity that brings goods and services to the neighbourhood via itinerant vendors and service providers (e.g. clothes, agricultural produce, plumbing, electrician).

When interrogated about the sustainability implications of their current level of access, residents are aware of their high dependency on motorised and low-occupancy transport for accessibility. In this line, there is also a perception by non-car-users that the higher income groups have contributed to the detriment in quality of available infrastructure without participating in the development of community initiatives for improving connectivity or local availability of opportunities. This neighbourhood presents an interesting case of community-developed infrastructure in the form of a small bridge built by earlier residents of the neighbourhood. Although there is recognition of the bridge's value for connecting the neighbourhood and improving accessibility, resident suggest that the construction of the bridge also opened access to higher-income car users who started using the newly connected roads for reducing their travel time, damaging the bridge and increasing traffic-related exposures to

neighbours of these roads. Figure 14 summarises the most frequent points raised by participants categorised under the main factors of accessibility identified in the framework in Figure 2.



Figure 14. Highlights from South Ridge Focus Group for different dimensions of accessibility

Source: Own elaboration

6. Conclusions

This paper summarises the results of a multidisciplinary research centred of accessibility in a case that has not been frequently explored in the transport literature focusing on Sub-Saharan Africa. The paper proposed conceptual, methodological and empirical innovations associated with the understanding of accessibility in a context of mobility transitions in Freetown. One of the main highlights of such incremental analysis, is that issues related to sustainable urban mobility transitions in Sub-Saharan African cities should be addressed using relevant accessibility conceptual frameworks and methods, to ensure that inequality issues are adequately tackled.

The paper also highlights the need to produce information to examine the effect of informality on access to employment when approaching accessibility as an instrument for planning and decision-making. Such information needs to encompass different scales and degrees of depth and complexity, which suggests the need for qualitative as well as quantitative data in addressing current and future accessibility practices. The challenge of georeferencing information is favored with tools such as WhatsApp. The pilot exercise showed in this paper suggests that the use of relatively common technologies in a participatory fashion expands collection and management capacities for quantitative and spatial data and use of results by groups beyond expert-led circles of policy and practice.

Our findings from both the mapping and focus group exercises also suggest that practitioners and communities have a deep spatial awareness and a better understanding of their city and its geography than traditionally recognized. In this regard, greater levels of community participation would imply new opportunities for implementing data collection strategies such as the ones outlined in this document combined with other techniques such as workshops, tours and photovoice. These will contribute to a better understanding of people's everyday experiences, as well as greater levels of participation of citizens in urban planning decisions.

The findings of the various analyses of accessibility suggest that inaccessibility leads to double marginalisation. On the one hand, inaccessible areas and population groups suffer from exclusion from opportunities for the development and accumulation of economic, social and human capital. On the other hand, as reflected by residents in South Ridge, the lack of sufficient access combined with inequalities in the use of road space and infrastructure lead to vulnerability and exposure to environmental risks and externalities, particularly for more vulnerable social groups.

In the face of limited technical and financial capacity, there is a need to develop incremental planning and transitional actions informed by comprehensive, evidence-based understandings of accessibility in its different scales. Accessibility analysis needs to inform detailed assessment of distributional issues, targeting of policies and optimisation of resources. Such type of analysis, which can be communicated and interpreted in a myriad of formats, is relevant to foster collective debate amongst policy makers, planners and citizen representatives. Such debates are of essential relevance for the co-production of a city vision and future policy directions rooted in improving accessibility while decreasing car dependency and promoting more sustainable use and distribution of land. The construction of collective deliberative spaces is essential in translating research into practice. In this regard, it is important to acknowledge that a number of African cities ae at a similar point in the transition than that observed in Freetown. We are therefore at a critical moment for wider consideration of the relevance and use of the findings and methodological learning in Freetown, and its extension not only to Maputo as the other case in the T-SUM project, but other cities across the region that are likely to be facing similar challenges and can have similar or more adequate conditions to test our methods and analysis.

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